STATE OF MISSOURI
PUBLIC SERVICE COMMISSION

At a session of the Public Service Commission held at its office in Jefferson City on the 5th day of December, 2018.

In the Matter of Union Electric Company d/b/a Ameren Missouri's 3rd Filing to Implement Regulatory Changes in Furtherance of Energy Efficiency as Allowed by MEEIA	))))	**File No. EO-2018-0211**

ORDER APPROVING STIPULATION AND AGREEMENT AND GRANTING WAIVERS

Issue Date: December 5, 2018 Effective Date: January 4, 2019

The Commission is approving the stipulation and agreement addressing Union Electric Company d/b/a Ameren Missouri's ("Ameren Missouri") Missouri Energy Efficiency Investment Act ("MEEIA") Cycle 3 plan.

On June 4, 2018, Ameren Missouri filed its application for approval of its proposed MEEIA Cycle 3 Plan. A procedural schedule was approved by the Commission and certain parties submitted pre-filed rebuttal and surrebuttal testimony. On October 25, 2018, Ameren Missouri, the Staff of the Missouri Public Service Commission, the Office of the Public Counsel, the Missouri Department of Economic Development -- Division of Energy, Consumers Council of Missouri, Renew Missouri Advocates d/b/a Renew Missouri, National Housing Trust, and Tower Grove Neighborhood Community Development Corporation (collectively referred to as the "Signatories") filed a *Stipulation and Agreement* purporting to resolve all the issues in this matter. Attached to the *Stipulation and Agreement* was the *Revised Ameren Missouri's 2019-21 Energy Efficiency Plan* and associated appendices. On

November 28, 2018, the Commission held an on-the-record presentation regarding the agreement.

Commission rule 4 CSR 240-2.115(2)(B) allows nonsignatory parties seven days to object to a nonunanimous stipulation and agreement. That same rule allows the Commission to treat the non-unanimous stipulation as unanimous if no party timely objects. More than seven days have elapsed since the Signatories filed the stipulation and agreement, and no party has objected. Thus, the Commission will treat the stipulation and agreement as unanimous.

The Commission has reviewed the stipulation and agreement including the *Revised Ameren Missouri's 2019-21 Energy Efficiency Plan* and its appendices,[1] finds them reasonable, and will approve them. The Commission incorporates the provisions of the *Stipulation and Agreement* and the *Revised Ameren Missouri's 2019-21 Energy Efficiency Plan* into this order as if fully set forth herein and directs the parties to comply with its terms.

Additionally, as part of its application, Ameren Missouri requested waivers from several Commission rules. The Signatories agreed that the waivers should be granted as follows.

a. Rule 4 CSR 240-20.094(4)(I)3 – This rule states, in relevant part, that the Commission can approve demand-side programs or program plans that it finds have met the filing and submission requirements of the MEEIA rules and "[a]re included in the electric utility's preferred plan or have been analyzed through the integration process required by 4 CSR 240-22.060 to determine the impact of the demand-side program

[1] Together, the *Stipulation and Agreement*, the *Revised Ameren Missouri's 2019-21 Energy Efficiency Plan,* and its appendices are referred to as the "MEEIA 2019-2021 Plan."

and program plans on the net present value of revenue requirements of the electric utility." While the 2017 Integrated Resource Plan (IRP) preferred resource plan does include analyses of demand-side resource options, those analyses were based on the best information available at that time. The Signatories agree that good cause exists to waive this rule provision because requiring the revision of the 2017 IRP preferred resource plan analyses to accommodate this filing does not warrant the time and effort that would be required to complete that revision.

b. Rule 4 CSR 240-20.094(2) – This rule prescribes guidelines to review progress toward the expectation that an electric utility's demand-side programs can achieve a goal of overall cost-effective demand-side savings. However, the rule expressly states that the prescribed guidelines are not mandatory and no penalty or other adverse consequence will result if a utility is unable to achieve annual savings goals specified in those guidelines. In order to eliminate any confusion regarding whether Ameren Missouri's MEEIA 2019-2021 programs are required to meet those "soft" goals related to kWh and kW load reductions, Ameren Missouri seeks a waiver of this rule. As an alternative to granting this waiver, the Signatories stated that the Commission could include a statement in its final order approving the MEEIA 2019-2021 Plan that Ameren Missouri will not be penalized in any way if it fails to meet goals expressed in the rule's guidelines. This Commission's decision is not binding on a future Commission and the Commission cannot make declaratory orders regarding future facts, so the Commission will grant the waiver rather than make a declaratory statement as suggested by the alternative request.

c. Rule 4 CSR 240-14.030(3) – This rule states, in relevant part, that an electric utility is prohibited from implementing any new promotional practice until after a tariff related to that practice has been filed with the Commission. The MEEIA 2019-2021 Plan anticipates Ameren Missouri will be required to change certain elements of its promotional practices – most notably incentive payments – to reflect marketplace changes. Requiring Ameren Missouri to file tariffs before such changes can be implemented would be burdensome and would prevent Ameren Missouri from quickly addressing conditions the promotional practice changes were designed to address. A waiver of this rule is necessary to give Ameren Missouri administrative flexibility necessary to timely address marketplace changes.

The Commission has reviewed the waiver requests and finds that good cause exists to grant the waivers of 4 CSR 240-20.094(4)(I)3, 4 CSR 240-20.094(2), and 4 CSR 240-14.030(3) for purposes of this filing and Ameren Missouri's MEEIA 2019-2021 Plan.

THE COMMISSION ORDERS THAT:

1. The *Stipulation and Agreement* including the *Revised Ameren Missouri's 2019-21 Energy Efficiency Plan* and its associated appendices filed on October 25, 2018 and attached hereto are approved. These documents, known as the "MEEIA 2019-2021 Plan," are incorporated into this order by reference as if fully set forth herein. The parties are ordered to comply with the provisions of the MEEIA 2019-2021 Plan.

2. Union Electric Company d/b/a Ameren Missouri is granted waivers of 4 CSR 240-20.094(4)(I)3, 4 CSR 240-20.094(2), and 4 CSR 240-14.030(3) for purposes of this case and Ameren Missouri's MEEIA 2019-2021 Plan.

3. This order shall be effective on January 4, 2019.

BY THE COMMISSION

Morris L Woodruff

Morris L. Woodruff
Secretary

Silvey, Chm., Kenney, Hall,
Rupp, and Coleman, CC., concur.

Dippell, Senior Regulatory Law Judge

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Union Electric Company d/b/a Ameren Missouri's 3rd Filing to Implement Regulatory Changes in Furtherance of Energy Efficiency as Allowed by MEEIA.	))))	File No. EO-2018-0211

STIPULATION AND AGREEMENT

COME NOW Union Electric Company d/b/a Ameren Missouri ("Ameren Missouri" or the "Company"), Staff of the Missouri Public Service Commission ("Staff"), the Office of the Public Counsel ("OPC"), Missouri Division of Energy ("DE"), Consumers Council of Missouri, Renew Missouri Advocates d/b/a Renew Missouri, National Housing Trust, and Tower Grove Neighborhood Community Development Corporation, (collectively referred to as "Signatories"), and submit this *Stipulation and Agreement* ("*Stipulation"*) for approval by the Missouri Public Service Commission ("Commission"). All parties to this proceeding have either signed this *Stipulation* or have indicated they will not oppose this *Stipulation*.[1]

In support of this *Stipulation*, the Signatories respectfully state as follows:

BACKGROUND

1. On June 4, 2018, Ameren Missouri filed its *Application to Approve DSIM and Demand-Side Management Portfolio and Plan, Request for Variances, and Motion to Adopt Procedural Schedule,* ("*Application*") together with a report, including associated appendices, entitled, *Ameren Missouri's 2019-24 Energy Efficiency Plan* (the "*Report"*) in this case under the Missouri Energy Efficiency Investment Act ("MEEIA") and the Commission's MEEIA rules for

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[1] Midwest Energy Consumers Group, Natural Resources Defense Council, Kansas City Power and Light Company, KCP&L Greater Missouri Operations Company, and Spire Missouri, Inc. have indicated that while they are not Signatories to *Stipulation*, they do not oppose its approval.

approval of its proposed MEEIA Cycle 3 plan. Notice of the *Application* was given and numerous parties intervened in the proceeding. An Amended Procedural Schedule was approved by the Commission on August 1, 2018, under which certain parties submitted pre-filed rebuttal and surrebuttal testimony, and a five-day evidentiary hearing was scheduled to begin on October 15, 2018.

2. After the submission of pre-filed testimony in this case, the parties conferred to see if an agreement could be reached in order to provide an appropriate resolution to this matter. This *Stipulation* reflects the results of those efforts, and presents the Commission with a third cycle of MEEIA programs that will allow Ameren Missouri to continue to promote demand-side programs, including energy efficiency and demand response programs. As described in more detail in the *Revised Ameren Missouri's 2019-21 Energy Efficiency Plan* (the *"Revised Report*"), its associated appendices, and this *Stipulation* (collectively, "MEEIA 2019-21 Plan"),[2] the Signatories recommend that the Commission approve the MEEIA 2019-21 Plan, a high-level summary of which follows:

- The low-income programs available under the MEEIA 2019-21 Plan will be implemented over a nearly six-year period (70 months), from March 1, 2019, to December 31, 2024.
- All other programs offered under the MEEIA 2019-21 Plan will operate over a nearly three-year period (34 months), from March 1, 2019, to December 31, 2021.
- The 34-month portion of the MEEIA 2019-21 Plan (which includes the first 34 months of the low-income programs) will operate on a budget of approximately $195 million.
- The MEEIA 2019-21 Plan will consist of the demand-side programs shown in the following table:

[2] The Revised Report supersedes and replaces the original *2019-24 MEEIA Energy Efficiency Plan* document and its associated appendices filed June 4, 2018.

Low-Income Programs	Residential Programs	Business Programs
Multifamily Low-Income Single Family Low-Income Business Social Services	Appliance Recycling Efficient Products Energy Efficiency Kits Home Energy Reports HVAC Lighting Multifamily Market Rate Demand Response Residential Education	Custom New Construction Retro-Commissioning Small Business Direct Install Standard Business Demand Response Business Education

3. In light of the foregoing, the Signatories to this *Stipulation* agree to the following terms and conditions.

SPECIFIC TERMS AND CONDITIONS

4. Complete Settlement of the Case.[3] As a result of extensive settlement discussions, the Signatories have agreed that implementation of the MEEIA 2019-21 Plan attached to this *Stipulation*, on and subject to the terms and conditions set forth herein, constitutes a full and final resolution of all issues in this case. This MEEIA 2019-21 Plan is solely the result of compromise in the settlement process for this matter and does not serve as precedent beyond this *Stipulation*.

5. Approval of Plan. Subject to the terms and conditions contained herein, the Signatories recommend the Commission grant approval for Ameren Missouri to implement a third cycle of demand-side programs ("MEEIA Programs" or "Programs") and the Demand-Side Investment Mechanism ("DSIM") as described in the *Revised Report*, and in light of the additional agreements contained in this *Stipulation*. The following table summarizes revisions made to the original appendices, as reflected in the appendices to the *Revised Report*:

[3] Unless otherwise specifically defined, the terms used in this *Stipulation* are defined in the Commission's MEEIA rules, specifically 4 CSR 240-20.092.

Appendix	Rationale
Appendix A: Summary Tables	Revised to reflect agreements reached by the Signatories
Appendix B: Program Templates	Revised to reflect agreements reached by the Signatories
Appendix C: Avoided Costs	Only revised to reflect new MEEIA 2019-21 Plan title.
Appendix D: Incentive Ranges	Revised to reflect updates contained in Surrebuttal Testimony
Appendix E: Sample Evaluation Plans	Revised to reflect agreements reached by the Signatories
Appendix F: Deemed Savings Table	Only revised to reflect new MEEIA 2019-21 Plan title; subject to further revision as described in Paragraph 13.
Appendix G: Technical Resource Manual ("TRM") Volume 1	Only revised to reflect new MEEIA 2019-21 Plan title.
Appendix H: TRM Volume 2	Only revised to reflect new MEEIA 2019-21 Plan title; subject to further revision as described in Paragraph 13.
Appendix I: TRM Volume 3	Only revised to reflect new MEEIA 2019-21 Plan title; subject to further revision as described in Paragraph 13.
Appendix J: Exemplar Tariffs	Revised to reflect agreements reached by the Signatories
Appendix K: Customer DSIM Explanation	Only revised to reflect new MEEIA 2019-21 Plan title.[4]
Appendix L: Customer Bill Examples	Only revised to reflect new MEEIA 2019-21 Plan title.
Appendix M: Accounting	Only revised to reflect new MEEIA 2019-21 Plan title

[4] Since customer notice has already been published, it cannot be retroactively revised.

6. Budget variance. The variance of up to 20% between the budget approved by the Commission and the amount actually spent by the Company, which is allowed by 4 CSR 240-20.094(5), will be set at 5% for the length of the MEEIA 2019-21 Plan.

7. Integrated Resource Plan ("IRP"). As part of its triennial IRP compliance filing in 2020, Ameren Missouri will analyze demand-side resources included within alternative resource plans (including all performance metrics) both in its traditional manner and with "dynamically optimized portfolios." Such portfolios will be based on logical groupings of measures and the associated adoption curves from the potential study. The dynamically optimized portfolios will be built from the bottom up, based on capacity shortfall and needs to add enough demand-side resources to meet capacity needs using a timeline consistent with adoption curves from an updated potential study that includes new primary research. Also through its 2020 IRP, the Company will perform additional analyses to support its avoided transmission and distribution estimates that will be utilized in its next cycle MEEIA programs.

8. Demand Response. The Signatories will engage in collaborative discussions to explore how to keep demand response implemented in the market for the long-term. The collaborative effort will explore topics such as engaging in long-term agreements (with specific off-ramps) for certain budget levels as well as standardized earnings opportunity and throughput disincentives.[5] The Company will host at least three collaborative meetings on this topic and, within 12 months of a Commission order approving this *Stipulation*, the Company will file in this docket a report summarizing the issues explored in these collaborative meetings and potential recommendations, including any rule revisions identified as necessary.

[5] The Signatories recognize that the Commission's MEEIA rules provide a general framework for program costs, throughput disincentive, and earnings opportunity.

9. Energy Efficiency Equity Baseline Data. Within 60 days of the approval of this *Stipulation*, Ameren Missouri will file updated participation data by zip code for Schedule WRD-SR6 to the surrebuttal testimony of Company witness Bill Davis to include program-level participation data within this docket. Further, the following information will be included in the annual EM&V reports for MEEIA 2019-21:

- Aggregated participation data by program and by zip code;[6] and
- Aggregated energy consumption data by zip code.

10. Multifamily Low-Income Program. The Signatories agree that the following shall apply to the implementation of the Multifamily Low-Income Program as described in the *Revised Report* and associated appendices:

a. The Company will post information about the types of projects and the types of customer measures that could qualify under the Multifamily Low-Income Program, as well as applicable case studies, on its website.

b. The Company will share its experiences, as they develop, regarding the implementation of long-lead time projects implemented in MEEIA 2016-18 in the collaborative process described below to determine the best way to accommodate substantial rehabilitation projects. While that evaluation is ongoing, the Company will provide up to a 12-month funding commitment within the implementation period of the MEEIA 2019-21 Plan and will accommodate extensions and Low-Income Housing Tax Credit timelines when possible.

c. The Signatories recognize that the ramp rate for a new program design in the low-income multifamily market is unpredictable and agree that the presented budgets are not to be treated as annual budget caps. In support of this, the Company's contract with its implementation contractor for this program will incentivize the contractor to meet and exceed performance savings goals as well as explicitly allow

[6] The Company will provide this information based on 5-digit zip codes, but will evaluate the feasibility and practicality of expanding this reporting to 5+4 zip codes.

shifting budgets from future years to fund higher than planned participation levels in earlier years. In the event customer participation sustainably and significantly exceeds approved budget levels over the first 18 months, the Company will present those findings to stakeholders and explore recommended responsible actions, including the potential to request Commission approval for increased budgets.

11. Collaborative Meetings to Explore Additional Opportunities. No later than June 1, 2020, Ameren Missouri will file in this docket a report summarizing collaborative discussions between the Signatories similar to its MEEIA 2016-18 Collaborative Report. The objective of this collaborative effort is to systematically explore additional savings opportunities with the intention to impact possible changes to MEEIA 2019-21 programs and/or to provide a foundation for new and/or modified programs for a proposed MEEIA Cycle 4. The Company will host at least four meetings, with no more than six months in between the meetings.

As part of the annual EM&V review process, the Company will host at least one separate meeting to specifically review and discuss the process evaluation results for each program to assess potential changes to improve MEEIA 2019-21 programs as well as gain feedback on future research areas of process evaluation.

12. Prepaid Electric Service Programs under MEEIA. The Company agrees not to seek approval of a prepaid electric service program under MEEIA similar to the Flex Pay program proposed in File No. EO-2015-0055 before 2025. The Company agrees that if it files a non-MEEIA prepaid electric service program before 2025, it will meet with the Signatories three months in advance of the filing.

13. Technical Resource Manual ("TRM") and Deemed Savings Table Updates. By December 31, 2018, the Company will file for Commission approval of an updated TRM and an updated Deemed Savings Table to reflect the results of MEEIA 2016-18 Program Year 2017 evaluation results. The updates will also include fixed incremental cost calculations identified

while investigating Staff's concerns about the cost-effectiveness of certain measures. The updated TRM will include new sections, as written below, regarding demand response to provide more specificity on the determination of energy and demand savings:

- *Business demand response*: For demand and energy savings associated with calling a demand response event, a customer baseline load ("CBL") approach will be used. A CBL approach applies a model or algorithm to develop customer-specific baselines for each event that are used to estimate load impacts for each hour of the event. Demand impacts will be estimated from the average of the hours over all event periods. Energy savings impacts will be estimated from comparing the 24 hours of the CBL for each event day to the 24 hours of actual kWh consumption for each event day.
- *Residential demand response*: For demand and energy savings associated with calling a demand response event, smart thermostat program participants will be randomly partitioned into two groups. In this scenario, on an event day, participants in one group receive a signal to initiate activity on the thermostat, while the other group of participants would not receive this signal. As a result, the participants who receive the signal will serve as the treatment group, and the participants who do not receive a signal will serve as the control group. Demand impacts will be estimated from the average of the hours over all event periods. Energy savings impacts will be estimated from comparing the 24 hours of the control group for each event day to the 24 hours of actual kWh consumption for each event day.

14. Testimony admitted into evidence. The Signatories ask the Commission to enter the pre-filed testimony submitted in this case into the record in support of the settled MEEIA 2019-21 Plan.

15. Waivers. The Signatories agree that the following waivers are appropriate for implementation of MEEIA 2019-21 and should be granted:

Waiver Requested from:	Rationale	Justification
4 CSR 240-20.094(4)(I)3	Rule 4 CSR 240-20.094(4)(I)3 states, in relevant part, the Commission can approve demand-side programs or program plans that it finds have met the filing and submission requirements of the MEEIA rules and "[a]re included in the electric utility's preferred plan or have been analyzed through the integration process required by 4 CSR 240-22.060 to determine the impact of the demand-side program and program plans on the net present value of revenue requirements of the electric utility." While the 2017 IRP preferred resource plan does include analyses of demand-side resource options, those analyses were based on the best information available at that time.	Good cause for this waiver exists because requiring the revision of the 2017 IRP preferred resource plan analyses to accommodate this filing does not warrant the time and effort that would be required to complete that revision.
4 CSR 240-20.094(2)	Rule 4 CSR 240-20.094(2) prescribes guidelines to review progress toward the expectation an electric utility's demand-side programs can achieve a goal of overall cost-effective demand-side savings. However, the rule expressly states that the prescribed guidelines are not mandatory and no penalty or other adverse consequence will result if a utility is unable to achieve annual savings goals specified in those guidelines.	To eliminate any confusion regarding whether Ameren Missouri's MEEIA 2019-21 programs are required to meet those "soft" goals related to kWh and kW load reductions, the Company seeks a waiver of this rule. Alternatively, the Commission could include a statement in its final order approving the MEEIA 2019-21 Plan that Ameren Missouri will not be penalized in any way if it fails to meet goals expressed in the rule's guidelines.
4 CSR 240-14.030(3)	Rule 4 CSR 240-14.030(3) states, in relevant part, an electric utility is prohibited from implementing any new promotional practice until after a tariff related to that practice has been filed with the Commission. The MEEIA 2019-21 Plan anticipates the Company will be required to change certain elements of its promotional practices – most notably incentive payments – to reflect marketplace changes.	Requiring Ameren Missouri to file tariffs before such changes can be implemented would be burdensome and would prevent the Company from quickly addressing conditions the promotional practice changes were designed to address. A waiver of this rule is necessary to give Ameren Missouri administrative flexibility necessary to timely address marketplace changes.

GENERAL PROVISIONS

16. This *Stipulation* is being entered into solely for the purpose of settling the issues specifically set forth above, and represents a settlement on a mutually-agreeable outcome without resolution of specific issues of law or fact. This *Stipulation* is intended to relate *only* to the specific

matters referred to herein; no Signatory waives any claim or right which it may otherwise have with respect to any matter not expressly provided for herein. No party will be deemed to have approved, accepted, agreed, consented, or acquiesced to any substantive or procedural principle, treatment, calculation, or other determinative issue underlying the provisions of this *Stipulation*. Except as specifically provided herein, no Signatory shall be prejudiced or bound in any manner by the terms of this *Stipulation* in any other proceeding, regardless of whether this *Stipulation* is approved.

17. This *Stipulation* has resulted from extensive negotiations, and the terms hereof are interdependent. If the Commission does not approve this *Stipulation*, approves it with modifications or conditions to which a party objects, or issues an order in another Commission case that negates its approval or conditions or modifies the *Stipulation* in a manner to which any party objects, then this *Stipulation* shall be null and void, and no Signatory shall be bound by any of its provisions.

18. If the Commission does not approve this *Stipulation* unconditionally and without modification, and notwithstanding its provision that it shall become void, neither this *Stipulation*, nor any matters associated with its consideration by the Commission, shall be considered or argued to be a waiver of the rights that any Signatory has for a decision in accordance with Section 536.080 RSMo 2016 or Article V, Section 18 of the Missouri Constitution, and the Signatories shall retain all procedural and due process rights as fully as though this *Stipulation* had not been presented for approval, any suggestions or memoranda, testimony or exhibits that have been offered or received in support of this *Stipulation*, shall become privileged as reflecting the substantive content of settlement discussions and shall be stricken from and not be considered as

part of the administrative or evidentiary record before the Commission for any further purpose whatsoever.

19. If the Commission unconditionally accepts the specific terms of this *Stipulation* without modification, the Signatories waive, with respect only to the issues resolved herein: their respective rights (1) to call, examine and cross-examine witnesses pursuant to Section 536.070(2), RSMo 2016; (2) their respective rights to present oral argument and/or written briefs pursuant to Section 536.080.1, RSMo 2016; (3) their respective rights to seek rehearing pursuant to Section 386.500, RSMo 2016; and (4) their respective rights to judicial review pursuant to Section 386.510, RSMo 2016. These waivers apply only to a Commission order respecting this *Stipulation* issued in this above-captioned proceeding, and do not apply to any matters raised in any prior or subsequent Commission proceeding, or any matters not explicitly addressed by this *Stipulation*.

20. This *Stipulation* contains the entire agreement of the Signatories concerning the issues addressed herein.

21. This *Stipulation* does not constitute a contract with the Commission and is not intended to impinge upon any Commission claim, right, or argument by virtue of the *Stipulation's* approval. Acceptance of this *Stipulation* by the Commission shall not be deemed as constituting an agreement on the part of the Commission to forego the use of any discovery, investigative or other power which the Commission presently has or as an acquiescence of any underlying issue. Thus, nothing in this *Stipulation* is intended to impinge or restrict in any manner the exercise by the Commission of any statutory right, including the right to access information, or any statutory obligation.

22. The Signatories agree that this *Stipulation*, except as specifically noted herein, resolves all issues related to these topics, and that the agreement should be received into the record without the necessity of any witness taking the stand for examination.

WHEREFORE, the Signatories respectfully request that the Commission approve the settled MEEIA 2019-21 Plan, comprised of this *Stipulation*, together with the *Revised Report* and its associated appendices. Additionally, the Signatories request the Commission approve the waivers requested herein, so that Ameren Missouri may implement MEEIA 2019-21 programs beginning March 1, 2019, and grant any other and further relief as it deems just and equitable.

Respectfully submitted,

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For OFFICE OF THE PUBLIC COUNSEL

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and correct copy of the foregoing was served on all parties of record via electronic mail (e-mail) on this 25th day of October, 2018.

/s/ ***Paula N. Johnson***
Paula N. Johnson

Ameren Missouri

2019-21 MEEIA Energy Efficiency Plan

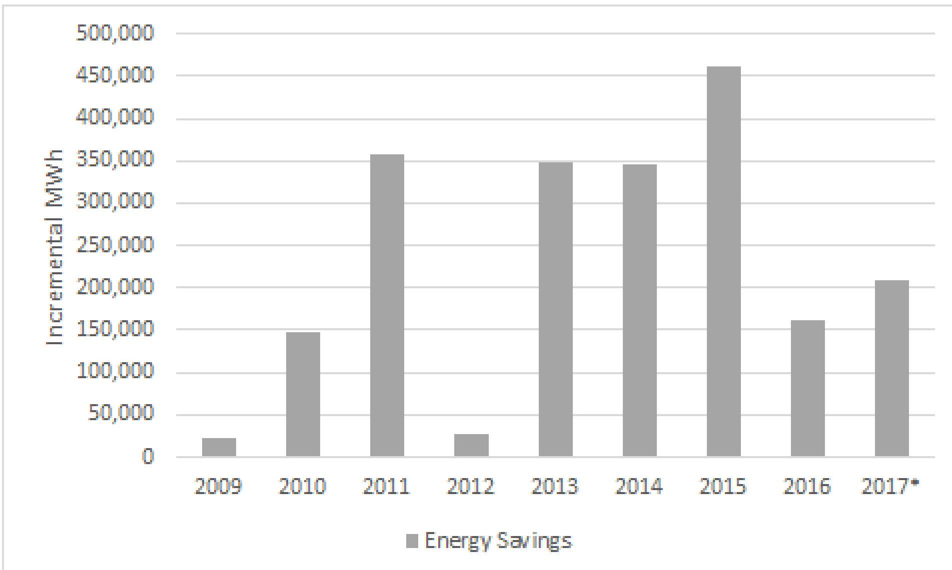
Ameren
MISSOURI

Table of Contents

1.0 Portfolio Summary

Ameren Missouri's recent history with implementation of large-scale customer energy efficiency programs began in earnest in 2009 when MEEIA was passed into law. From 2013 through 2017, Ameren Missouri's energy efficiency programs achieved net savings of 2,078,929 MWh. The chart below demonstrates Ameren Missouri's energy efficiency efforts. These results further demonstrate that, with the Commission's support through approval of MEEIA 2013-15 and MEEIA 2016-18, Ameren Missouri has been able to provide its customers with substantial cost-effective energy savings.

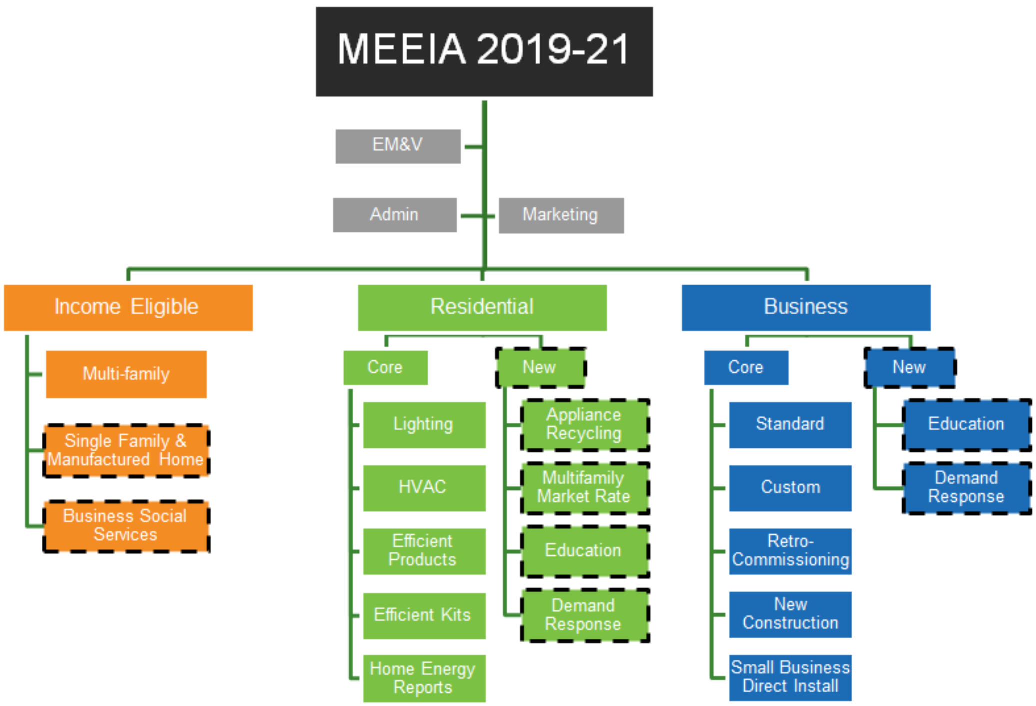
Figure 1 – Historical Ameren Missouri Energy Efficiency Program Savings



*2017 results are net-as-filed; evaluation results are not yet available

The MEEIA 2019-21 portfolio builds on Ameren Missouri's past successes and adds important new elements. The figure below represents a high-level overview of the portfolio, with the details of the programs explained later in this report.

Figure 2 – MEEIA 2019-21 Portfolio Structure



The two figures below show the targeted cumulative energy savings and demand savings for the MEEIA 2019-21 portfolio. The cumulative portfolio energy savings of 794 GWh represent an 2.5% cumulative reduction to retail energy sales, or an annual average of 0.8%. The cumulative portfolio demand savings of 361 MW represent a 5% cumulative reduction to retail demand, or an annual average of 1.7%. It is also apparent that the business portfolio will result in significantly more cumulative energy savings while the demand savings are evenly split between the residential and business portfolios.

Figure 3 – Cumulative Portfolio Energy Savings by Sector

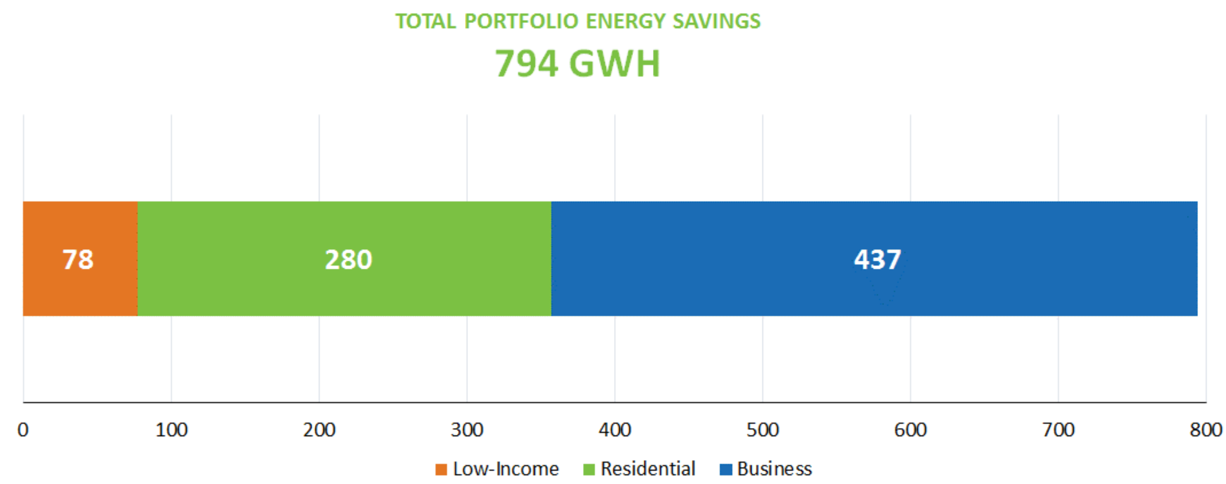
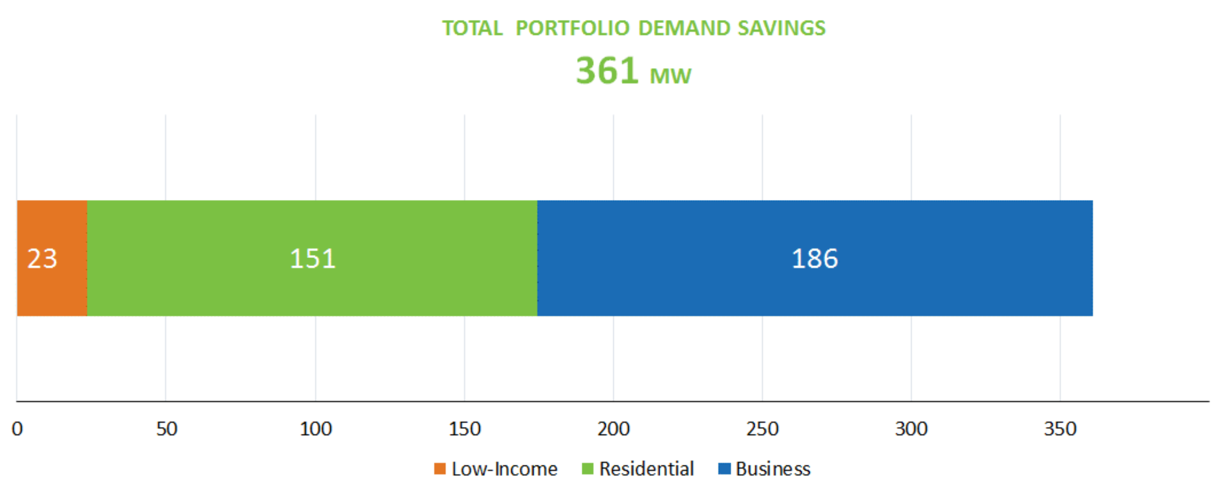


Figure 4 – Cumulative Portfolio Demand Savings by Sector



The two figures below show the same cumulative energy and demand savings, but broken out for each year. This highlights the aggressive growth in the business portfolio.

Figure 5 – Cumulative Portfolio Energy Savings by Sector by Year

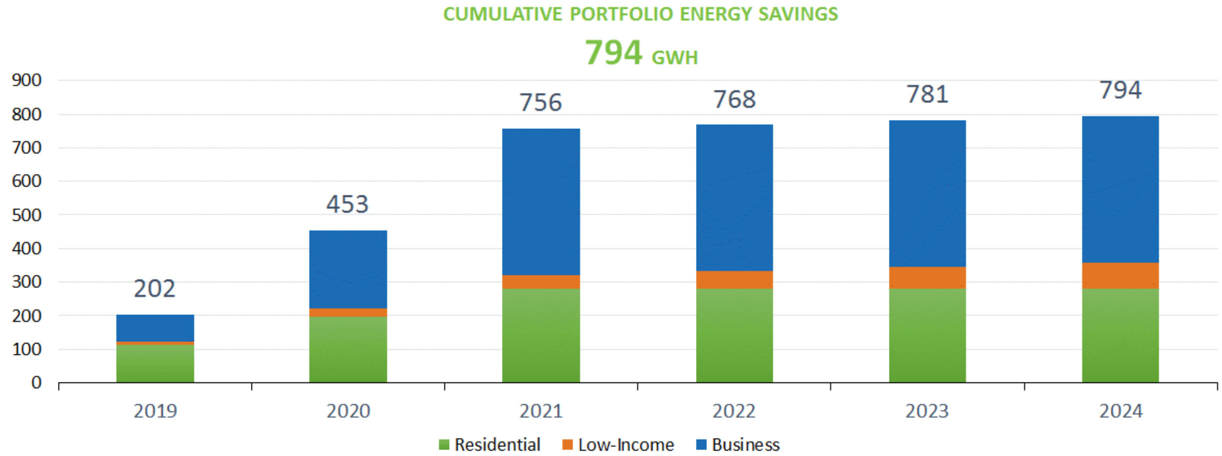
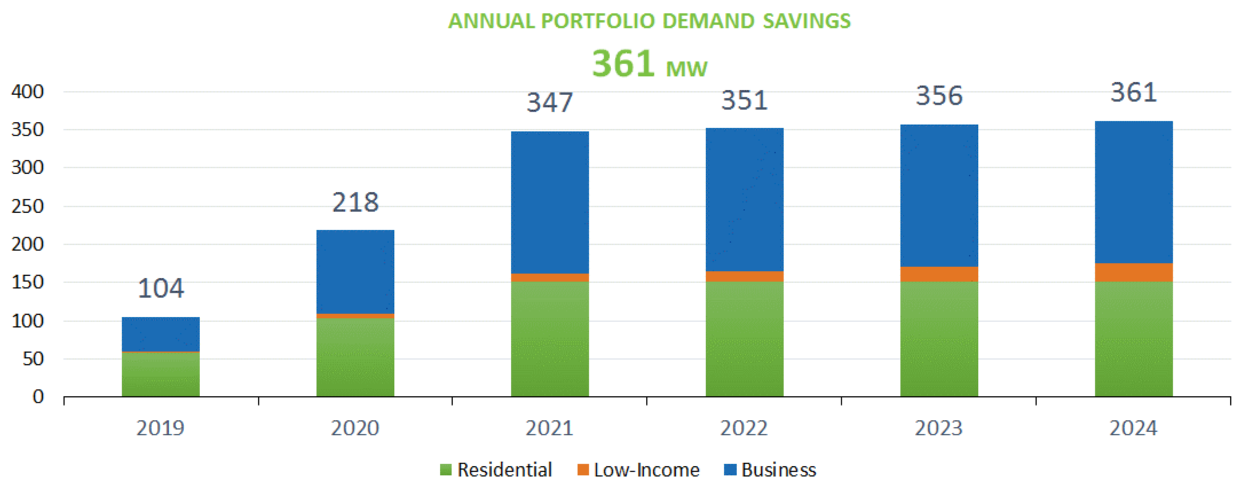


Figure 6 – Cumulative Portfolio Demand Savings by Sector by Year



The two figures below show the portfolio budgets for MEEIA 2019-21. The $195.5 million three-year budget is 37% below the budget estimates reflected in the IRP and compares favorably to the MEEIA 2016-18 budget on a cost-per-unit basis. A sizable portion of the total budget - approximately $50 million - is directed to the low-income sector.

Figure 7 – Total Portfolio Budgets by Sector

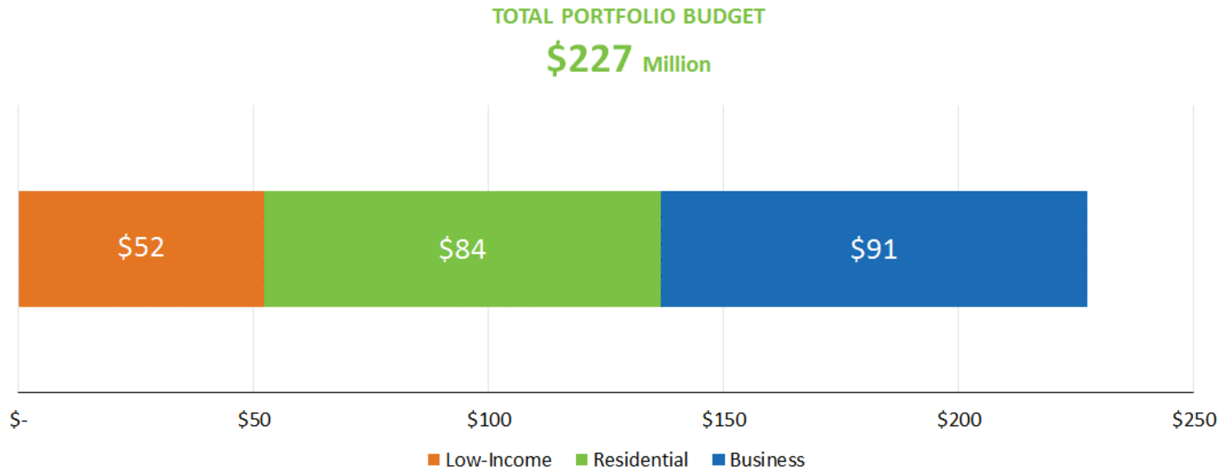
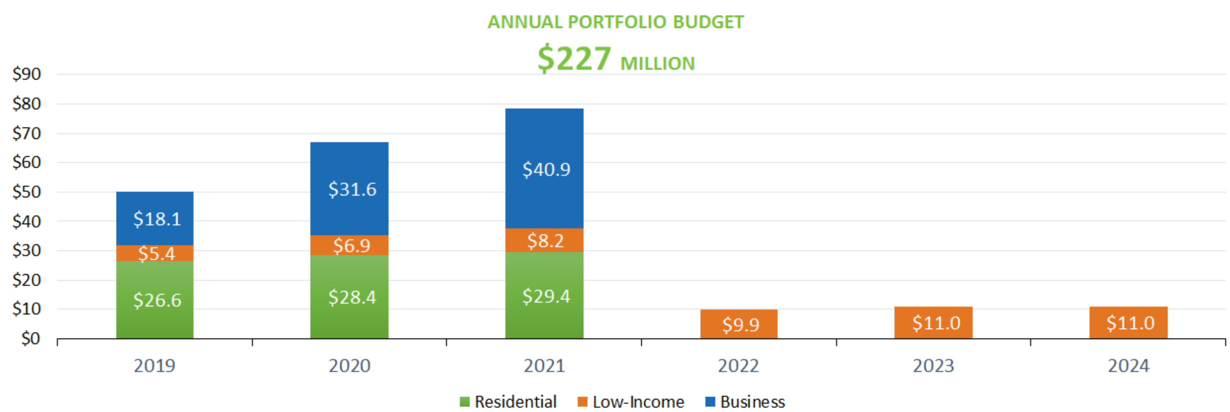


Figure 8 – Total Portfolio Budgets by Sector by Year



Annual tables of energy savings, demand savings, and cost-effectiveness results[1], by program, are available in Appendix A. The figures below demonstrate the portfolio's cost-effectiveness. From the utility cost standpoint, the Plan results in $324 million in lifetime net benefits. It results in $219 million in lifetime net benefits from a total cost perspective.[2]

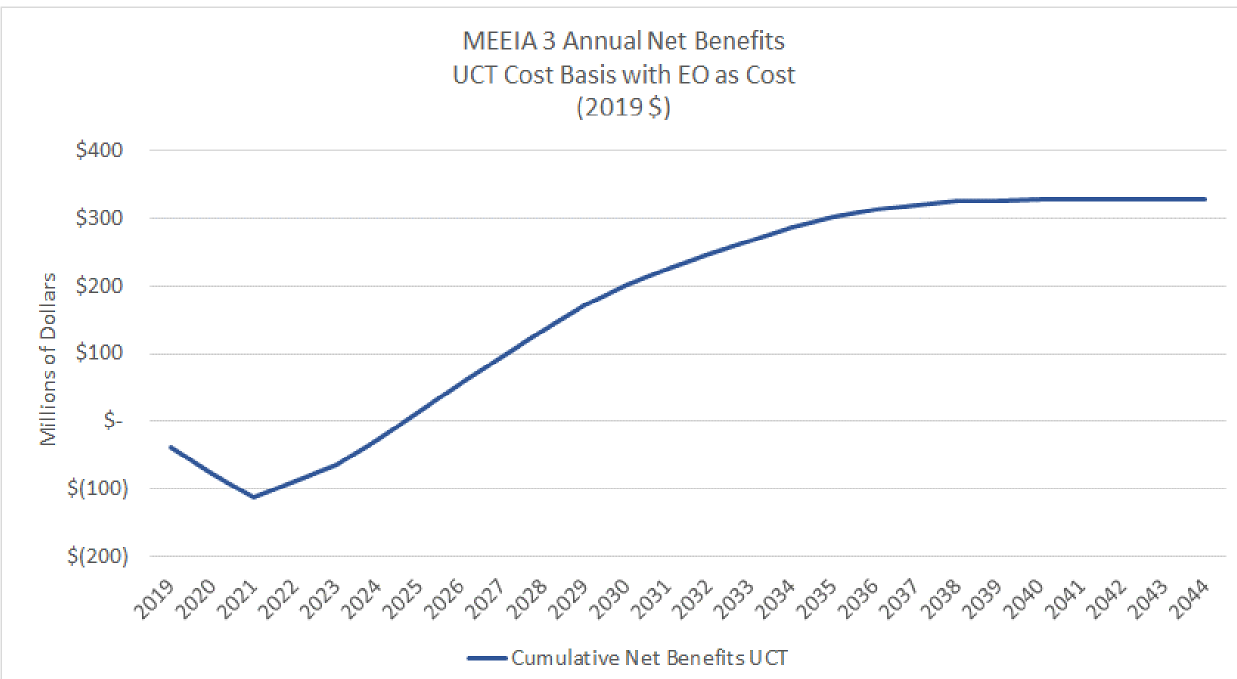
[1] Societal Cost Test results are identical to the Total Resource Cost test results because no Non-Energy Benefits were quantified. Therefore, the Societal Cost Test results were not reported separately.
[2] Avoided costs were based on the Company's 2017 IRP and can be found in Appendix C.

Table 1 – Portfolio Cost-Effectiveness Summary (NPV)[3]

Portfolio Cost Effectiveness		
	Utility Cost Test	Total Resource Cost
Benefits	$ 592,338,018	$ 592,338,018
Costs	$ 242,054,545	$ 347,690,162
Earning Opportunity	$ 25,916,228	$ 25,916,228
Net Benefits	$ 324,367,245	$ 218,731,628
UCT Benefits/Costs Ratio	2.21	
TRC Benefits/Costs Ratio		1.59

The figure below shows the annual cumulative lifetime benefits by year. The payback to customers is demonstrably substantial, and happens within 7 years compared to the 25+ years of program benefits.

Figure 9 – Annual Cumulative Net Present Value of Net Benefits (UCT)



Pursuing the Policy Goal of MEEIA

As part of the 2017 IRP, the Company analyzed a variety of demand-side portfolios, including Realistic Achievable Potential ("RAP"), Maximum Achievable Potential

[3] Net Present Value. Includes the lifetime costs and benefits of Demand Response programs over a 10-year effective useful life.

("MAP"),[4] and a Mid-Case Portfolio, as well as portfolios where energy efficiency and demand response were offered together and also separated. In addition to analyzing a variety of demand-side portfolios, the Company's 2017 IRP analyzed those demand-side portfolios against competing supply-side alternatives and weighed the various resource plans against its decision-making criteria. The Company's Preferred Resource Plan calls for the adoption of the RAP, and the goals in MEEIA 2019-21 are lower than the Preferred Resource Plan.

Table 2 – Comparison of MEEIA 2019-21 to the IRP

	Energy (MWh)	**Demand (MW)**	**Cost ($MM)**
2017 IRP Preferred Plan	986,034	524	$308.5
MEEIA 2019-21	755,829	347	$195.5
% Difference	-23%	-34%	-37%

The Commission's MEEIA rules provide guidelines to review progress towards the goal of all cost-effective demand-side savings. The provided guideline is the greater of RAP or a list of savings percentages. According to the listed savings percentages (starting with program year seven), the incremental energy reduction guidelines are 1.5%, 1.7%, and an ongoing 1.9% reduction for subsequent years, while the incremental demand reduction targets are 1% per year. The rules provide further guidance for cumulative savings by program year. The figures below compare the MEEIA 2019-21 portfolio to the non-mandatory MEEIA guidelines. From Figures 10 and 11 below, it is apparent that the energy savings percent guidelines in the Commission's MEEIA rules are much more aggressive than the proposed portfolio. Even though the MEEIA 2019-21 incremental energy savings are below the percent guidelines found in the Commission's MEEIA rules, the cumulative chart demonstrates the ongoing significant progress reflected in the Plan. In contrast, Figures 12 and 13 demonstrate that the Company's incremental and cumulative demand savings goals exceed the percent guidelines in the Commission's MEEIA rules.

[4] RAP and MAP were based on the Company's latest Market Potential Study which was also part of the Company's 2017 IRP as Appendix A to Chapter 8 – Demand-side Resources.

Figure 10 – Comparison to Incremental Energy Savings Guidelines

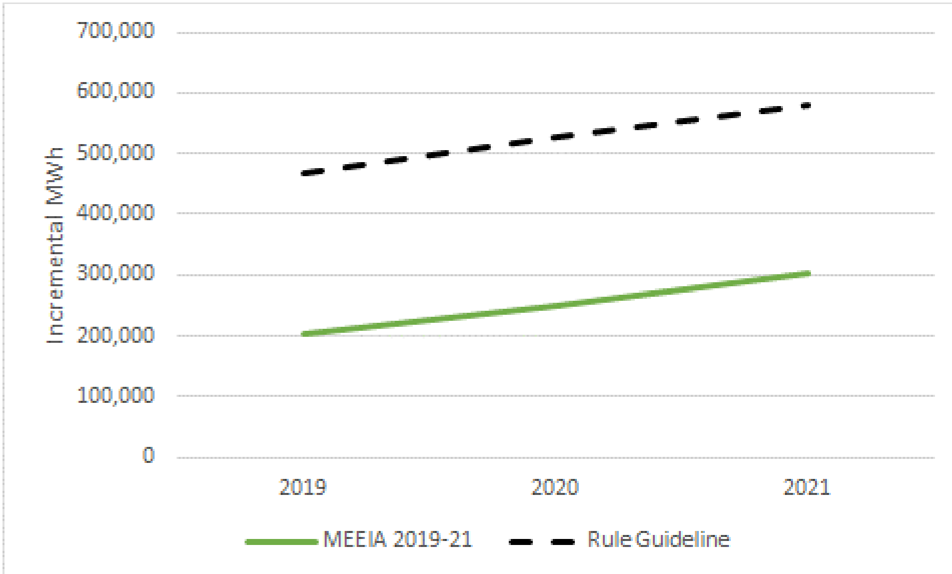


Figure 11 – Comparison to Cumulative Energy Savings Guidelines

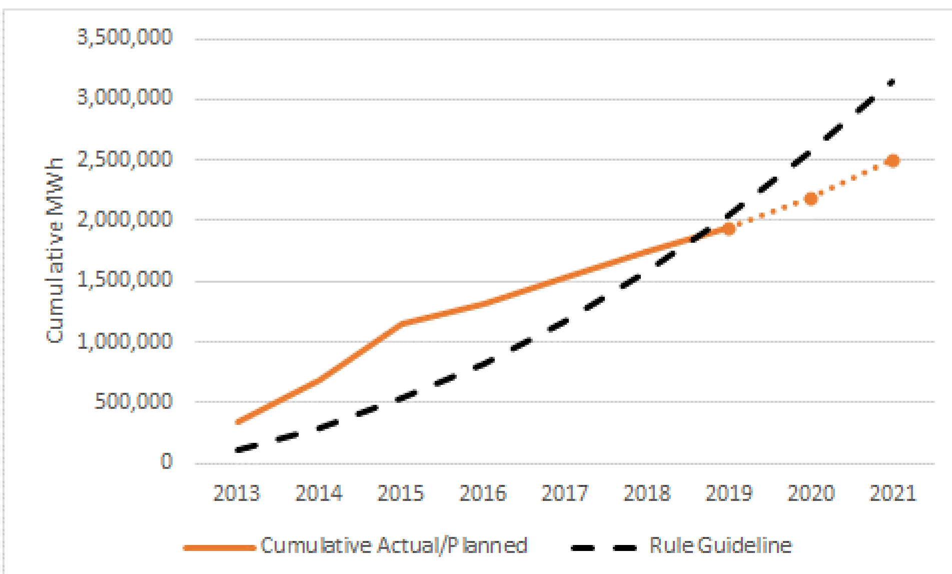


Figure 12 – Comparison to Incremental Demand Savings Guidelines

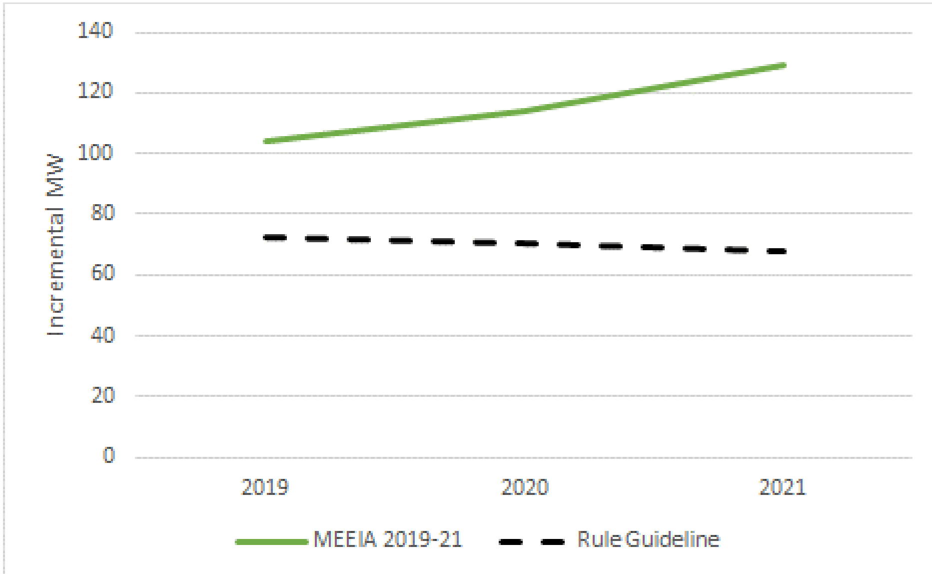
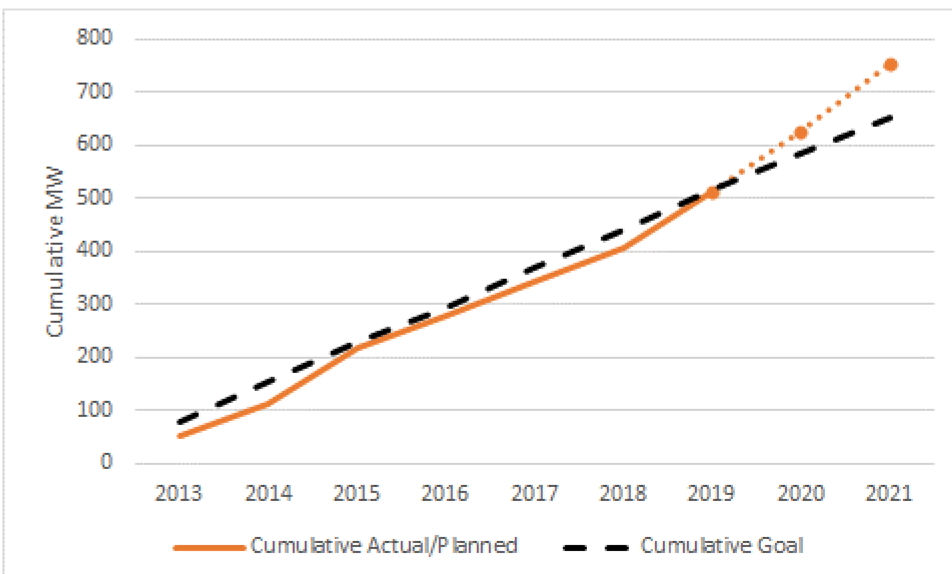


Figure 13 – Comparison to Cumulative Demand Savings Guidelines



2.0 Sector Programs

The Portfolio Summary above provides an overview of the portfolio broken down into three main sectors: Low-Income, Residential, and Business. The sections below deliver more granular sector assessments by providing more description about the underlying programs within each sector, as well as the relevant savings and budgets for each. The program templates included as Appendix B provide additional details for each of the programs proposed by the Plan.

2.1 Low-Income Sector Programs

As shown in Figure 2 above, the Plan's portfolio has three low-income programs designed to achieve savings in three distinct market segments: multifamily dwellings, single family dwellings, and qualifying businesses that have facilities providing social services to the public.

The Plan includes significantly increased investment in energy efficiency programs to serve low-income customers as compared to the previous MEEIA cycle. The multifamily program budget alone reflects an average increase in program spending of nearly 40%.

Residential Single Family Low-Income - New	Employs multiple delivery channels to provide a one-stop-shop for single family, whole-home energy efficiency upgrades for the benefit of low-income residential customers
Residential Multifamily Low-Income	One-stop-shop approach for owners and operators of multifamily low-income properties to assist with applications for financing and technical support along with incentives designed to overcome barriers to completing comprehensive retrofits.
Business Social Services - New	Deliver, install and complete paperwork for low-cost and/or no-cost energy efficiency measures in business social services facilities so they can better serve low-income individuals.

2.1.1 Low-Income Sector Discussion

Residential Low-Income Programs

The low-income programs are designed to serve eligible participants through multiple channels to expand participation and overcome hurdles specific to each customer and/or property type. Multiple delivery channels ensure a diversity of participants and equitable delivery across Ameren Missouri’s service territory.

These programs will conduct individual and/or group educational meetings with participating low-income customers to increase awareness of energy efficiency habits and measures, such as purchasing ENERGY STAR® certified products to encourage market transformation.

The residential single family and multifamily programs are highlighted below.

<u>Single Family Low-Income Program</u>

The program is offered to residential customers residing in single family detached housing, duplexes, and mobile homes (wood-frame bolted to steel chassis, designed to be transported). The program will use a neighborhood approach to identify low-income areas with the greatest need, such as those with high energy usage, high incidence of arrearages, or payment delinquencies, allowing the Company to group participants and focus on a single geographic area at a time. In some instances, the program may also serve a single home as the result of receiving a referral by a qualified low-income assistance agency. The program will provide energy assessments and/or diagnostic testing and install a comprehensive package of whole house energy saving measures at no or low cost to customers.

The program will seek to collaborate with familiar community-based organizations and leaders -- such as homeowner associations, churches, senior centers, schools, other non-profits, and employers or local community leaders -- to obtain their endorsements promoting the program and their assistance with opportunities to stage cooperative recruitment drives and/or education events. This approach of utilizing trusted, familiar organizations generates enthusiasm and momentum behind the effort.

As a subcomponent of the Single Family Low-Income Program, the program administrator may make free energy saving measure packages or incentives directly available to organizations that can provide labor for qualified installations of measures at no charge to low-income residential end users (i.e., provide Low-Income Efficiency Housing Grants). LEDs will also be available for distribution by qualifying organizations, such as food banks. In connection with these grants, the program will provide technical information, education, and support to the receiving organizations so they can understand and comply with the program requirements. Approved Low-Income Efficiency Housing Grants must:

a. Be implemented by a not-for-profit organization, governmental body, entity representing residential customers served by the Company, or through a Company-sponsored event;
b. Be limited in distribution to residential customers residing in the Ameren Missouri service territory;
c. Be used for a project that provides access and sufficient performance data to allow the project's evaluation, measurement, and verification ("EM&V"); and
d. Include consumer education elements regarding the installed equipment.

Multifamily Low-Income Program

Beginning in 2015, Ameren Missouri revised its Multifamily Low-Income Program to administer the residential and business components using a single implementation contractor. To assist in overcoming many of the barriers unique to multifamily properties, the program established a one-stop-shop offering a concierge approach to assist property owners through the process of applying for and securing energy efficiency upgrades using a single application. The program also continued to offer free direct installation of dwelling unit measures and increased common area/whole building incentives by 25% above those offered to other business customers. While the increased incentives were a program enhancement, tying them to business program incentives proved problematic. For example, lowering business incentives also lowered multifamily low-income incentives, thus reducing the ability to encourage participation. Having learned from this, Ameren Missouri will establish separate low-income multifamily program incentives in the Plan.

Ameren Missouri will continue the one-stop-shop approach in MEEIA 2019-21 in order to encourage property owners along in their energy efficiency journey and enable easy engagement with the program. The goal is to help multifamily property managers understand their buildings' energy usage amounts, continue to achieve immediate energy savings through no-cost direct install measures, and move beyond initial measures to investments in standard and/or custom measures for common areas, building shell, and whole-building systems in order to benefit from deeper energy savings.

The multifamily implementation strategy includes the following:

- Direct outreach and marketing to inform eligible property managers of the many benefits of improving their properties' energy efficiency.
- Assignment of a dedicated contact to assist building managers throughout the process.
- Offering Level I Energy Assessment to qualifying buildings at no cost to provide a report including:
    - list of measures;
    - estimated energy savings;
    - estimated cost savings;
    - estimated cost for equipment and installation;
    - simple payback analysis; and
    - identify appropriate incentive package options to achieve whole-building energy and demand savings.
- Providing bid specifications and referrals for repair work, if required.
- Identifying scope of work and securing qualified program partners to perform energy efficiency upgrades.
- Assisting with retrofit scheduling and completion.
- Verifying quality installation of selected measures.
- Providing all eligible participants with past 12 months of energy usage and technical assistance to begin benchmarking buildings using ENERGY STAR® Portfolio Manager.
- Assisting managers of participating multifamily properties in maintaining their improved building efficiency and boost market transformation by providing incentives to defray the cost to attend Building Operator Certification ("BOC") Training.

Along with project incentives, the program will seek to encourage property owners to achieve maximum savings possible by offering seamless access to financing and other alternatives to reduce financial barriers to investing in energy efficiency upgrades. For example, the Company will obtain a list of applicants with allocated low-income housing tax credits that could be invested in energy efficiency and continue to work with the Missouri Housing Development Commission to establish a link to new tax credit applicants. If the Level I assessment indicates the need for higher capital expenditures, the program will pay for up to 100% of an ASHRAE[5] Level 2 audit, not to exceed $10,000 per property for properties applying for tax credits through MHDC. Further, where a Home Energy Rating System energy audit is more appropriate for MHDC applicants (e.g. a garden-style property without central systems), audit incentives will also be available. The Company will also facilitate access for its customers to other funding that could be used for energy efficiency measures, such as grants (e.g., federal and state weatherization funding for income-qualified properties), Federal Housing Administration loan incentives, Fannie and Freddie's green loan incentives and energy financing mechanisms such as Property Assessed Clean Energy and energy performance contracts.

In addition to the strategies noted above, Ameren Missouri will continue its successful collaboration with gas utilities to co-deliver MEEIA programs, which reduces program costs and provides a comprehensive energy efficiency solution for our customers. In the event co-delivery is not possible, the program will ensure participants are aware of all available utility incentives and will assist participants in claiming them.

In addition to maintaining records to assist in on-going business development opportunities, data collected for this program will include measure information, financial data, energy and demand savings, customer outreach and participation information. Data will be tracked and available for EM&V. The following list is not all inclusive, but is an example of tracked data points:

- Number of buildings and units within each property;
- Number of properties that received benchmarking assistance;
- Number of audits performed;
- Number of and type of measures installed;
- Percent energy savings implemented versus identified energy savings opportunity; and
- Incentives paid by property.

The Company will continue to provide quarterly updates to stakeholders and, following receipt of the EM&V report, will provide an annual update to the Missouri Energy Efficiency Advisory Collaborative ("MEEAC").

<u>Eligibility Guidelines for All Residential Low-Income Programs</u>

The goal of these eligibility guidelines is to reduce barriers to participation in the Company's residential low-income offerings by providing multiple pathways to establish eligibility.

[5] American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Approved participants will be required to meet one of the following income eligibility requirements:

1. Participation in a federal, state, or local subsidized housing program.
2. Proof of resident income[6] levels at or below 80% of area median income or 200% of federal poverty level.
3. Fall within a census tract included on the Company's list of eligible low-income census tracts.

With respect to the multifamily program, where a multifamily property does not meet one of the income eligibility criteria listed above but has a combination of qualifying tenants and non-qualifying tenants, at least 50% of the tenants must be eligible to qualify the entire property.

Business Social Services Program

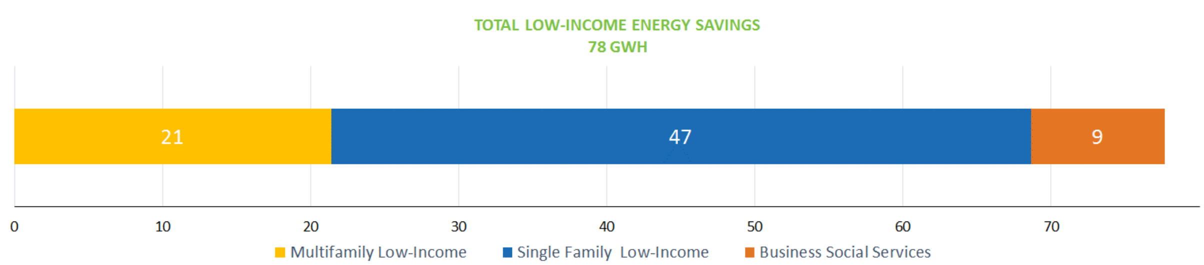
The Business Social Services Program will promote the installation of energy efficient technologies by removing participation barriers. Non-profit businesses with qualifying facilities will be eligible for a streamlined program process with no-cost and low-cost project opportunities. Participation will save energy and allow social service businesses to better serve the low-income public. Such non-profit businesses with qualifying facilities will be able to take advantage of no-cost efficiency lighting upgrades and higher than standard incentives for deep dive savings opportunities, such as HVAC, for those facilities.

A non-profit business's qualifying facilities include those that receive small or large general electric service, and that are primarily used for low-income public social services such as food banks, food pantries, soup kitchens, homeless shelters, employment services, worker training, job banks, and childcare.

2.1.2 Low-Income Sector Summary Charts

The figure below shows that a large majority of the low-income savings are from the Multifamily and Single Family programs.

Figure 14 – Cumulative Low-Income Energy Savings by Program



[6] Proof of income can be accomplished in multiple ways, including but not limited to submission of rent rolls or documentation of being on the US Department of Energy ("DOE") Weatherization Assistance Program waitlist.

Figure 15 – Cumulative Low-Income Demand Savings by Program

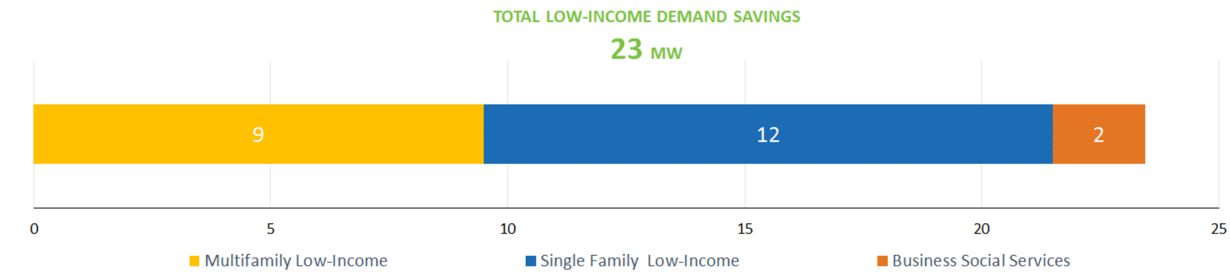


Figure 16 – Cumulative Low-Income Energy Savings by Program by Year

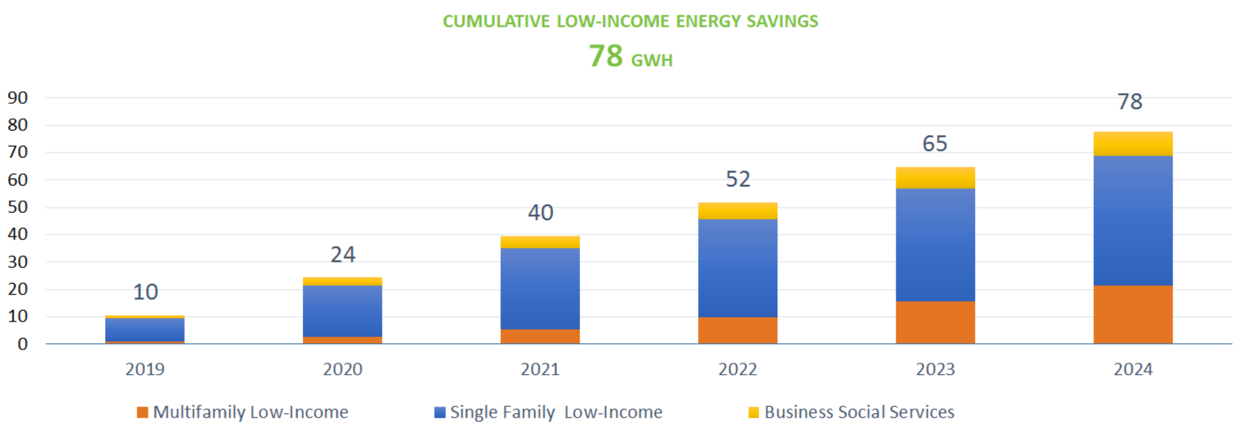
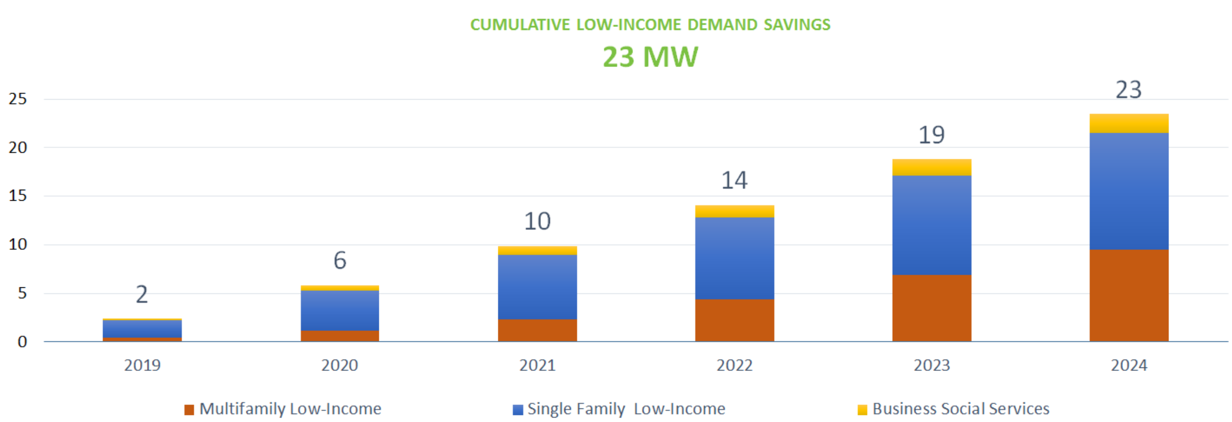


Figure 17 – Cumulative Low-Income Demand Savings by Program by Year



The figures below show that a majority of the budgets are going to the multifamily and single family low-income programs and the budgets are roughly split in an even manner between the two programs.

Figure 18 – Total Low-Income Budgets by Program

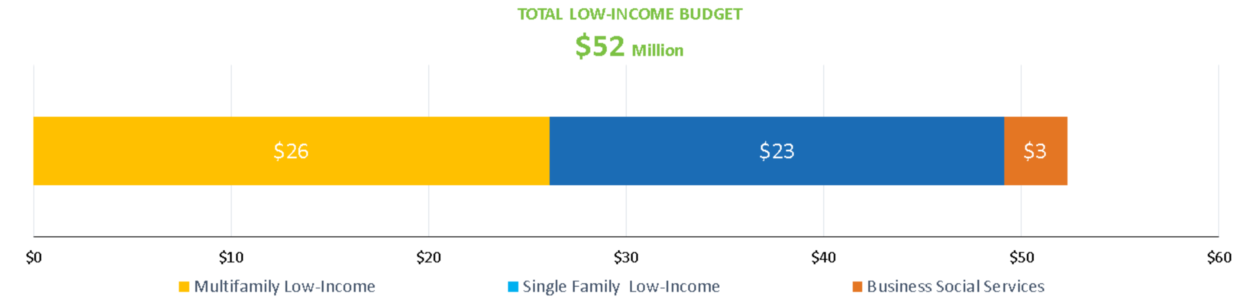
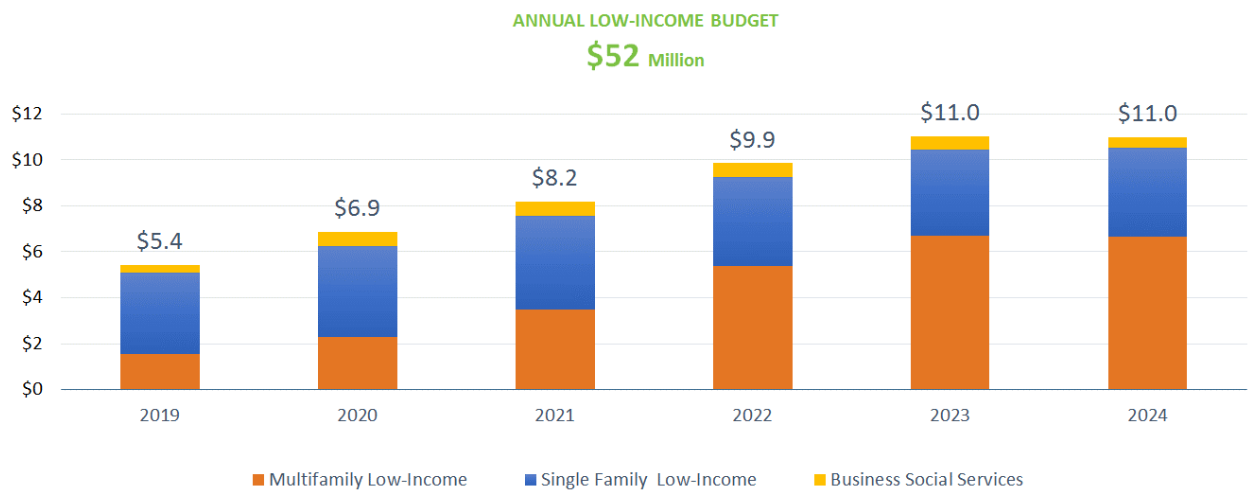


Figure 19 – Total Low-Income Budgets by Program by Year



Although MEEIA does not require low-income programs to pass cost-effectiveness testing, the table below shows that the Low-Income programs proposed in the Plan result in net benefits to all customers:

Table 3 – Low-Income Sector Cost-Effectiveness Summary (NPV)

Low-Income Cost Effectiveness		
	Utility Cost Test	Total Resource Cost
Benefits	$ 54,586,622	$ 54,586,622
Costs	$ 44,435,748	$ 46,878,418
Net Benefits	$ 10,150,874	$ 7,708,204
UCT Benefits/Costs Ratio	1.23	
TRC Benefits/Costs Ratio		1.16

2.2 Residential Sector Programs

The Plan's portfolio design for residential energy efficiency programs includes five core programs continued from MEEIA 2016-2018, plus three new programs and five new education programs. All of these programs are designed to increase customer access to information about available incentives for energy efficient equipment and how to lower energy costs. The residential programs include traditional energy efficiency programs as well as behavioral and demand response programs. These programs are intended to provide education and awareness through a variety of channels, encourage continued participation through cross-promotion, and provide personalized offers that are timely and relevant. The following is a summary description of the residential programs. A detailed description of each residential program can be found in Appendix B.

Lighting	Incentives are provided to local, national and retail partners to increase sales and awareness of ENERGY STAR® qualified products whereby the end-user receives a discount on the price of ENERGY STAR® qualified or other high efficiency lighting products in stores or online.
Efficient Products	Incentives are provided to customers to raise awareness of the benefits of "high-efficiency" products whereby the end-user receives a discount on the price of qualified products via mail-in rebate, online and/or from program partners and contractors.
HVAC	Incentives are provided to customers for improving the efficiency of new and existing HVAC systems, heat pumps, and air conditioners by achieving electric energy savings. Incentives may also be provided to manufactures or distributers as a midstream channel to promote the sale of energy efficient HVAC measures.
Appliance Recycling - New	An incentive and free pickup is provided to customers for the retirement and recycling of an inefficient refrigerator, freezer, dehumidifier and room ACs in working condition. A turnkey appliance recycling company will verify customer eligibility, schedule pick-up appointments, pick up appliances, recycle and dispose units, and perform incentive processing.
Energy Efficiency Kits	Provides energy efficient kits and educational materials through secondary schools, single family homes and community based events to raise customer awareness of the benefits of high-efficiency products and educates residential customers about energy use in their homes and to offer information, products, and services to residential customers to effectively save on energy costs.
Home Energy Reports	Provides customers with a comparison of their energy usage to that of similar homes and provides personalized energy savings tips to encourage energy consumption behavior changes that result in reduced energy use.
Multifamily Market Based - New	Provides customers who are tenants, property owners, and operators of eligible multifamily properties with education and incentives to encourage the installation of high efficient products and equipment to lower energy usage.
Demand Response – New	Provides customers the resources and incentives necessary to identify and take advantage of demand response opportunities using an integrated, data-informed approach to customer engagement and marketing of available demand response offerings.

EDUCATION PROGRAMS	
Science, Technology, Engineering, and Mathematics (STEM) Education – New	Curriculum for high school students focused on aspects of energy generation and delivery with particular emphasis on consumption and energy efficient equipment and behaviors.
Home Building Code Compliance – New	Education provided to builders, sub-contractors, designers, and others in the home building industry that are focused on high-energy impact measures that are commonly missed in residential code compliance.
Workplace Employee Education – New	Designed to educate residential customers at their workplace on energy use, tactics to reduce energy consumption and to promote long-term energy savings.
Smart Home Energy Management – New	Educates residential customers about Smart Home Energy Management products and availability, to advance and increase adoption of those technologies.
Real Estate Audits – New	Designed to use real estate institutions as a channel to encourage the use of home energy audits to improve home performance prior to the purchase of a new home.

2.2.1 Discussion of Selected Residential Sector Programs

The residential programs in the Plan build on the traditional energy efficiency concepts and programs that have proven successful in the nearly decade of experience in delivering energy efficiency programs in the marketplace. At its core, the suite of program offerings provides education, awareness, and financial incentives to offset the cost of energy efficient products or energy saving solutions. The Company will continue to deliver and build upon the relationships and delivery strategies that deliver cost-effective programs such as:

- The promotion of ENERGY STAR® certified products;
- Promotion of high impact energy saving technologies such as heating and cooling equipment through a network of trained professionals;
- Delivery of products such as energy efficient kits as an entry to educating customers in energy efficiency; and
- Co-delivery of energy saving products and equipment with gas and/or water utilities.

Lighting Program

The Lighting Program is a low-cost participation opportunity for customers. The following aspects of the Lighting Program are noteworthy:

- The program offers only LED general service lighting through rebates and distribution (no CFLs).

- The design for the Lighting Program assumes that most general service light bulbs manufactured in 2020 will be 60-70% efficient.[7] The baseline assumption for standard light bulbs will be halogen technology through 2021 (assuming that there will still be some halogen products available in 2021) switching to a CFL baseline starting in 2022. Baselines and lighting product offerings will be assessed by EM&V throughout the MEEIA 2019-21 implementation period.
- For purposes of cost-effectiveness modeling and performance target-setting, an annual hours-use degradation factor was applied based on the historic and current observed EM&V assessments. Over time, efficient residential lighting measures are expected to be installed within sockets with lower hours of use.

Appliance Recycling Program

The Appliance Recycling Program is a popular program for customers and does not require a purchase to participate. The program was offered in the MEEIA 2013-15 plan, but was not included in the MEEIA 2016-18 plan. The 2016 market potential study included an Appliance Recycling Program and the Company sees this program as a potential gateway to participation in other programs. Annual EM&V analysis will help effectively monitor the market for this program and support future adjustments if necessary.

Home Energy Report

Since the Home Energy Report ("HER") was first introduced to customers in 2016, several improvements have been identified and implemented. Such improvements include: the addition of an electronic HER; reconstituting the target segment to focus on high energy users; and redesigned report elements.

The MEEIA 2019-21 program is designed to build off experience thus far and add powerful new features. The HER will begin with a new design with the following typical primary components: home comparison; savings tips; and a cross promotion/marketing module. Three key enhancements will be added upon program launch: 1) end-use disaggregation; 2) a new engaging online portal; and 3) increased frequency of delivery over multiple channels. The end-use disaggregation provides customers with more relevant and actionable tips. The new online portal will provide opportunities to set goals, participate in challenges, and update the home profile, among others. A paper copy will be mailed to customers 6 times per year, with 12 email reports per year, and 12 energy challenge emails per year.

[7] This is the efficiency standard generally necessary to be compliant with rules pertaining to Energy Independence and Securities Act.

Heating and Cooling ("HVAC") Program

The HVAC Program produces significant cost-effective savings with long-lived system coincident peak demand reductions. The following aspects of the HVAC Program are noteworthy:

- Rebates for SEER 14 central air conditioners will no longer be offered for non-low-income customers.
- Rebates for tune-ups will no longer be offered for non-low-income customers.

Residential Demand Response Program

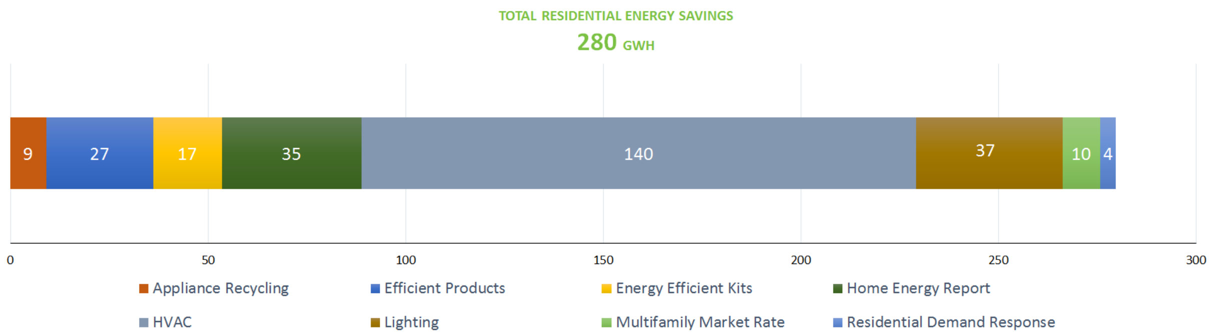
The Residential Demand Response ("DR") Program is new to the residential portfolio and enables a new method for obtaining cost-effective peak demand and energy savings. The Residential DR Program is designed to leverage smart thermostats to reduce consumption during summer system peak conditions. The program is "comfort-centric," as the program will operate with a specific goal to stay within temperature guidelines for each customer based on the customer's smart thermostat temperature set points. In addition to the peak demand savings from a typical DR program, the Company's program design includes energy savings from custom smart thermostat programming intended to achieve energy savings throughout the year that are above and beyond the inherent energy savings from smart thermostats.

The Residential DR Program will partner with device manufacturers to balance a variety of channels to recruit program participants, such as integrating with the Ameren Missouri online marketplace, leveraging the existing network of smart thermostat owners seeded through the MEEIA 2016-18 programs, and planning for the option of installation incentives in later years as the program reaches for deeper participation beyond early adopters.

2.2.2 Residential Sector Summary Charts

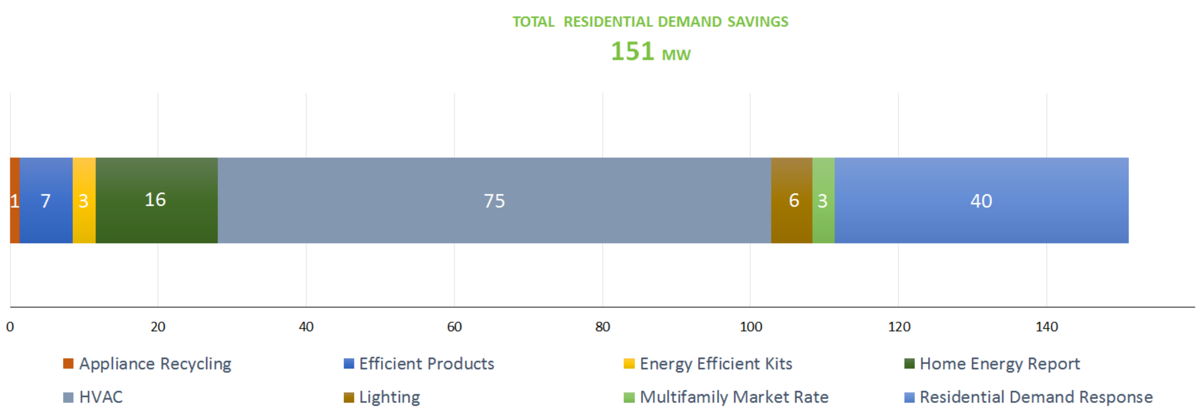
As Figure 20 below shows, the HVAC Program continues to contribute the largest portion of residential energy savings, at about 50% of the residential portfolio. As can also be seen in Figure 20, the Lighting Program contributes less than historically observed due to factors described earlier in this section.

Figure 20 – Cumulative Residential Energy Savings by Program



The figure below shows HVAC is the largest contributor to demand savings (at about 50%), with demand response contributing 26% and the remaining 24% from the other programs.

Figure 21 – Cumulative Residential Demand Savings by Program



The figures below illustrates that HER savings are only incremental for the first year. This is because behavioral energy savings for HER are estimated to have a one-year life and will occur annually as HERs are distributed throughout the implementation period.

Figure 22 – Incremental Residential Energy Savings by Program by Year

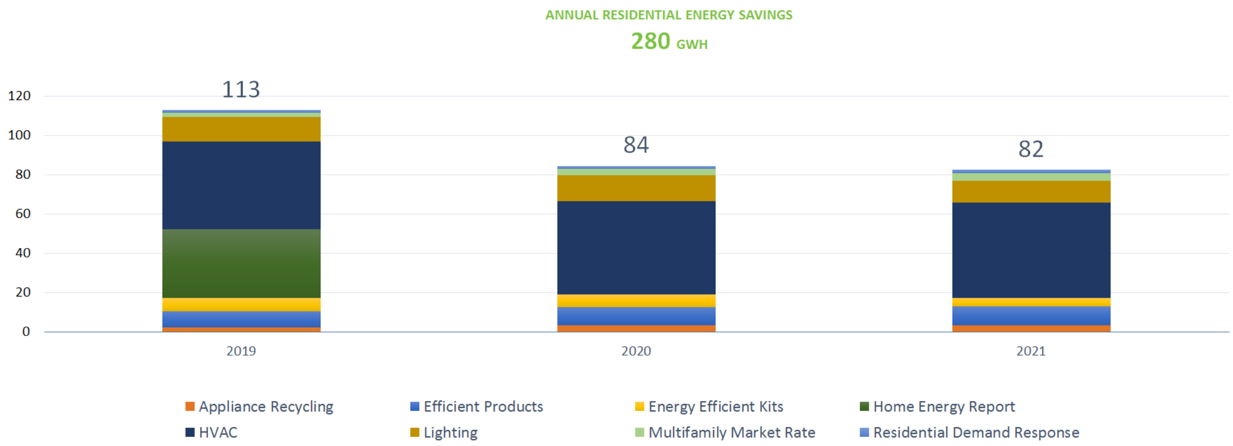
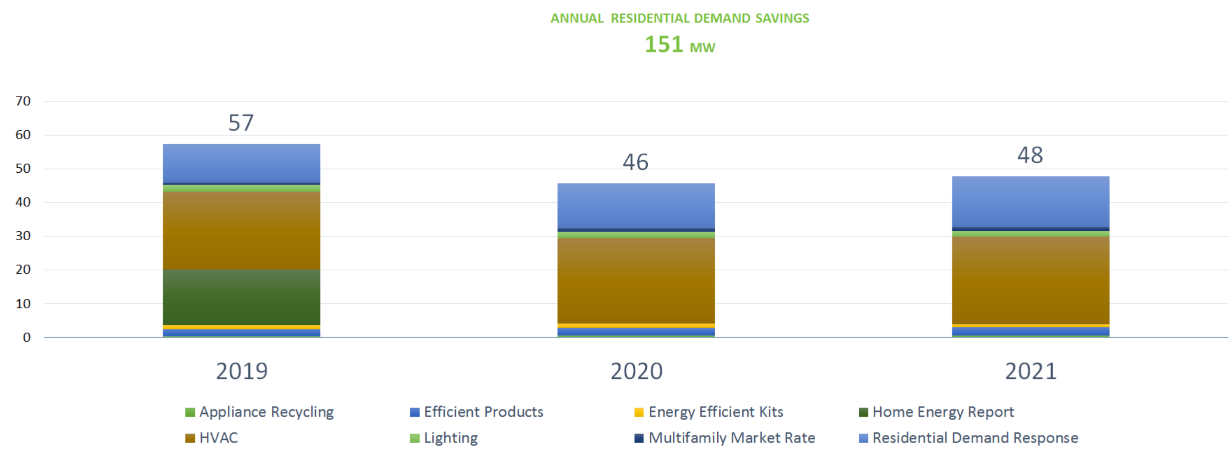
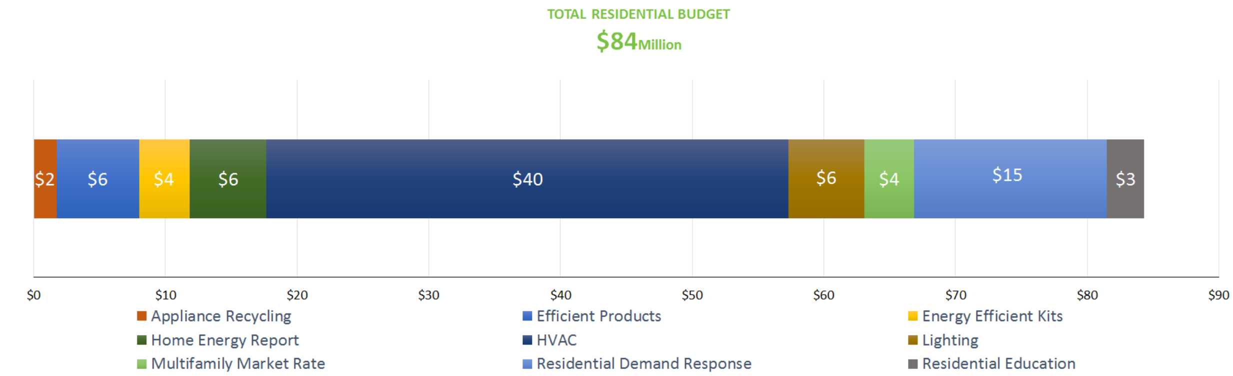


Figure 23 – Incremental Residential Demand Savings by Program by Year



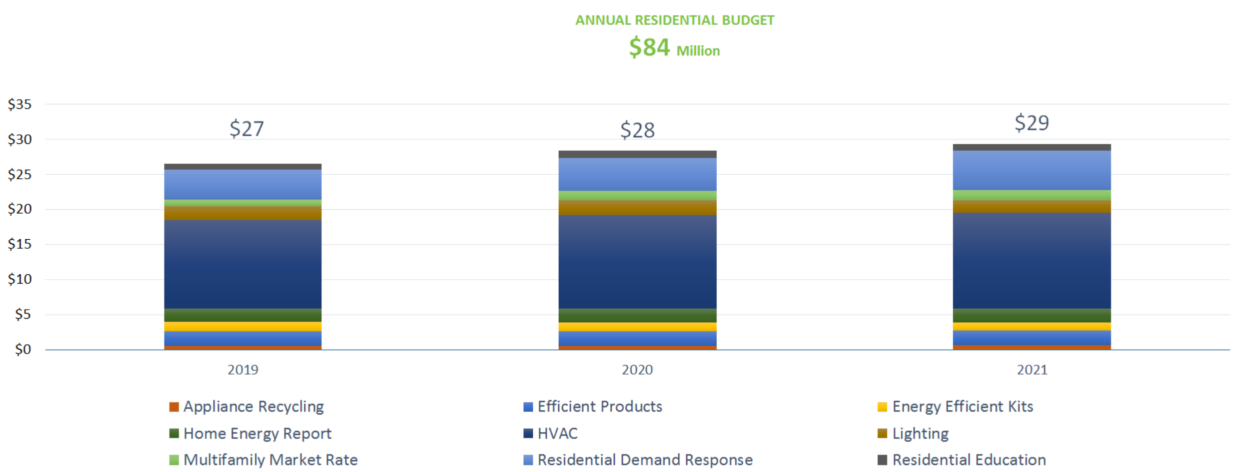
The HVAC and DR Programs make up the largest portion of the Residential Programs' budget at 64%, and have the highest impact on demand savings.

Figure 24 – Total Residential Budgets by Program



Most program budgets remain fairly consistent over the implementation period.

Figure 25 – Total Residential Budgets by Program by Year



The table below indicates, from a utility cost standpoint, residential customers will benefit $2.41 for every $1 spent.

Table 4 – Residential Sector Cost-effectiveness Summary (NPV)[8]

Residential Cost Effectiveness		
	Utility Cost Test	Total Resource Cost
Benefits	$ 222,766,709	$ 222,766,709
Costs	$ 92,287,103	$ 128,616,801
Net Benefits	$ 130,479,606	$ 94,149,908
UCT Benefits/Costs Ratio	2.41	
TRC Benefits/Costs Ratio		1.73

2.3 Business Sector Programs

The Business Sector Programs are built around the importance of customers understanding energy and being aware of how they use it, and Ameren Missouri's ability to identify and implement savings opportunities. In addition to expanding the current business portfolio by adding a DR Program, the Company is supporting customers by reducing barriers to participation through:

- A concierge-customer approach;
- Benchmarking and energy usage to identify savings targets;
- Using targeted business segments;
- Connecting businesses with trade ally contractors;
- Providing energy efficiency project finance options; and
- Offering a mobile energy savings application tool.

Each Business Sector Program is summarized below and a detailed description of each program can be found in Appendix B.

Standard Incentive	Provides incentives to customers to purchase energy efficient measures with predetermined savings value savings calculations and fixed incentive levels.
Custom Incentive	Applies to energy efficient measures that do not fall into the Standard Incentive Program. These projects are often complex and unique, requiring separate incentive applications and calculations of estimated energy savings.
Retro-Commissioning	This program has a special focus on complex control systems and provides options and incentives for businesses to improve operations and maintenance practices for buildings, systems, and processes, achieving electric energy savings.
New Construction	Provides incentives to overcome cost barriers to incorporating energy efficient building design and construction to achieve electric energy savings.
Small Business Direct Install	Provide installation of low-cost and/or no-cost energy-efficient measures to small business customers. Program providers will deliver, install and complete paperwork for measures provided for in this program. The primary objective of the

[8] Includes the lifetime costs and benefits of Demand Response programs over a 10-year effective useful life.

	Small Business Direct Install Program is to remove participation barriers for small businesses through a simple and streamlined process.
Demand Response - New	Provides customers the resources and incentives necessary to identify and take advantage of demand response opportunities.

EDUCATION PROGRAMS

Building Operator Certification - New	Ameren Missouri will coordinate with the Midwest Energy Efficiency Alliance ("MEEA") to offer BOC to business customers participating MEEIA Cycle 3. BOC achieves measurable energy savings in the operation of public facilities and commercial buildings by training individuals directly responsible for day-to-day operations. The Company agrees to work with a program implementer to support offering at least one, but no more than two, Building Operator Certification training series per year, with such funding not to exceed $25,000 per series.

2.3.1 Discussion of Selected Business Sector Programs

Building on Ameren Missouri's support of the City of St. Louis' "Building Energy Awareness" ordinance and the MEEIA 2016-18 benchmarking project, a new initiative will be started to allow customers to verify multiple electric accounts associated with a single facility and automatically upload the monthly aggregated usage data directly into the EPA ENERGY STAR® Portfolio Manager ("ESPM"). The first stage of this project, to be completed in 2019, is focused on (but not limited to) all single premise facilities with 4 or more electric accounts with an aggregate annual load of 48,000 kWh or greater. The objective of the second stage, to be completed in 2020, is to identify and implement a cost-effective energy tool that can effectively segment small business customers based on how effectively they use electricity. Some of the primary components will include business type, facility size, and historic electric energy usage. This will be used to identify and act on business energy efficiency opportunities. As part of this initiative, our approaches and value opportunities will be promoted and shared with other natural gas and water utilities.

The Company's outreach plans focused on specific business customer segments will be implemented using direct outreach by the program administrator and trade allies to educate customers on savings opportunities and secure energy efficiency incentives through the business programs. Targeted market approaches will include considerations such as business types, energy usage, energy intensity ratings, and Energy Star® benchmarking scores.

Concierge service will be implemented in MEEIA 2019-21 to support the customer through all phases of a project. As part of this service, business development representatives will coach customers to implement ESPM benchmarking and assist them with energy savings opportunities. For customers who participate in the programs and decide to pursue certification, the business development representative will also facilitate ENERGY STAR® Certification. A primary target segment is one or more electric accounts under a parent account using two million kWh annually, and applying additional criteria mentioned in the prior paragraph. Examples of customers in this targeting include school districts, property management groups, and government accounts such as state, county, and local governments.

Additionally, to aid with connecting customers with energy efficiency program trade allies, Ameren Missouri will initiate a web connection tool where a customer's potential projects, identified through the benchmarking process or other means, can be posted. This will provide trade ally members the opportunity to review each customer's potential project, engage in project development, and present energy efficiency upgrade proposals to customers. As part of the concierge service, the implementation specialist or business development representative will support customers with the upload of their project data into the web connection tool. This reduces customer barriers associated with identifying energy efficiency contractors and gives trade ally contractors an additional avenue to engage potential customers. A simple request form to submit potential projects will include customer contact information, proposal scope, technology (e.g., lighting, HVAC, refrigeration, etc.) and proposal timeline.

Ameren Missouri will also add finance options to energy efficiency incentive offers to help business customers move ahead with proposed upgrades. Continuing with the concierge service approach, financing options will be an integral part of the total energy efficiency incentive offer. An energy efficiency financial calculator will be used to demonstrate different financial structure scenarios, utilizing typical rates, terms, etc. Financing will be available for qualified customers through traditional business loans along with specialty financing such as Missouri Energy Loan Program and Property Assessed Clean Energy ("PACE"). The executed loan agreements and financing costs will be between the customer and lender.

Combined Heat and Power (“CHP”) can qualify under the Business Custom Program. Consistent with Ameren Missouri’s Custom project applications, CHP projects will be reviewed and approved on a case-by-case basis and approval shall be based upon available program funding and appropriate interconnection agreements. The Company will document all inquiries regarding CHP and retain records associated with such requests. The Company will inform the Missouri Division of Energy of all CHP customers.

The Business DR Program is new to the business portfolio. The Company will procure demand savings through an aggregator who will recruit customers using unique contract offerings and price points for each customer. With the aggregator providing the contracted demand savings, Ameren Missouri expects to register this DR program as a Load Modifying Resource in the MISO market.

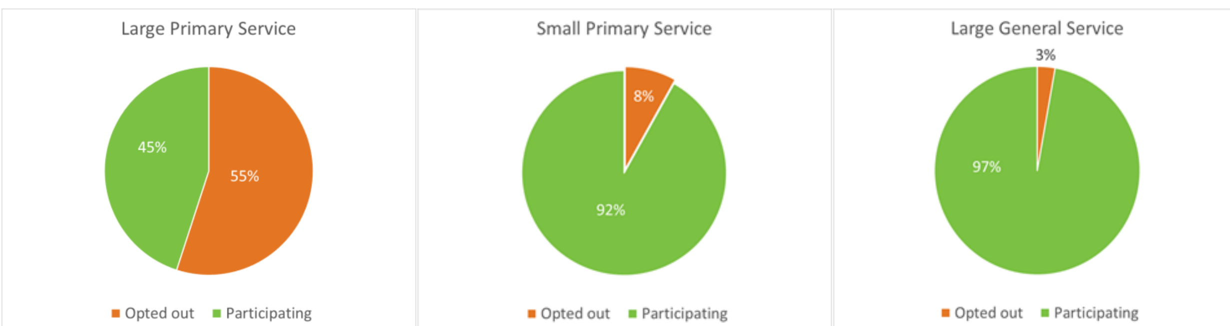
2.3.1.1 Business Customer Opt-Out

MEEIA allows eligible customers to opt-out of paying the costs of utility energy efficiency programs. Three categories of customers can opt-out:

- Customers with a single facility exceeding 5,000 kW of peak demand can opt-out without restriction;
- Interstate pipeline pumping station customers can opt-out without restriction; and
- Customers that can aggregate accounts to greater than 2,500 kW of coincident demand can opt-out provided the customer has a comprehensive demand-side or energy efficiency program and can demonstrate an achievement of savings at least equal to those expected from utility-provided programs. Opt-out shall be in effect for 10 years beginning with the first calendar year of the opt-out. Customers must declare their desire to continue to opt-out after the 10 years.

In 2017, 26 Commercial and Industrial ("C&I") customers opted out of the MEEIA program with their total annual load of 2,629,990 MWh. This is 14.1% of the total C&I customers' load. The figure below shows the percentage of energy by rate class that opted-out.

Figure 32 – Opt-Out Percentage by Rate Class (2017 Actuals)



Based on market information, approximately 9 additional customers with an approximate total load of 1,131,660 MWh may apply to opt-out in the 2018 fall opt-out window.

Customers electing to opt-out are not eligible to participate in the Business Demand Response Program since the program provides incentives to participating customers.

2.3.1.2 Transition Plan for Long-Lead Projects

Transition plans between MEEIA cycles are required to obtain all cost-effective energy savings and allow customers with long-lead projects that span cycles to take advantage of energy savings opportunities. A MEEIA 2019-21 transition plan will allow customers to accept an energy efficiency incentive commitment for projects during the MEEIA 2019-21 term and receive the incentive payment beyond the term, whether or not there is another MEEIA plan.

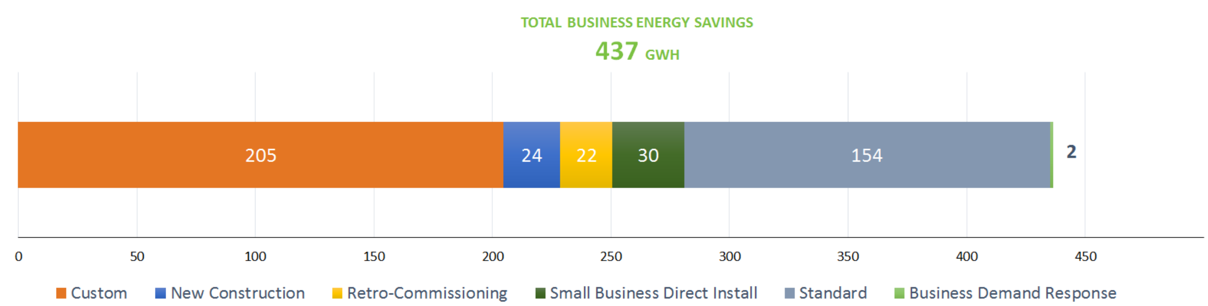
During MEEIA 2016-18, a transition plan was developed collaboratively with regulatory stakeholders and approved by the Commission. This transition plan allowed customers with long-lead projects to participate in MEEIA 2016-18 even if the completion dates of their projects fall after the current MEEIA cycle expires, as long as the completion date still falls within a specified timeline. With 9 months still remaining in MEEIA 2016-18, 57 long-lead projects in different stages of planning have an estimated total energy savings of 35,248 MWh and completion dates beyond MEEIA 2016-18. These customers would not have had the opportunity to obtain these savings without the agreed-upon transition plan. It is still anticipated the number of projects and savings requests may far exceed the $4 million MEEIA 2016-18 transition budget.

With the need to obtain additional knowledge on the effectiveness of the MEEIA 2016-18 transition plan, the Company will lead discussions with interested regulatory stakeholders about implementing a MEEIA 2019-21 transition plan by the end of the second program year.

2.3.2 Business Sector Summary Charts

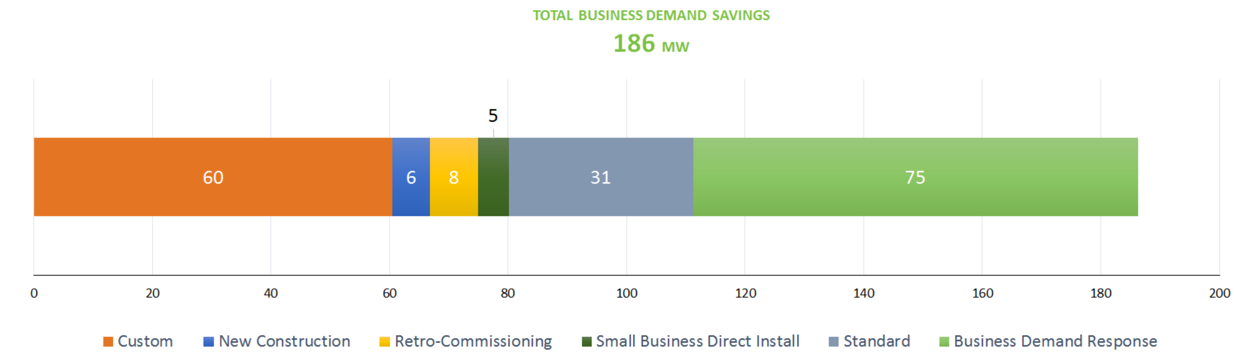
Over the implementation period, Custom and Standard Business Programs make up 80% of the total energy savings forecast with New Construction, Retro-Commissioning, Small Business Direct Install, and DR making up the remainder.

Figure 26 – Cumulative Business Energy Savings by Program



The Custom Program also leads in demand savings with the DR Program a close second, combining for 73% of the demand savings.

Figure 27 – Cumulative Business Demand Savings by Programs



The first year slow start in energy and demand savings is associated with the beginning of a new cycle and the programs not starting until March 1, 2019.

Figure 28 – Incremental Business Energy Savings by Program

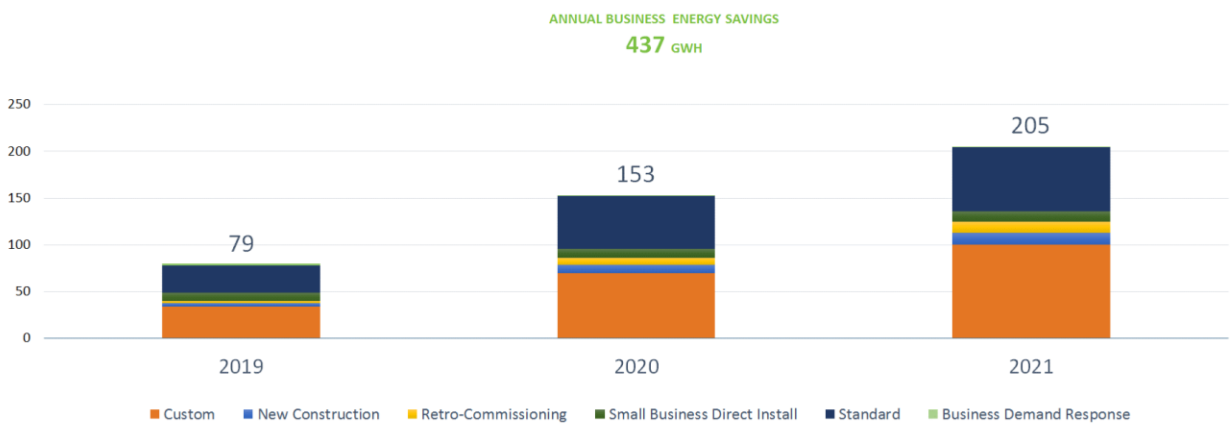
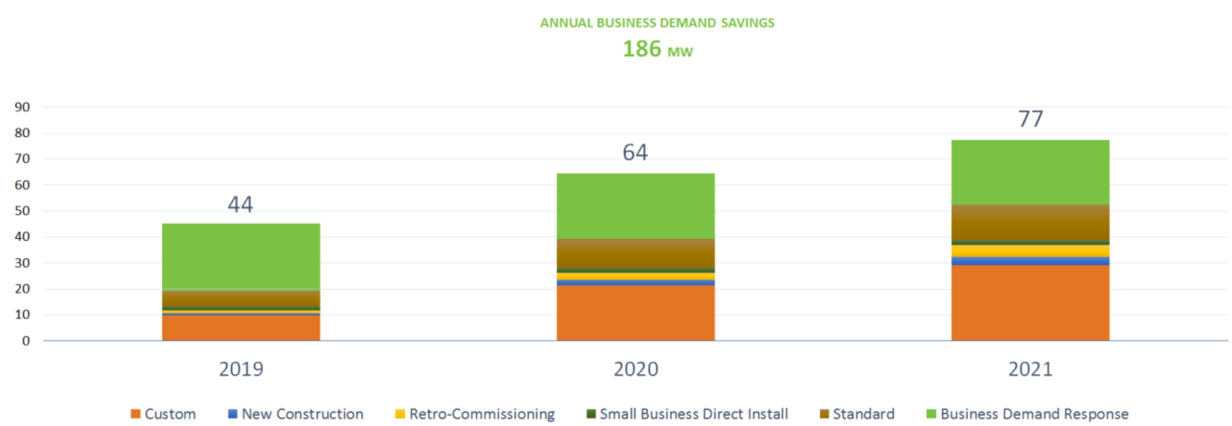


Figure 29 – Incremental Business Demand Savings by Program



Based on implementation budget cost versus associated demand reduction, the DR Program is the most cost-effective, with the Small Business Direct Install Program having the highest implementation costs versus energy and demand savings.

Figure 30 – Total Business Budgets by Program

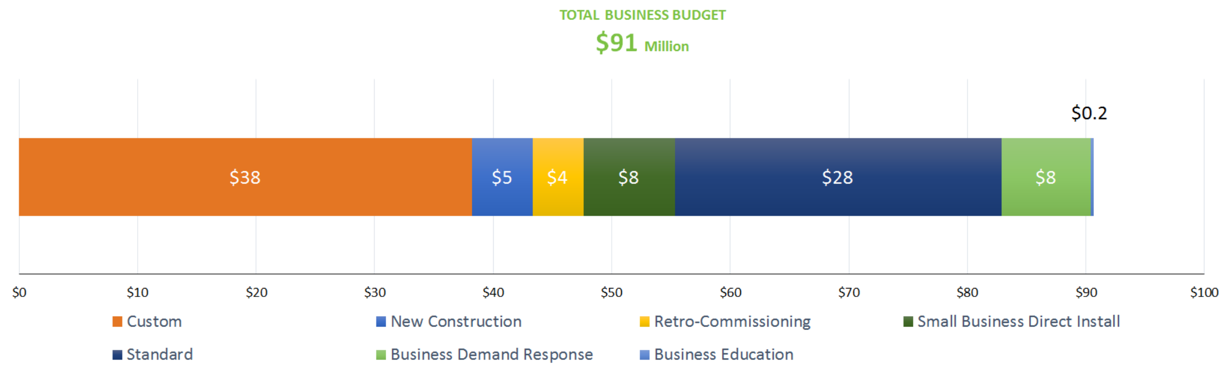
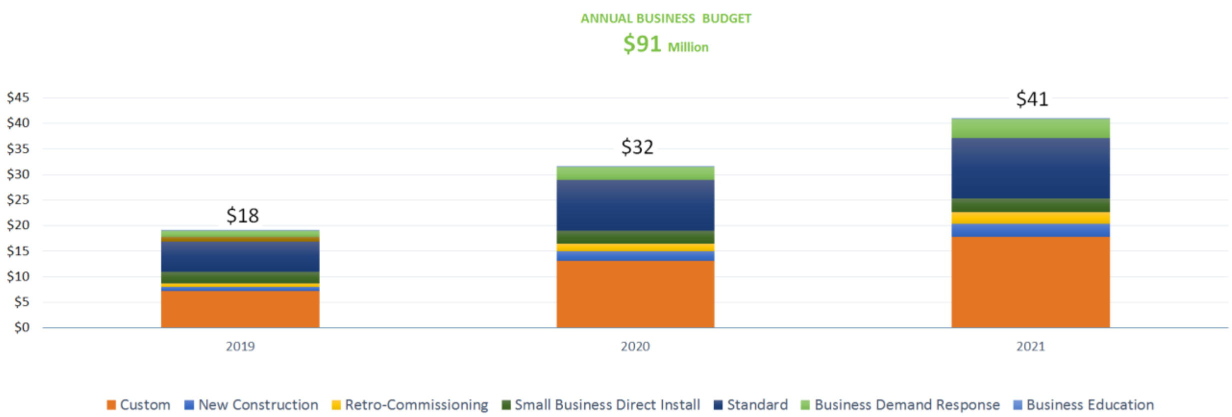


Figure 31- Total Business Budgets by Program by Year



When compared to Table 3 (Residential Sector Cost-Effectiveness), it is apparent that the Business Programs are significantly more cost effective.

Table 5 – Business Sector Cost-Effectiveness Summary (NPV[9])

Business Cost Effectiveness		
	Utility Cost Test	Total Resource Cost
Benefits	$ 314,984,687	$ 314,984,687
Costs	$ 105,331,695	$ 172,194,942
Net Benefits	$ 209,652,992	$ 142,789,744
UCT Benefits/Costs Ratio	2.99	
TRC Benefits/Costs Ratio		1.83

3.0 Evaluation, Measurement and Verification

3.1 Structure and Processes

A robust EM&V assessment of savings associated with a demand-side program is comprised of, at a minimum, an impact evaluation and a process evaluation. The impact evaluation answers whether the program works by taking a systematic assessment of the relevant data relating to the operational outcomes of a program (e.g., the MWh saved). The process evaluation provides insights on how the program can be improved through careful examination of program implementation, by reviewing existing procedures, and by interviewing program participants and program staff. This review attempts to determine whether procedures are being followed and how well the procedures are working.

Ameren Missouri will procure the services of an independent, third-party contractor to provide an objective assessment of the performance of the MEEIA 2019-21 portfolio. The completed evaluations will be performed in accordance with EM&V best practices like those documented in the International Performance Measurement and Verification Protocols and/or the Uniform Methods Project protocols. The use of established protocols reinforces the reliability of the assessed savings achieved by the energy efficiency programs.

The Commission rules require the use of an EM&V Auditor ("Auditor") hired by the Commission to audit and report on the work of Ameren Missouri's independent EM&V contractors. Ideally, for the MEEIA 2019-21 programs, the Commission Auditor:

1. Monitors the planning, implementation and analysis activities of Ameren Missouri's independent EM&V contractors;

[9] Includes the lifetime costs and benefits of Demand Response programs over a 10-year effective useful life.

2. Provides on-going feedback to Ameren Missouri's stakeholders on EM&V issues; and
3. Provides stakeholders with a copy of a final annual report in a timely manner.

A budget of 5% of the program administration and incentive costs has been established for the EM&V efforts during MEEIA 2019-21. Primary market research will be performed during the course of the EM&V program assessments. This will provide for an important, broader perspective on market/customer activities beyond the utility's programs, as well as an ongoing update to critical inputs used for program planning in a way that is internally consistent with the research conducted on utility demand-side resource programs.

3.2 Evaluation Contractor Role

In addition to the reporting of savings estimates, the evaluation contractors are expected to contribute meaningfully to operational efforts, to measure consideration discussions, to inform the design of customer forms and materials, to assist in the setup of the data tracking system, and to suggest program delivery modifications. Besides coordinating independent EM&V, Ameren Missouri requires implementation contractors to develop and implement internal Quality Assurance and Quality Control ("QA/QC"), inspection, and due diligence procedures. These procedures will vary by program and are in place to assure customer eligibility, completion of installations, and the reasonableness and accuracy of savings upon which incentives are based. Evaluators will review these QA/QC procedures. To be successful in these areas, it is important to maintain open lines of communication with both the evaluation contractors and the implementation contractors while maintaining the independence of all evaluation and implementation contractors.

3.2.1 Evaluation Plans

The evaluation plans are work plans developed at the beginning of the program cycle that fulfill the evaluation objectives and identify the planned activities undertaken in each program year with step-by-step action plans.

The sample evaluation plans found within Appendix E provide a high level description of the EM&V effort that will take place for each of the MEEIA 2019-21 programs. The detailed evaluation plans for each program will be developed and shared with stakeholders at least 30 days prior to program launch. As programs and markets evolve each year, the evaluation methods may need to change to ensure the evaluation method(s) being used continue to be appropriate. Findings from process evaluations and market assessments will help identify when to reassess impact evaluation methods. The regulatory stakeholders will be engaged with the development and review of the overall EM&V plan prior to its implementation and informed as modifications are made throughout the program cycle.

Ameren Missouri will conduct customer research as part of its annual evaluation process. Before each program year begins, the evaluator will submit a full evaluation plan to the Company, the program implementers, and the stakeholders for feedback. In addition to typical EM&V activities, the evaluation plan will cover topics through surveys and/or focus groups, such as gauging what customers want and in which programs they may be willing to participate and what barriers may keep customers from participating in programs. The Company will seek to determine, through its customer research methods, leading ways in which customers and specific customer groups (e.g., low-income, multi-family housing, homeowners) may be most effectively educated on energy efficiency measures as well as specific efficiency programs that would most likely be effectively utilized by such customer groups. Surveys will collect data regarding income level, rental versus owner status, multifamily versus single family, and zip code. Such customer research should encompass participants and non-participants.

3.2.2 Impact Evaluation

One of the most important aspects of evaluation is the measurement of savings achieved by implemented energy efficiency measures. The impact evaluation estimates of gross measure savings may include engineering analysis and formulas, building simulation models, meter data, statistical models and billing analysis. The evaluator is expected to complete annual impact evaluations of all programs. This will include any necessary measurement to recommend adjustments to the attributes of the measures, including changes/updates to measure inputs, incremental costs, and formulas to calculate savings and cost-effectiveness.

3.2.3 Demand Response Evaluation

Evaluations performed for a DR program differ from an evaluation done for an energy efficiency program. For DR, the evaluation will capture at least the following two measures of savings:

- The amount of demand reduced during a peak shaving event and the associated energy savings; and
- Total kW under control by the program at program year-end and available to be called under Ameren Missouri's system peak conditions.[10]

For Residential DR, the evaluation will include analysis of the time before an event to account for pre-cooling and after an event to account for snap back usage to return the home to a normal temperature setting. EM&V will also calculate energy savings on non-event days due to additional energy management activities undertaken through this program. Because DR is a resource used to meet future peak demand needs during a system peak event on the Ameren Missouri system, it is important to also report its

[10] This includes weather-normalized actual average event demand reductions (to system peak design conditions) and scaled to the total number of program participants at year end.

capabilities under conditions that are consistent with how Ameren Missouri forecasts peak demand and performs its long-term planning analyses. Therefore, DR capability will be weather-normalized to a design criteria consistent with the Company's peak forecasting weather assumptions. The normalized DR kW capability at this design criteria will then be multiplied by the total number of participants in the program at the end of the program year.

For Business DR, the actual meter readings during a DR event will be compared to the customer's baseline to calculate the consumption and demand savings per event. The DR annual capacity will be the average demand savings across all peak shaving events throughout the summer event season. Similar weather normalization and resource capability calculations will be performed on the Business DR to the extent they are relevant.

3.2.4 Process Evaluations

Ameren Missouri will again collaborate with its evaluators to identify appropriate process evaluation goals, procedures, and practices. These evaluations focus more on program design and delivery, market segments, and other societal factors that affect the program’s performance. Additionally, the evaluations will address the requirements of 4 CSR 240-22.070(8), which include:

1. Identifying primary market imperfections common to the target market segment;
2. Identifying the adequacy of market segment definition and the appropriateness of the market segments;
3. Identifying if the mix of end-use measures adequately addresses the market segment end-use needs and measure diversity;
4. Appropriateness of communication channels of market segment delivery mechanisms; and
5. Methods for overcoming identified market imperfections to increase customer acceptance and program effectiveness.

Further, the process evaluation will review the performance of the programs that are being delivered and make recommendations regarding improvements that can be made associated with the delivery of energy efficiency products.

Because of uncertainty in the residential lighting market (including the execution of equipment efficiency standards) and the fast pace of change in LED prices and adoption, for the Residential Lighting Program, the evaluation contractor will perform an annual assessment to identify specific Stock Keeping Units ("SKU") of lights for each delivery channel that should no longer be offered because of market changes.

3.2.5 Annual EM&V Reporting

As required by the Commission's MEEIA regulations, the evaluators will provide the regulatory stakeholders with a copy of the draft and the final EM&V report at the same time as they are provided to Ameren Missouri.

The reports will include energy savings and demand reductions for each of the programs and each of the residential and non-residential portfolios. The reports will also summarize *ex-ante* and *ex-post* measure level savings on which the updates for the Deemed Savings Table (Appendix F) and Technical Resource Manual ("TRM") (Appendices G – I) will be based.[11] Finally, the reports will include a summary of the process evaluation and will identify specific details regarding the impact methodologies and results as well as key findings, conclusions, and recommendations. Based on the annual evaluations, Ameren Missouri will complete the cost-effectiveness analysis at the program and portfolio level and calculate the net lifetime benefits of the programs to be included in the evaluation reports. Additionally, before the end of 2018, Ameren Missouri will host a meeting with stakeholders to develop high-level reporting protocols. These protocols include items like report structure, the use of standardized definitions, etc. This activity aligns well with certain efforts already underway with the Missouri Statewide Collaborative.

Similar to the process reflected in the Company's MEEIA 2013-15 and 2016-18 plans, as approved by the Commission, the below-described process is included in this Plan and will govern review and finalization of annual EM&V:

- EM&V reports will be completed for each program year the Plan. Seventy (70) days after the end of each program year, the EM&V contractor will circulate a draft EM&V report to all parties to the MEEIA 2019-21 case ("evaluation stakeholders") and the Commission's Auditor.

- Fifty-six (56) days after circulation of the draft EM&V report, the Auditor and each evaluation stakeholder can provide any comments and recommendations for report changes to the EM&V contractor and to all other evaluation stakeholders and the Auditor.

- Prior to issuing the Final EM&V Report, the EM&V contractor will host at least one conference call/meeting with the Auditor and the evaluation stakeholders to discuss the comments and recommendations for report changes. The EM&V contractor will determine what comments and/or changes are incorporated into the Final EM&V Report. Thirty-five (35) days after the deadline for comments and recommendations for report changes, a Final EM&V Report will be provided to all evaluation stakeholders and the Auditor by the EM&V contractor. Fourteen (14) days following the Final EM&V Report, the Commission's Auditor will issue its final report.

[11] The Deemed Savings Table and Technical Resource Manual are discussed further below.

- Any evaluation stakeholder who wants a change to the impact evaluation portion of the Final EM&V Report will have twenty-one (21) days from the issuance of the Final EM&V Report to file a request with the Commission to make such a change ("Change Request"). Any evaluation stakeholder filing a Change Request will set forth all reasons and provide support for the requested change in its initial Change Request filing. Responses to a Change Request may be filed by any evaluation stakeholder and are due twenty-one (21) days after the Change Request is filed. The response must set forth all reasons and provide support for opposing or agreeing with the Change Request. Within seven (7) days after the deadline for filing a Change Request (if a Change Request is filed), the evaluation stakeholders will hold a conference call/meeting to agree upon a proposed procedural schedule that results in any evidentiary hearing that is necessary to resolve the Change Request to be completed within sixty-three (63) days of the filing of the Change Request. The proposed procedural schedule will also recommend to the Commission that a Report and Order resolving the Change Request be issued within thirty (30) days after the conclusion of such a hearing. The evaluation stakeholders will be parties to a Change Request resolution proceeding without the necessity of applying to intervene. The procedural schedule for such a Change Request proceeding will provide that data request objections must be lodged within seven (7) days and responses will be due within ten (10) days (notifications that additional time is required to respond will also be due within seven (7) days).

- For purposes of calculating achievements towards annual earnings opportunity metrics, the Company will utilize the impact evaluation energy and demand savings (kWh and kW) estimates of the Final EM&V Report, as it may be modified by the Commission's resolution (using the above-described process) of any issues related to the impact evaluation portion of the Final EM&V Report.

3.3 Technical Resource Manual

The Ameren Missouri MEEIA 2019-21 TRM is largely based on the draft Missouri Statewide TRM, which was led and created in collaboration with the Missouri Department of Economic Development - Division of Energy. The draft Missouri Statewide TRM serves as the source for measure savings formulas and default inputs (to use in the absence of utility-specific evaluation results). The Deemed Savings Table represents the application of the formulas in the TRM for discrete measures that are being offered and also reflects the inputs into those formulas based on utility-specific evaluation results. The Deemed Savings Table is attached as Appendix F and the TRM is attached in three volumes as Appendices G - I: TRM-Introduction and User Guide (Appendix G); TRM-Business Measures (Appendix H); and TRM-Residential Measures (Appendix I). Together, the TRM and the Deemed Savings Table are important to improve the transparency of savings calculations. To facilitate further transparency, the Deemed Savings Table has been created in Excel with working formulas for each measure and organized in a way to improve connection to the formulas specified in the TRM. The evaluators will utilize the Excel-based Deemed Savings Table to save time by making updates to the measure savings/inputs inherent in the evaluation process and thus avoiding the extra effort typically expended after an evaluation to translate the EM&V results into the necessary regulatory updates. To the extent evaluators suggest alternative savings algorithms compared to what the TRM specifies, such recommendations will be made as part of the evaluation plans and justification will be provided.

The TRM and Deemed Savings Table are living documents that will be updated periodically throughout MEEIA 2019-21. Changes to the TRM will be submitted for Commission approval and will likely be a result of evaluations and/or the need to add additional measures. The Deemed Savings Table will be the primary source of savings used as inputs for the throughput disincentive calculations and will be updated regularly (roughly annually depending on evaluation cycles) to reflect updates to measure savings from evaluations. To the extent final EM&V results from program year 2017 of MEEIA 2016-18 require, the TRM and/or Deemed Savings Table included with this Plan will be updated before the start of the Plan's programs. To the extent the Deemed Savings Table requires only changes to measures and measure inputs, those updates will be achieved by following steps 3,4,5,6, 10, & 11 of the 11-Step Change Process outlined in the Company's tariffs.

3.4 Net-To-Gross

The TRM and Deemed Savings Table described above govern the estimation of the gross impacts of the measures delivered by Ameren Missouri's programs. However, a second and important part of the savings equation is the estimation of net savings based on application of a Net-to-Gross ("NTG") ratio. The NTG ratio is what establishes the amount of savings that are attributable to utility programs.

The MEEIA 2019-21 equation for estimating the NTG ratio for energy efficiency programs is:

$$\boldsymbol{NTG\ Ratio} = 1 - Freeridership\ ratio + Spillover\ ratio$$

$$(where\ the\ denominator\ in\ each\ ratio\ is\ the\ gross\ savings)$$

Free-ridership is the program savings attributable to free-riders (program participants who would have implemented a program measure or practice in the absence of the program).

Spillover refers to additional reductions in energy consumption or demand that are due to program influences beyond those directly associated with program participation. As a result, these savings may not be recorded in the program tracking system and credited to the program.

4.0 Demand-Side Investment Mechanism

The DSIM included in the Plan reflects a set of regulatory policies and practices that provide timely recovery of program costs, align the financial interests of the Company with helping its customers use energy more efficiently and in a manner that sustains or enhances its customers' incentives to use energy more efficiently, and provide an earnings opportunity. For the MEEIA 2019-21 plan, the DSIM from MEEIA 2016-18 provides a useful framework from which to begin. In fact, the basic structure of the DSIM proposed for MEEIA 2019-21 is very similar in most respects to the DSIM that is currently in place for the MEEIA 2016-18 programs. Ameren Missouri has updated its analysis to reflect new portfolio characteristics, new avoided costs, and new margin rates to produce updated throughput disincentive and earnings opportunity components of the DSIM. Overall, the existing framework has been effective in aligning incentives and otherwise discharging the Commission's obligations under MEEIA. As noted, the proposed DSM includes three components: 1) program cost recovery; 2) throughput disincentive recovery; and 3) an earnings opportunity. These components and other terms of the DSIM are outlined further below. In addition, the operation of the DSIM and its defined terms, which are explained in this report, are also embedded into the Rider EEIC tariff, included with this report as part of Appendix J. Appendix K includes the proposed notice to explain the proposed DSIM to customers, while Appendix L shows a sample of how the DSIM line item will appear on a residential and non-residential bill.

Below are key elements of the proposed Rider EEIC that are also a continuation of the MEEIA 2016-18 DSIM framework:

1) The Company will make a Rider EEIC filing each calendar year to become effective as of the subsequent calendar year’s February billing month. The Company is allowed, or may be ordered by the Commission, to make one other Rider EEIC filing in each calendar year with such subsequent filing to be effective beginning with either the June or October billing month (to coincide with rate changes in the Company's Fuel Adjustment Clause rate).
2) The Energy Efficiency Investment Rate (EEIR) will be the sum of the Net Program Costs (NPC), Net Throughput Disincentive (NTD), Net Earnings Opportunity (NEO), and Net Ordered Adjustments (NOA) divided by the Projected Energy, in kWh, forecasted to be delivered to the customers to which the Rider EEIC applies during the effective period (typically the 12 billing months applicable to the Rider EEIC filing).
3) Each subcomponent of the EEIR will include a monthly reconciliation of actual costs to billed revenues with interest at the Company's short-term borrowing rate.
4) Any remaining reconciliation balances from MEEIA 2016-18 for program costs, earnings opportunity, and other Commission-ordered amounts will be rolled into the respective reconciliation balances for MEEIA 2019-21 starting in February 2022. Any remaining reconciliation balance for MEEIA 2016-18 throughput disincentive will be rolled into the throughput disincentive reconciliation balance for MEEIA 2019-21 starting in February 2024.

4.1 Cost Allocations[12]

Residential Program costs and throughput disincentive will be recovered from the residential service class, with the exception of low-income costs as explained below. Non-residential program costs will be allocated based on non-residential service classification retail sales (kWh) as adjusted for opt-out, while the non-residential throughput disincentive will be allocated based on MEEIA 2019-21 energy savings for each respective non-residential service classification. Portfolio-level common program costs, low-income program costs, low-income throughput disincentive, and the low-income Rider EEIC exemption will be allocated to each service classification based on retail sales (kWh) as adjusted for opt-out of eligible business customers. The earnings opportunity will also be allocated to each service classification based on retail sales (kWh) as adjusted for opt-out.

4.2 Program Costs

For the program cost recovery component of the DSIM, the coming year's program expenses will be forecasted and included in Rider EEIC. Each month, the cumulative difference between actual program expenditures and actual revenues billed for program costs will accrue short-term interest and be trued-up through Rider EEIC over the following year. In short, Rider EEIC reflects identical mechanics of program costs as reflected in the current Rider EEIC.

Program costs to be recovered include the cost of customer incentives, administration and professional services (including business development, project analysis, trade ally management, planning, and customer interaction), incremental energy efficiency labor and benefits, marketing (including creative development, direct mail, television, radio, social media, collateral, and program literature), potential study, EM&V, data tracking, education (including energy efficiency awareness activities, programs to educate customers about energy efficiency and conservation), and other costs. These will be tracked by specific project codes within accounts 908 or 930 and an Activity Code of "M3PC" for each program in MEEIA 2019-21, as seen in Appendix M. Costs will be further delineated using Resource Types. For example, the Resource Type "CI" will be used for customer incentives, "EX" for administration and professional services, and other Resource Type for other costs, as specified in Appendix M.

Different than MEEIA 2016-18, the MEEIA 2019-21 DISM includes the Company's internal incremental labor costs until those labor costs are included in base rates. This change in treatment of internal labor costs is directly related to the expected increase of internal resources due to the aggressive expansion of the portfolio. Incremental labor for MEEIA 2019-21 will be for employees hired by Ameren Missouri after Commission

[12] Ameren Missouri is not proposing programs for its Lighting Service classifications; therefore, no MEEIA 2019-21 costs will be allocated to or charged to those classes at this time.

approval of the Plan who were 1) hired by Ameren Missouri after Commission approval of the MEEIA 2019-21 Plan that were (a) not hired to replace an Ameren Missouri or Ameren Services Company employee whose labor and benefit costs were accounted for in Ameren Missouri's prior general rate proceeding, (b) hired by Ameren Missouri and assigned exclusively to support Ameren Missouri's MEEIA Programs; and 2) were not an Ameren Missouri or Ameren Services Company employee whose labor and benefit costs were accounted for in Ameren Missouri's prior general rate proceeding. For such qualifying employees, the accounting for their time will be fixed so that it is charged directly to the MEEIA programs using a unique project code for Incremental Labor and the M3PC activity code, which will result in such an employee's labor and benefit costs being charged to the MEEIA programs as a program cost and included in Rider EEIC.

Throughput Disincentive

Over the Company's last two MEEIA cases, the throughput disincentive has been extensively documented, analyzed, and included in the Commission-approved DSIM. It is well documented that energy efficiency savings cause negative impacts on utility earnings due to the combination of regulatory lag (the time it takes to incorporate changes in billing determinants into base rates) and through the reliance on volumetric rates to cover fixed costs. Throughput disincentive starts impacting the utility the moment an energy efficient measure is installed, so absent an appropriate solution the negative earnings impact is immediate, cumulative, and continuous until base rates are updated to reflect the reduction in billing units. Therefore, in order to align utility incentives with helping customers use energy more efficiently, the reduction in revenues associated with covering fixed costs must be offset by allowing throughput disincentive recovery. The recovery of throughput disincentive is explicitly allowed by the updated MEEIA rules. In addition, to avoid a negative impact to utility earnings, the revenue from recovery of the throughput disincentive must meet a specific accounting standard due to the nature of what is being recovered (i.e., revenues that the Company would have received had it not implemented its MEEIA portfolio).

According to accounting rules that govern the types of revenues that come from Ameren Missouri's DSIM, in order to recognize the additional revenues to be billed in the future and to avoid a contemporaneous reduction in Company earnings, all of the following conditions must be satisfied:

1) The demand-side program must be established by an order from the utility's regulatory commission that allows for automatic adjustment of future rates (verification of the accuracy of the adjustment to future rates by the regulator would not preclude the adjustment from being considered automatic);

2) The amount of additional revenues for the period must be objectively determinable and probable of recovery; and

3) The additional revenues must be collected within 24 months following the end of the annual period in which they are recognized.

The Company's MEEIA 2016-18 Rider EEIC met these accounting requirements, and the proposed MEEIA 2019-21 Rider EEIC continues the key elements necessary to meet these accounting requirements.

Based on a margin rate analysis (that analyzed all customer bills for 12 months) and rate class level energy and demand savings estimates by end use categories, the Company has estimated total throughput disincentive for MEEIA 2019-21 of $51 million over 8 years (throughput disincentive continues until the first rate case with a true-up period that covers the last month of MEEIA 2019-21).[13] Actual throughput disincentive will be based on actual measure installations and relevant updates to inputs (e.g., TRM and Deemed Savings Table, margin rates, rebasing amounts, etc.) based on actual future EM&V results as well as general rate proceeding timing and outcomes.

Estimating the throughout disincentive requires detailed modeling of energy savings by rate class and by end-use category, interacted with ratemaking fundamentals. The Company has developed this detailed modeling over the years and has consistently made it more granular and more accurate. In fact, the MEEIA 2016-18 throughput disincentive recovery mechanism reflects these mechanics, and the Company has used the MEEIA 2016-18 Rider EEIC spreadsheets to estimate the throughput disincentive for MEEIA 2019-21. To forecast MEEIA 2019-21 throughput disincentive, the Company assumed that energy savings by rate class will follow the same split as the recent experience with MEEIA 2016-18 (March 2016 through January 2018).

With energy savings by rate class and end-use category, the next step is to convert those energy savings into dollars, which happens by multiplying rate class savings by a rate class margin rate (i.e., the rate portion associated with covering fixed costs). Because the Company's MEEIA 2016-18 programs have targeted demand savings more aggressively than MEEIA 2013-15, the marginal rate analysis needed to determine margin rates has been updated and the explanation of that update is below.

4.2.1 Marginal Rate Analysis

In order to quantify the financial impact on utility revenues and margins resulting from the decline in usage associated with the adoption of efficiency measures, it is necessary to identify the specific rate that is applied to usage of the customers and is reduced as such measures are implemented. This is more complicated than it may initially appear, as each customer class has a unique rate structure and not every kilowatt-hour of energy and kilowatt of demand is priced the same. In order to accurately assess the

[13] For purposes of this analysis, the Company assumed a rate case is filed July 1, 2019, then every 24 months thereafter.

financial impacts of the throughput disincentive, the Company has performed a study to determine the marginal rate for the average customer in each tariff class. Because of the unique rate structures applicable to each class, customers might pay a different amount for marginal usage or for the last kWh consumed than they do on average for all of their usage. This is relevant in the context of the throughput disincentive because customers that use less energy due to installation of energy efficient measures experience a reduction on their bill according to the price of the last kWh consumed (or the last kW of billing demand established for customers on a rate with demand charges). Therefore, using marginal rates will help accurately measure the bill savings to participants and of the throughput disincentive to the Company. To come up with marginal rates for each tariff class - and each end use category for classes with demand charges as will be discussed further below - every bill of every customer was analyzed for a one year period.

The Company first downloaded all of the bills for every customer from the 12-month period ending with the March 2018 billing month. Every bill was then calculated manually based on the applicable usage characteristics and tariff rate components. Next, each bill's usage was reduced by 1%, 5%, and 10%. These usage declines were used to simulate the effect of various energy efficient measures. For example, replacing a couple of light bulbs at a customer premise that has a relatively large load might only impact that customers' consumption by a percent. Replacing the air conditioning unit for a customer might save 10% or more of their usage. By analyzing 1%, 5%, and 10% declines, we can see the marginal impact on the bill of assorted types of measures. For the LGS, SPS, and LPS customer classes, which feature rates that include demand charges, this exercise was replicated to simulate the impacts of various end use categories, each of which may have a unique impact on energy and demand savings and may vary due to the seasonality of some of the end uses. For each scenario of usage reduction – and for each end use category for the applicable classes - the bill was recalculated. The result is to have a calculation representing the original bill and a bill after the implementation of various types of energy efficient measures. The total energy consumption and total billed revenues for each scenario were then summed from the individual customer bills. The three scenarios of usage reduction were compared to the base case by calculating the change in revenue and change in consumption relative to that base case. The division of those two components ($/kWh) results in the average customer's marginal rate. The table below shows the calculations for the residential rate class assuming a 1% usage decline induced by energy efficiency.

Table 6 – Marginal Rate Study: Residential Class 1% Energy Reduction

		Summer	Non-Summer	Total
Actual Bills	Class Usage (kWh)	4,712,942,640	8,438,376,647	13,151,319,287
	Class Revenue	592,888,184	640,673,540	1,233,561,724
	Average Rate	**$ 0.126**	**$ 0.076**	**$ 0.094**
1% Energy Reduction Case	Change in Usage (kWh)	(47,129,426)	(84,383,766)	(131,513,192)
	Change in Revenue	(5,928,882)	(5,580,781)	(11,509,663)
	Marginal Rate	**$ 0.126**	**$ 0.066**	**$ 0.087**
Marginal Rate vs Average Rate		**100%**	**87%**	**93%**

Note that in the summer the marginal and average rates are identical for this class. That is logical considering the rate structure. In the summer period, all kWh of residential usage are priced the same. If every unit of energy has the same price, by definition the average and marginal unit must have the same price. However, in the non-summer period, the first 750 kWh of consumption per customer per month are priced at one rate and any additional kWhs are priced at a lower rate. This is called a declining block rate structure.[14] Since the marginal usage for many customers occurs in the lower priced block, the bill reductions will actually occur at something less than the average energy rate. In this case, after analyzing all of the bills from that one-year period, the marginal rate is 93% of the average rate (or 7% lower).

For the other rate classes, the results are noticeably different. Each tariff has distinctive features of rate design. For the Small General Service ("SGS") class, the rate design is similar to the Residential class, with one notable exception: the size of the block after which the non-summer period declining rate structure is initiated is variable and customer specific. Each customer's May through October billing month usage is used to establish the cut off point for the declining block rate. When a customer uses less in the May-October timeframe (as they implement energy efficient measures), they essentially establish for themselves a more favorable block cut-off for the non-summer months, giving them a discount on more usage for the rest of the year. This unique feature of this rate actually causes the marginal rate to be higher than the average rate on an annual basis.

For the Large General Service ("LGS") and Small Primary Service ("SPS") rate classes, there is a common rate design that is sometimes referred to as an hours use rate. This more complex rate is not described fully here due to the technical complexity, but the workpapers with the filing have all of the supporting details. The notable feature of this rate is that, because it is applicable to a wide range of usage levels of

[14] The rationale for this type of rate structure is grounded in the fact that Ameren Missouri's maximum load occurs in the summer. Capacity is built to meet that load, but often results in excess capacity in the winter. The declining block winter rate reflects lower costs associated with more efficient utilization of the Company's existing fixed assets.

customers and incorporates interactions between a demand and energy charge, the hours use rate causes the average and marginal rates to be identical for all customers and usage levels that have a constant load factor.[15] The only way the marginal rate and average rate can be different is if the energy efficiency measure impacts the customer's billing demand differently than its energy. To assess the relative impacts of energy efficiency on energy consumption relative to demand, the Company used end use load shapes and load research data to determine the relationship between demand and energy savings of various energy efficiency measure categories. The end use load shapes used in this analysis were originally developed for the Company's 2017 IRP, and represent load research that characterizes the consumption patterns associated with customers' utilization of certain end use categories, such as lighting, refrigeration, air conditioning, etc.[16] For each end use category, the peak usage day of each month was identified from the load shape. Then, for each class, the hour of the day where the class peaks[17] (the hour which the classes' usage reaches its highest level) is identified. The value from the end use category load shape from the peak day of each month for the hour at which the class peaks is taken to estimate a reduction in billing demand for a given level of energy usage – which is represented by the sum of the hourly values from the end use category load shape for the given month. The marginal analysis incorporated this end use load shape information to determine the estimated percent reduction in customer billing demand for a given percentage energy reduction by month and by class, by comparing the end use category's impact on billing demand and energy as determined in the steps described above to the class demand and energy from the Company's load research in order to understand the relationship between energy savings and demand savings. This relationship between demand and energy was applied to the usage reduction scenarios (1%, 5%, and 10% savings) to determine corresponding reductions to monthly billing demands to be used when recalculating customer bills. For the end use categories with strong seasonal differences in usage (i.e., heating, cooling), the demand impact was set to zero in the "off" seasons (e.g. summer for heating and winter for cooling) due to the negligible usage of those end uses during those seasons.

Even though the rate design is slightly different, a similar method of analyzing

[15] The load factor is the ratio of the average usage level to the maximum usage level. It is informative about how efficiently a load utilizes capacity. A high load factor is indicative of a customer that has a relatively flat usage profile. This results in a lower average rate for the high load factor customer, since there isn't a need to build as much excess capacity that will remain idle during the customer's lower usage periods.

[16] The full list of end use categories for which unique marginal rate impacts are calculated includes: cooling, heating, water heating, cooking, refrigeration, miscellaneous/air compressors/motors, lighting, exterior lighting, HVAC (which applies to measures that impact both heating and cooling use), office equipment, and ventilation.

[17] The peak day of the class may not be the same as the peak day identified by the end use categories' load shape.

energy savings by end use categories was utilized for the Large Primary Service ("LPS") rate class to determine demand savings given a kWh or energy savings.

Once the marginal revenue reductions associated with each kWh of savings have been calculated, the marginal rate is reduced by a factor derived from the Company's Fuel Adjustment Clause ("FAC"). The marginal rate for each class (and end use category where applicable) is further reduced by the per kWh credit applied to all customer bills in that class as a result of the rate reduction implemented in the summer of 2018 to return the benefits associated with the federal income tax rate reduction to customers.

The resulting margin rates are different on a class-by-class basis and a month-by-month basis due to the load characteristics of that class and how they interact with the demand and energy savings associated with efficient measures. The margin rates determined by the marginal rate analysis for each class and end use category, where applicable, are presented in Appendix J.

It should be noted that the various cases (i.e., 1%, 5%, and 10% reductions) produced extremely similar results to each other, to the point of being immaterial in terms of the differences. This indicates that regardless of the size of the impact of the energy efficient measure, the margin rate is similar. With each general rate proceeding, the process above will be repeated to produce updated margin rates to reflect the outcome of the rate proceeding with regard to potential changes to items such as customer usage data, demand and energy savings by end use category, underlying costs, and class rate designs. Updated margin rates resulting from general rate proceedings will be updated in Rider EEIC and used for throughput disincentive calculations from that point forward until the results of the subsequent general rate proceeding. The process described above will be followed for those updates, using the same demand and energy relationships derived from the end use category load shapes, but excluding the tax reform rate credit to the extent that the credit is being discontinued in that case as the effects of the tax reform are directly incorporated into base rates.

4.2.2 Throughput Disincentive Calculation for Rider EEIC

The throughput disincentive ("TD") calculation will largely follow the same procedure as what is being used in MEEIA 2016-18 with the addition of Demand Response Event Net Energy component that will be handled differently due to the short-term nature of the savings associated with peak shaving events.

The first input required for the monthly throughput disincentive calculation is the kWh savings by end-use category by rate class. Monthly load shapes by end-use category are used to distribute types of energy savings (which are reported as annualized kWh savings) across the months in the year to better reflect the seasonality of the savings that were achieved. For example, the cooling category has most of its savings during the summer months while the lighting category has savings spread out more evenly with an increase in the winter months. The end-use categories and load shapes are detailed in volume 1 of the TRM (Appendix G). The conversion to monthly savings data allows the Company to determine current month energy savings[18] as well as cumulative monthly energy savings from prior month energy savings activities. As energy savings are incorporated into base rates, the cumulative monthly savings are reduced to avoid double counting. The process of including savings in base rates and rebasing the throughput disincentive is discussed further below. Next, the savings are multiplied by a NTG factor. Each program year will use an initially-assumed NTG of 0.85 until such time as ex-post gross savings and a NTG factor is determined through EM&V for that program year. Thereafter, for each given program year, the ex-post gross savings and NTG factor determined through EM&V will be used. This net monthly savings (current month plus cumulative savings less savings included in base rates) by rate class is then multiplied by the appropriate margin rate to arrive at the monthly dollar value of throughput disincentive by rate class.

When base rates are adjusted, upon the conclusion of a general rate proceeding or otherwise, the cumulative, annualized[19], and normalized (at a net-to-gross factor of 1.0) kWh savings from all active MEEIA programs, except for Demand Response Event Net Energy ("DRENE"), will be reflected in the unit sales and retail revenues used in setting the rates through the rate case true-up period.[20] In addition, the rate case test period hourly loads used for fuel modeling will be adjusted to reflect the annualization of kWh for MEEIA programs, except those listed above, using hourly end-use category load shapes. Upon the adjustment for the kWh savings in the rate case, the throughput disincentive will be rebased to subtract the kWh savings that are reflected in the billing units used to establish new rates from the cumulative kWh savings when the rates take effect. The

[18] Current month savings are divided by 2 to reflect a "half-month" convention, which reflects the fact that not all measures were installed on day 1 of a month just as all measures were not installed on the last day of the month.
[19] The Home Energy Report and Education Programs will not be annualized.
[20] The Procedure for computing the MEEIA annualization adjustment for billing units is as follows:

Step 1: Begin with estimated actual hourly load per class;
Step 2: Compute hourly weather normalized energy per class for Step 5;
Step 3: Compute calendar month energy efficiency annualization adjustment based on the difference between the actual monthly energy efficiency savings realized and the annualized energy efficiency savings for each end-use measure category and rate class;
Step 4: Compute hourly energy efficiency annualization adjustment by using the applicable end-use hourly shape for each measure category applied to the results of Step 3;
Step 5: Apply the hourly energy efficiency annualization adjustments from Step 4 to the hourly weather normalized energy from Step 2 (as adjusted for growth). The results of this step are to be used in the hourly loads used for fuel modeling; and
Step 6: Convert calendar month energy efficiency annualization adjustments from Step 3 to billing month energy efficiency annualization adjustments by computing a weighted average of the calendar months based on billing cycle percentages

rebasing adjustment will be applied for each program year vintage accordingly with the relevant vintage ex-post gross savings and portfolio-level net-to-gross factor.

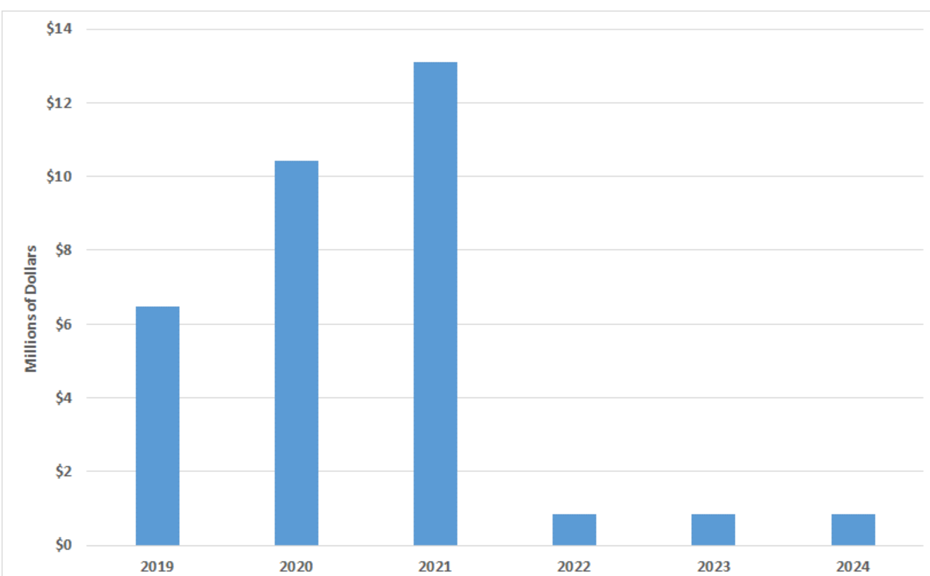
DRENE savings resulting from a demand response event are treated differently than first year savings from energy efficiency measures (including demand response annual energy savings). The DRENE savings are for a specific period and would not be allocated by load shape across the whole year. The savings also do not continue into any subsequent months. All of the throughput disincentive is occurring within a month and will be recovered within the same month. Any DRENE savings occurring in the test period used to establish base rates will be added back to the observed loads in those periods and the throughput disincentive associated with future DRENE savings will be recovered through the DSIM.

4.3 Earnings Opportunity

4.3.1 Earnings Opportunity Payouts

The Company has included an annual average earnings opportunity of approximately $10 million, which equates to a total of $30 million for the 2019-21 implementation period with another $2.5 million associated with the 2022-24 period for the low-income programs. The chart below shows the target annual payout amounts based on the performance targets in each year. This section further provides the details of the various performance targets as well as the justification of the earnings opportunity amount.

Figure 33 – Annual Earnings Opportunity Payout Targets



Earnings Opportunity Calculator

The MEEIA 2019-21 earnings opportunity includes annual targets, in contrast to a cumulative goal over the entire Plan implementation period. To determine the annual earnings opportunity award, the Earnings Opportunity Calculator (included as Appendix N) will be used. The Earnings Opportunity Calculator is a spreadsheet with a sheet for each program year containing all of the necessary calculations and details to calculate the earnings opportunity award. The Earnings Opportunity Calculator also has the cells color-coded to identify which cells are formulas, static inputs that do not change (like performance targets), input cells for EM&V results, and the earnings opportunity award payout amounts. Each of the seven performance metrics is setup in the Earnings Opportunity Calculator such that the EM&V results for each program year are the only cells (highlighted in blue) that are to be updated and the spreadsheet will automatically calculate the annual earnings opportunity payout amount for each program year. Each performance metric also has a performance target and maximum performance cap built into the Earnings Opportunity Calculator. Ameren Missouri will instruct its EM&V contractor to include a separate section in a portfolio summary report with each input for each performance metric in the Earnings Opportunity Calculator.

The seven metrics used in the earnings opportunities:

1) Average Percent Energy Savings Per Property for Multifamily Low-Income Program;
2) Average Percent Energy Savings Per Property for Single Family Low-Income Program;
3) Energy Savings of HER Program;
4) Subtotaled Portfolio Energy Savings for energy efficiency programs;
5) Subtotaled Coincident Peak Demand Savings from Measures 10-14 Year Useful Life;
6) Subtotaled Coincident Peak Demand Savings from Measures ≥15 Year Useful Life; and
7) Cumulative Demand Response Capability for demand response programs.

Inclusion of Throughput Disincentive True-up in the Annual Earnings Opportunity

After the completion of each program year, the EM&V schedule will be followed and those evaluated results will be input into the Earnings Opportunity Calculator. The Earnings Opportunity Calculator will determine the annual earnings opportunity award, which will be included in the subsequent Rider EEIC filing for recovery. Along with the annual determination of the earnings opportunity award, a true-up of the throughput disincentive will be determined for the program year based on the EM&V results compared to what was included in Rider EEIC as deemed savings. NTG will be trued-up at the portfolio level. The true-up amount (positive or negative) will be added to the annual earnings opportunity award amount subject to a floor of $0 per year. Program year vintages of throughput disincentive shall be tracked and trued-up separately until they are included in base rates.

Performance Metrics for Earnings Opportunity

Average Percent Energy Savings Per Property for Multifamily Low-Income Program

Rationale for Performance Metric: Provides incentives to pursue deeper savings per property as well as a holistic assessment of the program's impact.

The annual Multifamily Low-Income Program performance metric consists of two main elements. First is a threshold criterion that ensures at least 85% of the Commission-approved annual budget (administrative cost plus customer incentive cost) for the program year in question is spent. Each program year's budget, along with the calculation of the 85% threshold, has already been included in the Earnings Opportunity Calculator and will not change. The only input needed for this metric is the actual spend for each program year to compare to the 85% threshold budget. That actual spend will be reported directly out of the Company's accounting system and included in the EM&V report. If the Company's actual spend on the Multifamily Low-Income Program is less than the 85% threshold amount, then the Company is eligible for 0% of the earnings opportunity award for that specific performance metric for that program year. Otherwise, the Company is eligible for 100% of the earnings opportunity award amount subject to its performance in the second main element: Average Percent Energy Savings Per Property.

The Average Percent Energy Savings Per Property will be calculated as the total Multifamily Low-Income Program's evaluated energy savings for the program year divided by the total billed energy consumption for all of the properties served during that program year. The total billed energy consumption for all of the properties will be the billed consumption for each property covering 12 months prior to the month the property participated in the program, as reported in the Company's billing system. A property is defined as a multi-unit dwelling sharing the same address. For each program year, the EM&V report will report the Multifamily Low-Income Program's evaluated energy savings and the 12-month total billed energy consumption for use as inputs into the Earnings Opportunity Calculator. This performance metric has an annual cap of 125% performance compared to the annual target.

Average Percent Savings Per Property for Single Family Low-Income Program

Rationale for Performance Metric: Provides incentive to pursue deeper savings per property as well as a holistic assessment of the program's impact.

The annual Single Family Low-Income Program performance metric consists of two main elements. First is a threshold criterion that at least 85% of the Commission-approved annual budget (administrative cost plus customer incentive cost less the cost of Low-Income Efficiency Housing Grants) for the program year in question is spent. Each program year's budget, along with the calculation of the 85% threshold, has already been included in the Earnings Opportunity Calculator and will not change. The only input needed for this metric is the actual spend for each program year to compare to the 85% threshold budget. That actual spend will be reported directly out of the Company's accounting system and included in the EM&V report. If the Company's actual spend on the Single Family Low-Income Program is less than the 85% threshold amount, then the Company is eligible for 0% of the earnings opportunity award on that specific performance metric for that program year. Otherwise, the Company is eligible for 100% of the earnings opportunity award amount subject to its performance in the second main element: Average Percent Energy Savings Per Property.

The Average Percent Energy Savings Per Property will be calculated as the total Single Family Low-Income Program's evaluated energy savings (less the Low-Income Efficiency Housing Grants) for the program year divided by the total billed energy consumption for all of the properties served during that program year. The total billed energy consumption for all of the properties will be the billed consumption for each property covering 12 months prior to the month the property participated in the program as reported in the Company's billing system. A property is defined as the single dwelling at an address. For each program year, the EM&V report will report the Single Family Low-Income Program's evaluated energy savings (less the Low-Income Efficiency Housing Grants) and the 12-month total billed energy consumption for use as inputs into the Earnings Opportunity Calculator. This performance metric has an annual cap of 125% performance compared to the annual target.

Energy Savings of Home Energy Report Program

<u>Rationale for Performance Metric:</u> Provides incentives for ongoing intervention to produce repeatable annual savings from participants.

The performance metric for the HER will be the MWh energy savings reported in the EM&V report (not incremental savings). The reported energy savings for each program year will be input into the Earnings Opportunity Calculator to determine the earnings opportunity award amount for this performance metric. For program years 2020 and 2021 there is a threshold criterion that the evaluated TRC test be greater than 1.0. The TRC will be reported directly out of the EM&V report. If the TRC is less than the 1.0 threshold, then the Company is eligible for 0% of the earnings opportunity award on that specific performance metric for that program year. Otherwise, the Company is eligible for 100% of the earnings opportunity award amount subject to its performance in the evaluated MWh energy savings. This performance metric has an annual cap of 105% performance compared to the annual target.

<u>Subtotaled Portfolio Energy Savings</u>

Rationale for Performance Metric: Provides incentives for energy savings from qualifying energy efficiency programs. Energy savings have an important impact on future renewable resource requirements and therefore provide significant value to all customers.

The performance metric for the Energy Efficiency Energy Savings will be the first-year incremental MWh energy savings reported in the EM&V report. The residential low-income programs, Business Social Services Program, HER Program, Education Programs, and DR energy savings will be excluded from the energy savings for this performance metric. The EM&V report will include a subtotal of portfolio energy savings matching the definition of this performance metric for each program year and that subtotal will be input into the Earnings Opportunity Calculator to determine the earnings opportunity award amount for this performance metric. This performance metric has an annual cap of 115% performance compared to the annual target.

Subtotaled Coincident Peak Demand Savings from Measures 10-14 Year Useful Life

Rationale for Performance Metric: Provides incentives to achieve coincident peak demand savings recognizing that measures with significant useful lives can impact investments in supply-side resource needs like investments in transmission and distribution infrastructure. The payout per MW saved is lower than that for longer-life savings in the category below.

The performance metric for this performance measure will be the final-year[21] incremental MW coincident peak demand savings determined by multiplying the energy savings by the relevant measure category energy-to-peak-demand-conversion-factor specified in the TRM/Deemed Savings Table and will be reported in the EM&V report. Consistent with the Subtotaled Portfolio Energy Savings performance metric, the Residential Low-Income Programs, Business Social Services Program, HER Program, Education Programs, and DR energy savings will be excluded from this performance metric. Only measures with an effective useful life of 10-14 years will be included in this metric. The EM&V report will include a subtotal of portfolio coincident peak demand savings matching the definition of this performance metric for each program year and that subtotal will be input into the Earnings Opportunity Calculator to determine the earnings opportunity award amount for this performance metric. This performance metric has an annual cap of 125% performance compared to the annual target.

Subtotaled Coincident Peak Demand Savings from Measures ≥15 Year Useful Life

Rationale for Performance Metric: Provides incentives for coincident peak demand savings, recognizing that longer-lived measures' peak demand savings are more likely to

[21] Determined by the effective useful life of the given measure.

contribute to deferral of large supply-side generation investments in the future. The payout per MW saved is higher than that for shorter-life savings in the category above.

The performance metric for this performance measure will be the 15th year incremental MW coincident peak demand savings determined by multiplying the MWh energy savings by the relevant measure category energy-to-peak-demand-conversion-factor specified in the TRM/Deemed Savings Table and will be reported in the EM&V report. Consistent with the Subtotaled Portfolio Energy Savings performance metric, the Residential Low-Income Programs, Business Social Services Program, HER Program, Education Programs, and DR energy savings will be excluded from the energy savings for this performance metric. Only measures with an effective useful life of 15 or more years will be included in this metric. The EM&V report will include a subtotal of portfolio coincident peak demand savings matching the definition of this performance metric for each program year and that subtotal will be input into the Earnings Opportunity Calculator to determine the earnings opportunity award amount for this performance metric. This performance metric has an annual cap of 125% performance compared to the annual target.

Cumulative Demand Response Capability

Rationale for Performance Metric: Provides incentives for peak demand savings as well as the retention of the demand response capability over the implementation period.

This performance metric will be based on the cumulative MW demand response capability at the end of each program year. First, demand response savings will be measured during the peak events called each program year. Then those savings will be adjusted to reflect normal weather for peak conditions. Finally, peak demand savings will be adjusted to reflect enrollments through the end of the program year. For Residential DR, the total demand response capability in each year will be the sum of the normalized average peak savings per participant plus the normalized average peak savings per participant multiplied by the number of participants enrolled after the Program Season, but before the end of the program year[22]. For Business DR, the total demand response capability will be the evaluated MW reductions from customers enrolled during each year's summer peak events plus tested[23] MW reductions from new enrollees after the Program Season, but before the end of the program year.[24] The cumulative DR capability will be reported

[22] Participants enrolled after the Program Season in program year 3 will not count toward MW reduction targets.

[23] Tested MWs will be determined by simulating an event for a new participant equivalent to the average length of the events called within that program year. A 2 week window will be scheduled in which the test event will occur. The parameters for the event will be the same as if it were a real DR event. The notification, the baseline, the expectation of the participant's performance, and the evaluation of the participant's performance will be as if it were a real event.

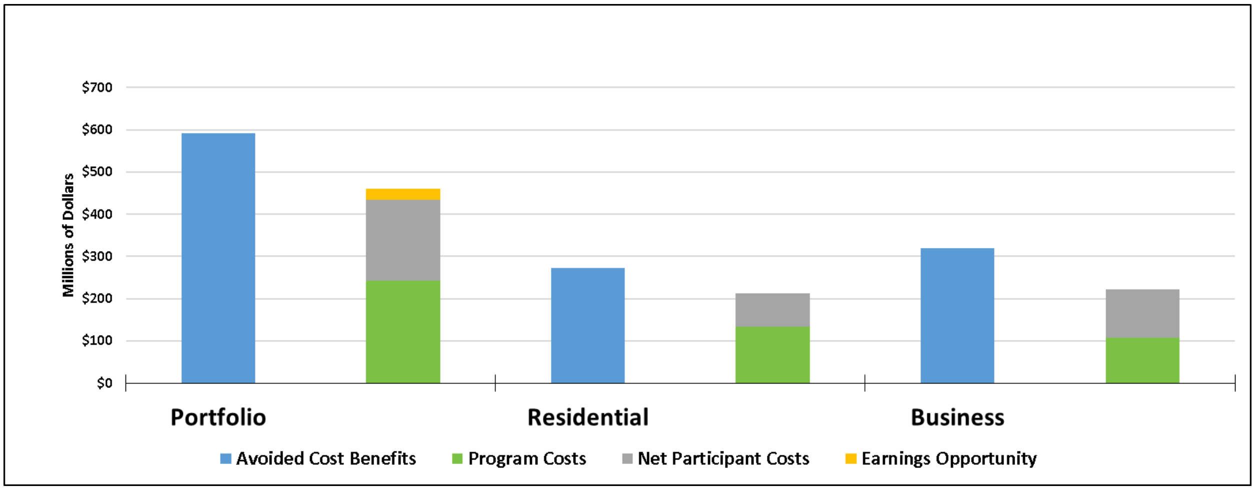
[24] Participants enrolled after the Program Season in program year 3 will not count toward MW reduction targets.

each year in the EM&V report. The reported cumulative MW capability for each program year will be input into the Earnings Opportunity Calculator to determine the earnings opportunity award amount for this performance metric. This performance metric has an annual cap of 125% performance compared to the annual target.

4.4 Impact on Customers

MEEIA 2019-21 is expected to result in a lifetime net benefits to all customers (participants and nonparticipants) of $324 million from the utility cost perspective and about $219 million from the total cost perspective. The benefits for both of these tests include the following categories: avoided energy, avoided generation capacity and avoided transmission and distribution investment. The figure below illustrates the total cost perspective and demonstrates that the benefits of MEEIA 2019-21 far exceed the costs.

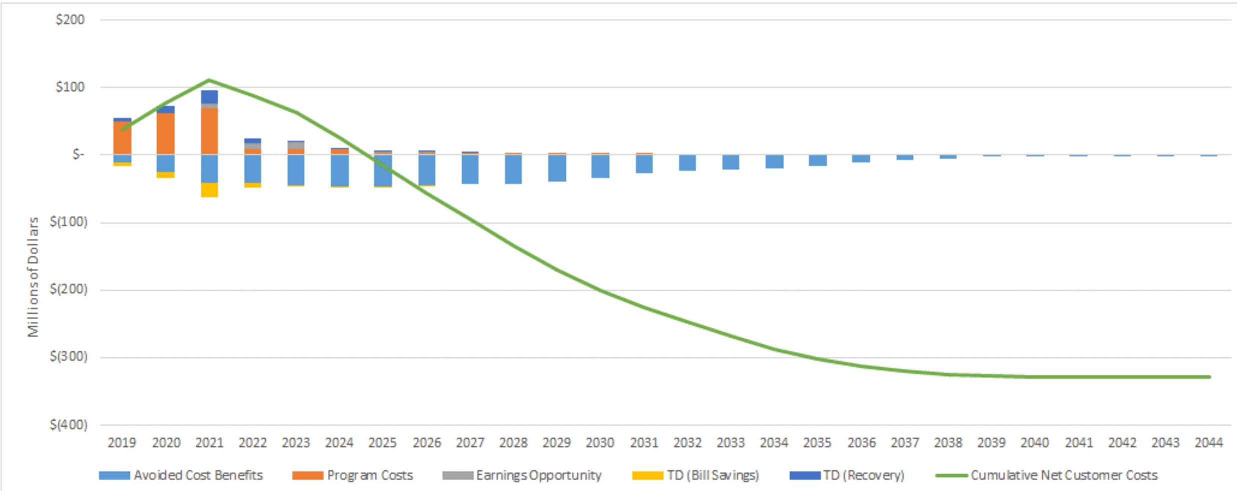
Figure 34 – TRC Cost-Effectiveness Results



It is important to note that the figure above does not include the throughput disincentive or the throughput disincentive recovery. As a practical matter, the throughput disincentive is a subset of "lost revenues" that are included in the Ratepayer Impact Measure ("RIM") cost-effectiveness test. In short, the throughput disincentive represents the amount of "lost revenue" from the RIM test that is in between rate cases while the RIM test assumes perfect ratemaking (i.e., that utility costs and revenues automatically balance out). The "lost revenues" in the RIM test are the same amount as the "bill savings" from the participant cost test. The TRC and UCT do not include "lost revenues" because they are not incremental costs to demand-side resources and are a transfer payment between customers.

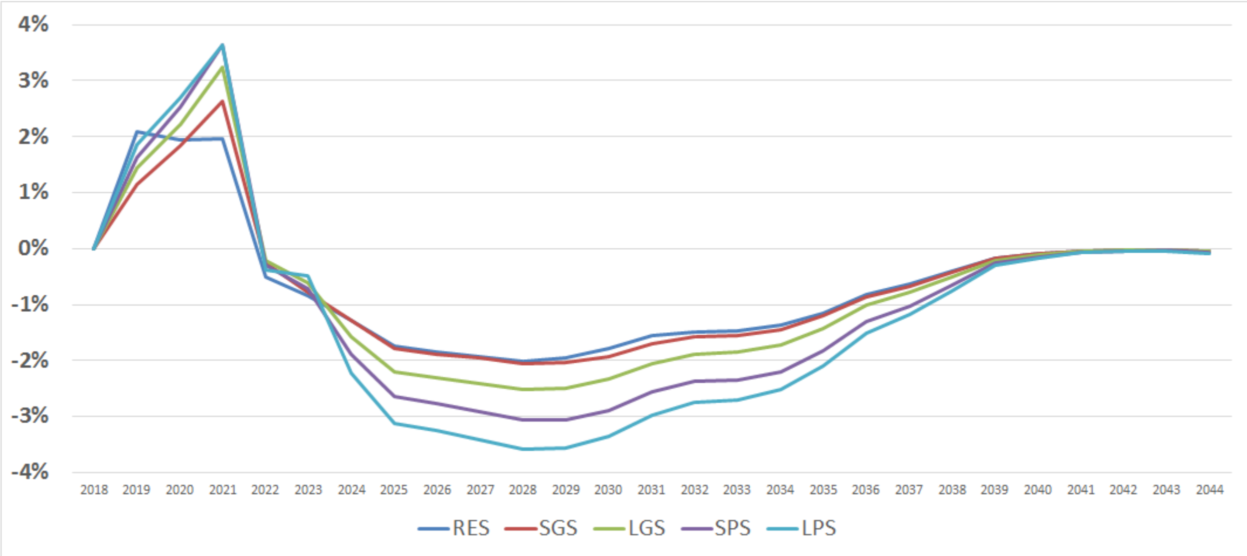
The figure below shows the annual and cumulative costs and benefits of MEEIA 2019-21. It is apparent from the figure below that the costs of the programs are borne by customers up front, consistent with MEEIA's requirement for timely cost recovery, but benefits continue to accrue for a long period of time following the end of the program implementation. The benefits surpass the costs in total magnitude in 2026, and continue to grow for the useful lives of the installed measures.

Figure 35 – 25 Year Revenue Requirement Impact of MEEIA 2019-21



The projected bill impacts by rate class associated with the MEEIA 2019-21 programs are shown in the figure below.

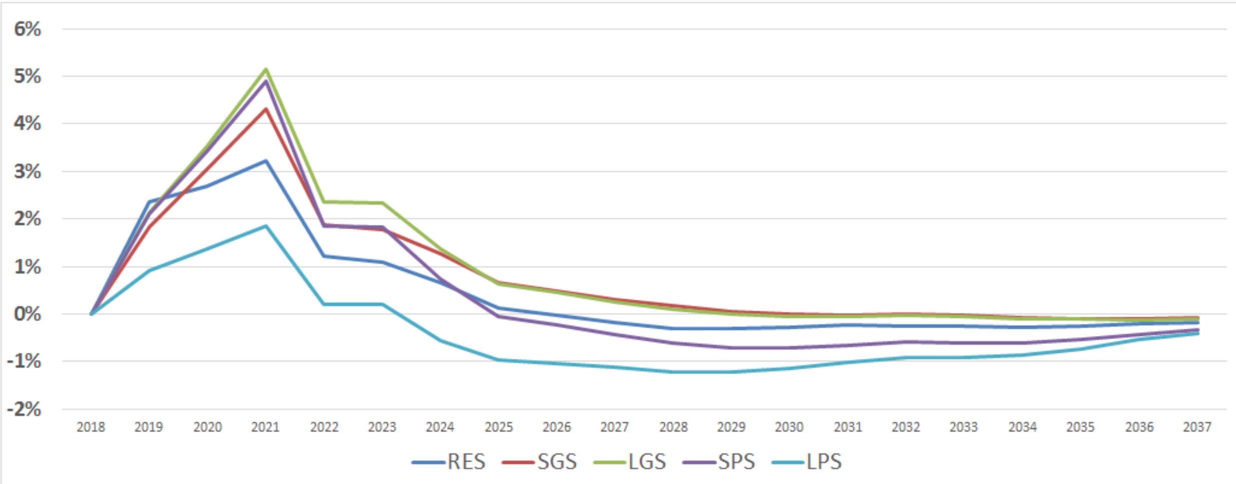
Figure 36 – DSIM Bill Impacts



Note that like the cumulative cost curve, the bill impacts cause an increase in total bills at first, as the program costs and throughput disincentive are paid as they occur and the EO is realized annually and collected over 2 years. As soon as the implementation period concludes and the costs are paid, bills are immediately lower beginning in 2022 than they would otherwise have been absent the programs. Depending on the rate class, by the time the earnings opportunity is paid in full, customers begin recognizing annual bill reductions of 2%-4% per year.

While bills trend lower over time, the same is not necessarily the case with average rates paid by customers. Keep in mind that over time customers receive bill savings even in the face of higher rates because the volumes of energy that they are purchasing at those rates are lower than they otherwise would have been. The rate impacts are still worth noting and are shown in the figure below.

Figure 37 – MEEIA 2019-21 Portfolio and DSIM Rate Impacts



The rate impacts also peak during the program years of 2019-2021 while costs are reflected in rates. After the end of the programs, rates are higher because the fixed costs of the utility revenue requirement end up being spread over fewer kWh of usage due to the energy savings customers are recognizing. It is imperative to recognize that despite higher rates, the total customer outlays for energy are fully expected to be lower with the implementation the MEEIA 2019-21 programs, as shown previously on the bill impacts. Again, the lifetime reduction in revenue requirement is $324 million.

4.5 Impact on the Company

4.5.1 Financial Impact

In order to find that the Company's incentives are aligned with helping customers use energy more efficiently, the Commission should assess the financial impact of the Plan, including the proposed programs and the DSIM, on the Company's projected financial results. There are two criteria that the Commission should use to establish a finding that it has discharged its obligations under MEEIA. The first is the very objective finding that program costs are being recovered on a timely basis and the negative impacts of the throughput disincentive are also remedied on a timely basis. The second is that there is a timely earnings opportunity to replicate the earnings opportunity associated with supply side and other investments that the Company forgoes when implementing energy efficiency. The Company has presented a number of analyses and benchmarks, so that the Commission has sufficient basis to find that the earnings opportunity aligns the Company's incentives with its customers' interest in using energy more efficiently. The table below presents the income statement impacts anticipated from the Plan assuming achievement of 100% of the savings goal.

Table 12 – MEEIA 2019-21 Plan Impacts on Net Income

	Total	2019	2020	2021	2022	2023	2024	2025	2026
Revenue									
Program Cost Recovery	$227.3	$50.1	$66.8	$78.5	$9.9	$11.0	$11.0	$0.0	$0.0
TD (Bill Savings)	$51.4	$5.6	$10.8	$23.6	$8.5	$1.1	$0.8	$0.8	$0.2
TD (Recovery)	$51.4	$5.6	$10.8	$23.6	$8.5	$1.1	$0.8	$0.8	$0.2
Earnings Opportunity	$32.5	$0.0	$6.5	$10.4	$13.1	$0.8	$0.8	$0.8	$0.0
Total Revenue	**$362.6**	**$61.3**	**$94.9**	**$136.1**	**$39.9**	**$14.1**	**$13.4**	**$2.4**	**$0.4**
Costs									
Program Costs	$227.3	$50.1	$66.8	$78.5	$9.9	$11.0	$11.0	$0.0	$0.0
Total Costs	**$227.3**	**$50.1**	**$66.8**	**$78.5**	**$9.9**	**$11.0**	**$11.0**	**$0.0**	**$0.0**
Gross Margin	$32.5	$0.0	$6.5	$10.4	$13.1	$0.8	$0.8	$0.8	$0.0
Income Taxes	$8.3	$0.0	$1.6	$2.7	$3.3	$0.2	$0.2	$0.2	$0.0
Net Income	**$24.2**	**$0.0**	**$4.8**	**$7.8**	**$9.8**	**$0.6**	**$0.6**	**$0.6**	**$0.0**

There are a few items worth observing in the table above. It is important to note that the TD bill savings equals the TD recovery, meaning that overall, the impact of TD is addressed adequately. Second, despite the fact that the earnings opportunity is collected over 12 months, the accounting treatment of the incentive affords the Company the ability to record the associated revenues in the year in which the award is earned. For purposes of this analysis, it is assumed that the award would be recorded as earnings each year as final EM&V results are available.

The overall impacts of the Plan and DSIM on key credit metrics (FFO[25]/Debt and FFO/Interest) are relatively small in context with the baseline credit metric levels which suggests little impact on the financial risk of the Company.

4.5.2 Business Risk Impact

Recognition and management of risk is critical to the success of the Company. The Company has identified the highest enterprise risks as being modifications to major power plants, greenhouse gas emission control requirements, cyber security, and nuclear event liability. In addition, the Company has identified load loss associated with energy efficiency (or other demand-side resources) outside of the Company's programs as an important business risk. The proposed DSIM does not directly impact the need for modifications to major power plants, greenhouse gas emission control requirements, nor the likelihood of a nuclear event liability. In regard to cyber security, implementing the MEEIA 2019-21 plan will require the Company to share certain information with its contractors, but the Company has extensive policies and procedures in place to mitigate those risks. The MEEIA 2019-21 plan is meant to accelerate adoption of energy saving behaviors and measures; therefore, the Plan is more likely to increase the risk of load

[25] FFO stands for Funds From Operations and is a key metric associated with operating cash flows.

loss outside the program to the extent the programs are effective at market transformation without capturing those effects through EM&V. In summary, the proposed DSIM has a negligible impact on overall business risk.

4.6 Low-Income Check-In Process

There are benefits to the certainty created by offering low-income programs for an extended period of time (70 months) but in no case is there an intention to preclude future changes to program offerings or to preclude obtaining input on those changes. To facilitate ongoing discussion of program delivery, before the implementation of each program year's annual evaluation, the Company's evaluation contractor will seek feedback on the proposed scope of the evaluation from the low-income working group of the Statewide Missouri Energy Efficiency Advisory Collaborative. Such annual evaluations may explore topics such as identifying program gaps in meeting market needs, the comprehensiveness of the program's one-stop-shop services, the effectiveness of the programs dealing with market barriers, the appropriateness of incentive levels, benchmarking program performance to other jurisdictions. Furthermore, the Company's evaluation contractor will hold at least two meetings with the low-income working group of the Statewide Missouri Energy Efficiency Advisory Collaborative to review the results of each annual evaluation. As deemed appropriate, the Company may make revisions to the Low-Income Programs based on discussions at the mid-cycle review through the 11-step Change Process described in Sheet No. 221.4 of the revised Appendix J. As part of the Company's 2020 IRP, the Company will include an explanation of how the updated potential study results are likely to affect its ongoing low-income programs. Furthermore, as part of the Company's MEEIA Cycle 4 Plan, the Company will solicit stakeholder feedback on potential changes to the remaining 2022-24 portion of the low-income programs and shall document and include that feedback in its MEEIA Cycle 4 filing. Other parties to the Company's MEEIA Cycle 4 Plan case will have the opportunity to propose additional low-income energy efficiency programs at that time, as well as the opportunity to recommend changes to the ongoing low-income programming.

5.0 Appendices

5.1 Appendix A – Portfolio and Programs Summary

5.2 Appendix B – Programs Templates

5.3 Appendix C – Avoided Costs

5.4 Appendix D – Incentive Ranges

5.5 Appendix E – Sample Evaluation Plans

5.6 Appendix F – Deemed Savings Table

5.7 Appendix G – TRM: Overview and User Guide

5.8 Appendix H – TRM: Business Measures

5.9 Appendix I – TRM: Residential Measures

5.10 Appendix J – Exemplar Tariffs

5.11 Appendix K – Customer DSIM Explanation

5.12 Appendix L – Customer Bill Examples

5.13 Appendix M – MEEIA 2019-21 Accounting

5.14 Appendix N – Earnings Opportunity Calculator

Total Program Costs
(With all costs allocated)

(In Millions of Dollars)

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	$ 5.41	$ 6.85	$ 8.19	$ 9.85	$ 11.04	$ 10.98	$ 52.32
Residential	$ 26.58	$ 28.39	$ 29.37	$ -	$ -	$ -	$ 84.34
Business	$ 18.15	$ 31.58	$ 40.93	$ -	$ -	$ -	$ 90.66
Portfolio Total	**$ 50.14**	**$ 66.83**	**$ 78.48**	**$ 9.85**	**$ 11.04**	**$ 10.98**	**$ 227.31**
Low Income							
Multifamily Low Income	$ 1.54	$ 2.27	$ 3.47	$ 5.38	$ 6.68	$ 6.68	$ 26.02
Single Family Low Income	$ 3.53	$ 3.98	$ 4.09	$ 3.87	$ 3.79	$ 3.85	$ 23.11
Business Social Services	$ 0.34	$ 0.60	$ 0.63	$ 0.60	$ 0.57	$ 0.45	$ 3.19
Low Income Total	**$ 5.41**	**$ 6.85**	**$ 8.19**	**$ 9.85**	**$ 11.04**	**$ 10.98**	**$ 52.32**
Residential							
Appliance Recycling	$ 0.52	$ 0.59	$ 0.60	$ -	$ -	$ -	$ 1.71
Efficient Products	$ 2.09	$ 2.03	$ 2.14	$ -	$ -	$ -	$ 6.26
Energy Efficient Kits	$ 1.38	$ 1.30	$ 1.15	$ -	$ -	$ -	$ 3.83
Home Energy Report	$ 1.90	$ 1.97	$ 1.97	$ -	$ -	$ -	$ 5.84
HVAC	$ 12.67	$ 13.32	$ 13.73	$ -	$ -	$ -	$ 39.71
Lighting	$ 1.93	$ 2.11	$ 1.67	$ -	$ -	$ -	$ 5.71
Multifamily Market Rate	$ 0.97	$ 1.32	$ 1.49	$ -	$ -	$ -	$ 3.78
Residential Demand Response	$ 4.28	$ 4.75	$ 5.60	$ -	$ -	$ -	$ 14.63
Residential Education	$ 0.85	$ 1.00	$ 1.00	$ -	$ -	$ -	$ 2.85
Res Total	**$ 26.58**	**$ 28.39**	**$ 29.37**	**$ -**	**$ -**	**$ -**	**$ 84.34**
Business							
Custom	$ 7.22	$ 13.15	$ 17.87	$ -	$ -	$ -	$ 38.23
New Construction	$ 0.80	$ 1.84	$ 2.46	$ -	$ -	$ -	$ 5.11
Retro-Commissioning	$ 0.60	$ 1.42	$ 2.29	$ -	$ -	$ -	$ 4.31
Small Business Direct Install	$ 2.39	$ 2.55	$ 2.75	$ -	$ -	$ -	$ 7.69
Standard	$ 5.80	$ 10.02	$ 11.70	$ -	$ -	$ -	$ 27.53
Strategic Energy Management	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business Demand Response	$ 1.26	$ 2.52	$ 3.78	$ -	$ -	$ -	$ 7.56
Business Education	$ 0.08	$ 0.08	$ 0.08	$ -	$ -	$ -	$ 0.24
Biz Total	**$ 18.15**	**$ 31.58**	**$ 40.93**	**$ -**	**$ -**	**$ -**	**$ 90.66**

Note: Other Portfolio costs (EM&V, Marketing and Admin) have been distributed among the Low Income , Residential and Business programs for graphing.

Total Program Costs
(With EM&V & Other Portfolio Costs unallocated)

(In Millions of Dollars)

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	$ 5.05	$ 6.45	$ 7.71	$ 9.39	$ 10.51	$ 10.45	$ 49.56
Residential	$ 23.18	$ 25.10	$ 26.01	$ -	$ -	$ -	$ 74.30
Business	$ 15.39	$ 28.66	$ 37.44	$ -	$ -	$ -	$ 81.50
Portfolio Costs	$ 6.51	$ 6.61	$ 7.32	$ 0.47	$ 0.53	$ 0.52	$ 21.96
Portfolio Total	**$ 50.14**	**$ 66.83**	**$ 78.48**	**$ 9.85**	**$ 11.04**	**$ 10.98**	**$ 227.31**
Low Income							
Multifamily Low Income	$ 1.50	$ 2.20	$ 3.35	$ 5.16	$ 6.40	$ 6.40	$ 25.01
Single Family Low Income	$ 3.24	$ 3.67	$ 3.76	$ 3.65	$ 3.57	$ 3.63	$ 21.51
Business Social Services	$ 0.32	$ 0.57	$ 0.60	$ 0.57	$ 0.55	$ 0.43	$ 3.04
Low Income Total	**$ 5.05**	**$ 6.45**	**$ 7.71**	**$ 9.39**	**$ 10.51**	**$ 10.45**	**$ 49.56**
Residential							
Appliance Recycling	$ 0.48	$ 0.55	$ 0.55	$ -	$ -	$ -	$ 1.59
Efficient Products	$ 1.88	$ 1.82	$ 1.91	$ -	$ -	$ -	$ 5.62
Energy Efficient Kits	$ 1.19	$ 1.14	$ 1.04	$ -	$ -	$ -	$ 3.37
Home Energy Report	$ 1.80	$ 1.88	$ 1.88	$ -	$ -	$ -	$ 5.55
HVAC	$ 10.52	$ 11.21	$ 11.52	$ -	$ -	$ -	$ 33.25
Lighting	$ 1.53	$ 1.74	$ 1.36	$ -	$ -	$ -	$ 4.64
Multifamily Market Rate	$ 0.90	$ 1.22	$ 1.38	$ -	$ -	$ -	$ 3.50
Residential Demand Response	$ 4.04	$ 4.54	$ 5.36	$ -	$ -	$ -	$ 13.94
Residential Education	$ 0.85	$ 1.00	$ 1.00	$ -	$ -	$ -	$ 2.85
Res Total	**$ 23.18**	**$ 25.10**	**$ 26.01**	**$ -**	**$ -**	**$ -**	**$ 74.30**
Business							
Custom	$ 5.87	$ 11.67	$ 16.04	$ -	$ -	$ -	$ 33.59
New Construction	$ 0.67	$ 1.67	$ 2.25	$ -	$ -	$ -	$ 4.59
Retro-Commissioning	$ 0.49	$ 1.28	$ 2.08	$ -	$ -	$ -	$ 3.85
Small Business Direct Install	$ 2.14	$ 2.39	$ 2.60	$ -	$ -	$ -	$ 7.13
Standard	$ 4.94	$ 9.17	$ 10.80	$ -	$ -	$ -	$ 24.90
Strategic Energy Management	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business Demand Response	$ 1.20	$ 2.40	$ 3.60	$ -	$ -	$ -	$ 7.20
Business Education	$ 0.08	$ 0.08	$ 0.08	$ -	$ -	$ -	$ 0.24
Biz Total	**$ 15.39**	**$ 28.66**	**$ 37.44**	**$ -**	**$ -**	**$ -**	**$ 81.50**
EM&V & Other Portfolio Costs							
EM&V	$ 2.22	$ 3.00	$ 3.53	$ 0.47	$ 0.53	$ 0.52	$ 10.27
Portfolio Marketing	$ 1.94	$ 2.26	$ 2.44	$ -	$ -	$ -	$ 6.64
Other (Potential Study, Data Tracking, Incremental Labor)	$ 2.35	$ 1.35	$ 1.35	$ -	$ -	$ -	$ 5.05
Portfolio Total	**$ 6.51**	**$ 6.61**	**$ 7.32**	**$ 0.47**	**$ 0.53**	**$ 0.52**	**$ 21.96**

Contractor Administrative Costs

(In Millions of Dollars)

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	$ 2.36	$ 2.63	$ 3.17	$ 3.93	$ 4.37	$ 4.35	$ 20.81
Residential	$ 11.55	$ 12.32	$ 13.15	$ -	$ -	$ -	$ 37.01
Business	$ 6.19	$ 10.92	$ 13.94	$ -	$ -	$ -	$ 31.04
Portfolio Total	**$ 20.10**	**$ 25.87**	**$ 30.25**	**$ 3.93**	**$ 4.37**	**$ 4.35**	**$ 88.87**
Low Income							
Multifamily Low Income	$ 0.82	$ 0.88	$ 1.44	$ 2.17	$ 2.62	$ 2.60	$ 10.53
Single Family Low Income	$ 1.47	$ 1.63	$ 1.61	$ 1.64	$ 1.64	$ 1.67	$ 9.66
Business Social Services	$ 0.07	$ 0.13	$ 0.12	$ 0.12	$ 0.11	$ 0.09	$ 0.63
Low Income Total	**$ 2.36**	**$ 2.63**	**$ 3.17**	**$ 3.93**	**$ 4.37**	**$ 4.35**	**$ 20.81**
Residential							
Appliance Recycling	$ 0.33	$ 0.33	$ 0.34	$ -	$ -	$ -	$ 0.99
Efficient Products	$ 0.76	$ 0.54	$ 0.55	$ -	$ -	$ -	$ 1.85
Energy Efficient Kits	$ 0.37	$ 0.32	$ 0.29	$ -	$ -	$ -	$ 0.97
Home Energy Report	$ 0.42	$ 0.40	$ 0.40	$ -	$ -	$ -	$ 1.22
HVAC	$ 3.61	$ 3.78	$ 3.89	$ -	$ -	$ -	$ 11.28
Lighting	$ 0.57	$ 0.62	$ 0.46	$ -	$ -	$ -	$ 1.65
Multifamily Market Rate	$ 0.62	$ 0.79	$ 0.86	$ -	$ -	$ -	$ 2.27
Residential Demand Response	$ 4.04	$ 4.54	$ 5.36	$ -	$ -	$ -	$ 13.94
Residential Education	$ 0.85	$ 1.00	$ 1.00	$ -	$ -	$ -	$ 2.85
Res Total	**$ 11.55**	**$ 12.32**	**$ 13.15**	**$ -**	**$ -**	**$ -**	**$ 37.01**
Business							
Custom	$ 2.12	$ 3.86	$ 5.01	$ -	$ -	$ -	$ 10.99
New Construction	$ 0.26	$ 0.60	$ 0.75	$ -	$ -	$ -	$ 1.61
Retro-Commissioning	$ 0.17	$ 0.41	$ 0.63	$ -	$ -	$ -	$ 1.22
Small Business Direct Install	$ 0.73	$ 0.76	$ 0.77	$ -	$ -	$ -	$ 2.26
Standard	$ 1.63	$ 2.81	$ 3.10	$ -	$ -	$ -	$ 7.54
Strategic Energy Management	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business Demand Response	$ 1.20	$ 2.40	$ 3.60	$ -	$ -	$ -	$ 7.20
Business Education	$ 0.08	$ 0.08	$ 0.08	$ -	$ -	$ -	$ 0.24
Biz Total	**$ 6.19**	**$ 10.92**	**$ 13.94**	**$ -**	**$ -**	**$ -**	**$ 31.04**

Incentive Costs

(In Millions of Dollars)

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	$ 2.69	$ 3.81	$ 4.54	$ 5.46	$ 6.14	$ 6.10	$ 28.75
Residential	$ 11.64	$ 12.78	$ 12.86	$ -	$ -	$ -	$ 37.28
Business	$ 9.20	$ 17.75	$ 23.50	$ -	$ -	$ -	$ 50.45
Portfolio Total	**$ 23.53**	**$ 34.34**	**$ 40.91**	**$ 5.46**	**$ 6.14**	**$ 6.10**	**$ 116.49**
Low Income							
Multifamily Low Income	$ 0.68	$ 1.32	$ 1.91	$ 2.99	$ 3.78	$ 3.80	$ 14.48
Single Family Low Income	$ 1.76	$ 2.05	$ 2.15	$ 2.01	$ 1.93	$ 1.96	$ 11.86
Business Social Services	$ 0.25	$ 0.45	$ 0.49	$ 0.46	$ 0.44	$ 0.34	$ 2.41
Low Income Total	**$ 2.69**	**$ 3.81**	**$ 4.54**	**$ 5.46**	**$ 6.14**	**$ 6.10**	**$ 28.75**
Residential							
Appliance Recycling	$ 0.15	$ 0.22	$ 0.22	$ -	$ -	$ -	$ 0.59
Efficient Products	$ 1.12	$ 1.28	$ 1.36	$ -	$ -	$ -	$ 3.77
Energy Efficient Kits	$ 0.82	$ 0.82	$ 0.76	$ -	$ -	$ -	$ 2.41
Home Energy Report	$ 1.38	$ 1.48	$ 1.48	$ -	$ -	$ -	$ 4.34
HVAC	$ 6.91	$ 7.43	$ 7.62	$ -	$ -	$ -	$ 21.96
Lighting	$ 0.96	$ 1.12	$ 0.90	$ -	$ -	$ -	$ 2.99
Multifamily Market Rate	$ 0.28	$ 0.43	$ 0.52	$ -	$ -	$ -	$ 1.23
Residential Demand Response	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Residential Education	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Res Total	**$ 11.64**	**$ 12.78**	**$ 12.86**	**$ -**	**$ -**	**$ -**	**$ 37.28**
Business							
Custom	$ 3.75	$ 7.82	$ 11.03	$ -	$ -	$ -	$ 22.60
New Construction	$ 0.41	$ 1.07	$ 1.49	$ -	$ -	$ -	$ 2.98
Retro-Commissioning	$ 0.32	$ 0.87	$ 1.45	$ -	$ -	$ -	$ 2.64
Small Business Direct Install	$ 1.41	$ 1.63	$ 1.83	$ -	$ -	$ -	$ 4.87
Standard	$ 3.31	$ 6.35	$ 7.70	$ -	$ -	$ -	$ 17.36
Strategic Energy Management	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business Demand Response	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business Education	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biz Total	**$ 9.20**	**$ 17.75**	**$ 23.50**	**$ -**	**$ -**	**$ -**	**$ 50.45**

EM&V Costs

(In Millions of Dollars)

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	$ 0.12	$ 0.16	$ 0.19	$ 0.47	$ 0.53	$ 0.52	$ 1.98
Residential	$ 1.32	$ 1.40	$ 1.45	$ -	$ -	$ -	$ 4.17
Business	$ 0.78	$ 1.45	$ 1.89	$ -	$ -	$ -	$ 4.12
Portfolio Total	**$ 2.22**	**$ 3.00**	**$ 3.53**	**$ 0.47**	**$ 0.53**	**$ 0.52**	**$ 10.27**
Low Income							
Multifamily Low Income	$ 0.01	$ 0.03	$ 0.05	$ 0.22	$ 0.28	$ 0.28	$ 0.87
Single Family Low Income	$ 0.10	$ 0.12	$ 0.13	$ 0.22	$ 0.22	$ 0.22	$ 1.01
Business Social Services	$ 0.01	$ 0.01	$ 0.01	$ 0.03	$ 0.03	$ 0.02	$ 0.11
Low Income Total	**$ 0.12**	**$ 0.16**	**$ 0.19**	**$ 0.47**	**$ 0.53**	**$ 0.52**	**$ 1.98**
Residential							
Appliance Recycling	$ 0.01	$ 0.02	$ 0.02	$ -	$ -	$ -	$ 0.05
Efficient Products	$ 0.07	$ 0.08	$ 0.09	$ -	$ -	$ -	$ 0.24
Energy Efficient Kits	$ 0.06	$ 0.06	$ 0.04	$ -	$ -	$ -	$ 0.17
Home Energy Report	$ 0.03	$ 0.04	$ 0.04	$ -	$ -	$ -	$ 0.11
HVAC	$ 0.74	$ 0.81	$ 0.86	$ -	$ -	$ -	$ 2.40
Lighting	$ 0.14	$ 0.14	$ 0.12	$ -	$ -	$ -	$ 0.40
Multifamily Market Rate	$ 0.02	$ 0.04	$ 0.04	$ -	$ -	$ -	$ 0.11
Residential Demand Response	$ 0.24	$ 0.22	$ 0.24	$ -	$ -	$ -	$ 0.70
Residential Education	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Res Total	**$ 1.32**	**$ 1.40**	**$ 1.45**	**$ -**	**$ -**	**$ -**	**$ 4.17**
Business							
Custom	$ 0.36	$ 0.70	$ 0.94	$ -	$ -	$ -	$ 2.00
New Construction	$ 0.03	$ 0.08	$ 0.11	$ -	$ -	$ -	$ 0.23
Retro-Commissioning	$ 0.03	$ 0.07	$ 0.11	$ -	$ -	$ -	$ 0.21
Small Business Direct Install	$ 0.07	$ 0.07	$ 0.08	$ -	$ -	$ -	$ 0.22
Standard	$ 0.23	$ 0.41	$ 0.47	$ -	$ -	$ -	$ 1.10
Strategic Energy Management	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business Demand Response	$ 0.06	$ 0.12	$ 0.18	$ -	$ -	$ -	$ 0.36
Business Education	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biz Total	**$ 0.78**	**$ 1.45**	**$ 1.89**	**$ -**	**$ -**	**$ -**	**$ 4.12**

Note: Education EM&V costs are distributed amongst the other programs

Other Portfolio Costs
(Marketing, Potential Study, Data Tracking & Incremental Labor)

(In Dollars)

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	$ 239,318	$ 246,140	$ 286,821	$ -	$ -	$ -	$ 772,279
Residential	$ 2,074,430	$ 1,894,150	$ 1,905,045	$ -	$ -	$ -	$ 5,873,626
Business	$ 1,977,472	$ 1,468,591	$ 1,598,114	$ -	$ -	$ -	$ 5,044,177
Portfolio Total	**$ 4,291,220**	**$ 3,608,881**	**$ 3,789,981**	**$ -**	**$ -**	**$ -**	**$ 11,690,081**
Low Income							
Multifamily Low Income	$ 28,322	$ 43,405	$ 71,550	$ -	$ -	$ -	$ 143,277
Single Family Low Income	$ 191,435	$ 189,494	$ 203,751	$ -	$ -	$ -	$ 584,681
Business Social Services	$ 19,560	$ 13,241	$ 11,520	$ -	$ -	$ -	$ 44,321
Low Income Total	**$ 239,318**	**$ 246,140**	**$ 286,821**	**$ -**	**$ -**	**$ -**	**$ 772,279**
Residential							
Appliance Recycling	$ 23,125	$ 27,453	$ 28,226	$ -	$ -	$ -	$ 78,803
Efficient Products	$ 135,418	$ 128,034	$ 140,449	$ -	$ -	$ -	$ 403,902
Energy Efficient Kits	$ 123,186	$ 102,345	$ 63,254	$ -	$ -	$ -	$ 288,785
Home Energy Report	$ 66,745	$ 57,054	$ 59,220	$ -	$ -	$ -	$ 183,018
HVAC	$ 1,416,225	$ 1,296,622	$ 1,351,636	$ -	$ -	$ -	$ 4,064,484
Lighting	$ 261,894	$ 224,929	$ 191,881	$ -	$ -	$ -	$ 678,704
Multifamily Market Rate	$ 47,838	$ 57,713	$ 70,379	$ -	$ -	$ -	$ 175,930
Residential Demand Response	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Residential Education	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Res Total	**$ 2,074,430**	**$ 1,894,150**	**$ 1,905,045**	**$ -**	**$ -**	**$ -**	**$ 5,873,626**
Business							
Custom	$ 988,499	$ 773,195	$ 881,297	$ -	$ -	$ -	$ 2,642,991
New Construction	$ 95,109	$ 91,511	$ 103,419	$ -	$ -	$ -	$ 290,039
Retro-Commissioning	$ 74,337	$ 75,218	$ 102,930	$ -	$ -	$ -	$ 252,486
Small Business Direct Install	$ 186,241	$ 80,616	$ 73,330	$ -	$ -	$ -	$ 340,187
Standard	$ 633,286	$ 448,052	$ 437,138	$ -	$ -	$ -	$ 1,518,475
Strategic Energy Management	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business Demand Response	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Business Education	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biz Total	**$ 1,977,472**	**$ 1,468,591**	**$ 1,598,114**	**$ -**	**$ -**	**$ -**	**$ 5,044,177**

Incremental MWh Savings

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	10,443	13,858	15,201	12,112	13,115	12,915	77,644
Residential	112,823	84,450	82,467	-	-	-	279,740
Business	78,696	152,847	205,044	-	-	-	436,587
Portfolio Total	**201,962**	**251,155**	**302,712**	**12,112**	**13,115**	**12,915**	**793,970**
Low Income							
Multifamily Low Income	900	1,650	2,680	4,644	5,760	5,760	21,394
Single Family Low Income	8,556	10,415	10,822	5,776	5,773	5,891	47,232
Business Social Services	987	1,793	1,700	1,692	1,582	1,263	9,017
Low Income Total	**10,443**	**13,858**	**15,201**	**12,112**	**13,115**	**12,915**	**77,644**
Residential							
Appliance Recycling	2,358	3,333	3,345	-	-	-	9,037
Efficient Products	8,222	9,188	9,800	-	-	-	27,209
Energy Efficient Kits	6,551	6,551	4,199	-	-	-	17,301
Home Energy Report	35,250	-	-	-	-	-	35,250
HVAC	44,361	47,594	48,350	-	-	-	140,305
Lighting	12,659	13,203	11,238	-	-	-	37,100
Multifamily Market Rate	2,292	3,270	4,064	-	-	-	9,626
Residential Demand Response	1,130	1,311	1,471	-	-	-	3,912
Res Total	**112,823**	**84,450**	**82,467**	**-**	**-**	**-**	**279,740**
Business							
Custom	34,247	69,882	100,445	-	-	-	204,573
New Construction	3,349	8,660	12,076	-	-	-	24,085
Retro-Commissioning	2,679	7,217	12,076	-	-	-	21,972
Small Business Direct Install	8,702	10,118	11,340	-	-	-	30,160
Standard	29,220	56,470	68,607	-	-	-	154,296
Strategic Energy Management	-	-	-	-	-	-	-
Business Demand Response	500	500	500	-	-	-	1,500
Biz Total	**78,696**	**152,847**	**205,044**	**-**	**-**	**-**	**436,587**

Incremental MW Savings

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	2.4	3.4	4.1	4.2	4.7	4.7	23.4
Residential	57.4	45.8	47.9	-	-	-	151.1
Business	44.4	64.5	77.4	-	-	-	186.2
Portfolio Total	**104.2**	**113.7**	**129.3**	**4.2**	**4.7**	**4.7**	**360.8**
Low Income							
Multifamily Low Income	0.4	0.7	1.2	2.1	2.6	2.6	9.5
Single Family Low Income	1.8	2.3	2.5	1.8	1.8	1.8	12.0
Business Social Services	0.2	0.3	0.4	0.4	0.4	0.3	1.9
Low Income Total	**2.4**	**3.4**	**4.1**	**4.2**	**4.7**	**4.7**	**23.4**
Residential							
Appliance Recycling	0.3	0.5	0.5	-	-	-	1.3
Efficient Products	2.1	2.4	2.6	-	-	-	7.2
Energy Efficient Kits	1.2	1.2	0.8	-	-	-	3.1
Home Energy Report	16.4	-	-	-	-	-	16.4
HVAC	23.3	25.4	26.1	-	-	-	74.8
Lighting	1.9	2.0	1.7	-	-	-	5.5
Multifamily Market Rate	0.7	1.0	1.3	-	-	-	3.0
Residential Demand Response	11.5	13.3	15.0	-	-	-	39.8
Res Total	**57.4**	**45.8**	**47.9**	**-**	**-**	**-**	**151.1**
Business							
Custom	9.9	21.4	29.2	-	-	-	60.5
New Construction	0.9	2.3	3.2	-	-	-	6.4
Retro-Commissioning	1.0	2.6	4.4	-	-	-	8.1
Small Business Direct Install	1.5	1.8	2.0	-	-	-	5.2
Standard	6.1	11.4	13.6	-	-	-	31.1
Strategic Energy Management	-	-	-	-	-	-	-
Business Demand Response	25.0	25.0	25.0	-	-	-	75.0
Biz Total	**44.4**	**64.5**	**77.4**	**-**	**-**	**-**	**186.2**

Total Resource Cost Test

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	1.20	1.30	1.33	1.04	1.07	1.11	1.16
Residential	1.61	1.76	1.83	-	-	-	1.73
Business	1.60	1.82	1.97	-	-	-	1.83
Portfolio Total*	**1.48**	**1.64**	**1.74**	**0.97**	**1.01**	**1.05**	**1.59**
Low Income							
Multifamily Low Income	0.50	0.66	0.74	0.87	0.91	0.95	0.83
Single Family Low Income	1.49	1.66	1.80	1.18	1.27	1.32	1.47
Business Social Services	1.30	1.43	1.49	1.59	1.66	1.74	1.53
Low Income Total	**1.20**	**1.30**	**1.33**	**1.04**	**1.07**	**1.11**	**1.16**
Residential							
Appliance Recycling	1.29	1.68	1.78				1.59
Efficient Products	1.14	1.33	1.42				1.30
Energy Efficient Kits	2.14	2.36	1.69				2.09
Home Energy Report	1.01	1.06	1.14				1.07
HVAC	1.78	1.96	2.07				1.93
Lighting	3.89	3.89	4.35				4.02
Multifamily Market Rate	1.10	1.21	1.35				1.23
Residential Demand Response	1.09	1.29	1.43				1.27
Res Total	**1.61**	**1.76**	**1.83**	**-**	**-**	**-**	**1.73**
Business							
Custom	1.67	1.90	2.02				1.91
New Construction	1.41	1.58	1.70				1.61
Retro-Commissioning	2.62	3.10	3.41				3.19
Small Business Direct Install	1.40	1.58	1.71				1.57
Standard	1.48	1.67	1.81				1.69
Strategic Energy Management							
Business Demand Response	1.64	1.81	1.98				1.81
Biz Total	**1.60**	**1.82**	**1.97**	**-**	**-**	**-**	**1.83**

*Includes Earnings Opportunity

Utility Cost Test

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	1.25	1.37	1.40	1.10	1.14	1.18	1.23
Residential	2.23	2.46	2.55				2.41
Business	2.36	3.00	3.39				2.99
Portfolio Total*	**2.02**	**2.36**	**2.56**	**1.02**	**1.07**	**1.11**	**2.21**
Low Income							
Multifamily Low Income	0.53	0.70	0.78	0.92	0.96	1.00	0.88
Single Family Low Income	1.56	1.73	1.89	1.25	1.35	1.40	1.55
Business Social Services	1.35	1.49	1.61	1.72	1.80	1.87	1.64
Low Income Total	**1.25**	**1.37**	**1.40**	**1.10**	**1.14**	**1.18**	**1.23**
Residential							
Appliance Recycling	1.29	1.68	1.78				1.59
Efficient Products	1.86	2.30	2.49				2.21
Energy Efficient Kits	2.57	2.86	2.09				2.53
Home Energy Report	1.01	1.06	1.14				1.07
HVAC	3.21	3.55	3.73				3.49
Lighting	3.89	3.89	4.35				4.02
Multifamily Market Rate	1.41	1.60	1.79				1.62
Residential Demand Response	1.09	1.29	1.43				1.27
Res Total	**2.23**	**2.46**	**2.55**	**-**	**-**	**-**	**2.41**
Business							
Custom	3.24	3.95	4.31				3.97
New Construction	2.81	3.34	3.68				3.40
Retro-Commissioning	2.95	3.55	3.93				3.66
Small Business Direct Install	1.84	2.13	2.33				2.10
Standard	2.59	3.01	3.27				3.02
Strategic Energy Management							
Business Demand Response	1.64	1.81	1.98				1.81
Biz Total	**2.36**	**3.00**	**3.39**	**-**	**-**	**-**	**2.99**

*Includes Earnings Opportunity

Participant Cost Test

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	5.29	4.70	4.28	2.70	2.62	2.64	3.46
Residential	4.46	4.51	4.30	-	-	-	4.42
Business	2.92	2.91	2.98	-	-	-	2.94
Portfolio Total	**3.76**	**3.54**	**3.42**	**2.70**	**2.62**	**2.64**	**3.49**
Low Income							
Multifamily Low Income	1.60	1.57	1.67	1.76	1.76	1.77	1.72
Single Family Low Income	7.94	8.36	8.50	4.67	5.02	5.10	6.72
Business Social Services	3.52	3.58	3.11	3.26	3.28	3.41	3.34
Low Income Total	**5.29**	**4.70**	**4.28**	**2.70**	**2.62**	**2.64**	**3.46**
Residential							
Appliance Recycling	∞	∞	∞	∞	∞	∞	∞
Efficient Products	3.05	3.05	3.08	-	-	-	3.06
Energy Efficient Kits	8.91	9.06	5.64	-	-	-	7.96
Home Energy Report	-	-	-	-	-	-	-
HVAC	3.02	3.11	3.16	-	-	-	3.09
Lighting	∞	∞	∞	∞	∞	∞	∞
Multifamily Market Rate	4.15	3.82	4.09	-	-	-	4.01
Residential Demand Response	∞	∞	∞	∞	∞	∞	∞
Res Total	**4.46**	**4.51**	**4.30**				**4.42**
Business							
Custom	2.70	2.67	2.74	-	-	-	2.71
New Construction	2.38	2.42	2.46	-	-	-	2.43
Retro-Commissioning	4.66	4.73	4.80	-	-	-	4.76
Small Business Direct Install	3.54	3.61	3.67	-	-	-	3.61
Standard	2.99	3.12	3.22	-	-	-	3.13
Strategic Energy Management	-	-	-	-	-	-	
Business Demand Response	∞	∞	∞	∞	∞	∞	∞
Biz Total	**2.92**	**2.91**	**2.98**				**2.94**

Ratepayer Impact Measure (Net Fuel)

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	0.54	0.59	0.64	0.67	0.71	0.73	0.64
Residential	0.77	0.83	0.89	-	-	-	0.83
Business	0.98	1.04	1.09	-	-	-	1.05
Portfolio Total*	**0.80**	**0.88**	**0.95**	**0.64**	**0.68**	**0.70**	**0.87**
Low Income							
Multifamily Low Income	0.44	0.56	0.62	0.71	0.74	0.77	0.69
Single Family Low Income	0.55	0.59	0.63	0.62	0.65	0.67	0.61
Business Social Services	0.58	0.62	0.72	0.75	0.79	0.80	0.71
Low Income Total	**0.54**	**0.59**	**0.64**	**0.67**	**0.71**	**0.73**	**0.64**
Residential							
Appliance Recycling	0.43	0.48	0.51	-	-	-	0.47
Efficient Products	0.61	0.68	0.73	-	-	-	0.67
Energy Efficient Kits	0.60	0.64	0.64	-	-	-	0.62
Home Energy Report	0.44	0.47	0.50	-	-	-	0.47
HVAC	0.87	0.93	0.98	-	-	-	0.92
Lighting	0.61	0.63	0.66	-	-	-	0.63
Multifamily Market Rate	0.56	0.62	0.66	-	-	-	0.62
Residential Demand Response	1.01	1.18	1.31	-	-	-	1.17
Res Total	**0.77**	**0.83**	**0.89**	**-**	**-**	**-**	**0.83**
Business							
Custom	0.97	1.10	1.15	-	-	-	1.10
New Construction	0.91	0.99	1.05	-	-	-	1.01
Retro-Commissioning	1.12	1.25	1.34	-	-	-	1.28
Small Business Direct Install	0.66	0.71	0.76	-	-	-	0.71
Standard	0.77	0.82	0.87	-	-	-	0.83
Strategic Energy Management	-	-	-	-	-	-	-
Business Demand Response	1.59	1.75	1.91	-	-	-	1.74
Biz Total	**0.98**	**1.04**	**1.09**	**-**	**-**	**-**	**1.05**

*Includes Earnings Opportunity

Net to Gross

Portfolio	2019	2020	2021	2022	2023	2024	Total
Low Income	99.4%	99.2%	99.3%	99.1%	99.2%	99.4%	99.3%
Residential	87.2%	82.5%	83.0%	-	-	-	84.5%
Business	94.0%	94.0%	94.0%	-	-	-	94.0%
Portfolio Total	**90.4%**	**90.1%**	**91.0%**	**99.1%**	**99.2%**	**99.4%**	**90.9%**
Low Income							
Multifamily Low Income	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Single Family Low Income	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Business Social Services	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%
Low Income Total	**99.4%**	**99.2%**	**99.3%**	**99.1%**	**99.2%**	**99.4%**	**99.3%**
Residential							
Appliance Recycling	77.0%	77.0%	77.0%	-	-	-	77.0%
Efficient Products	72.5%	72.6%	72.4%	-	-	-	72.5%
Energy Efficient Kits	90.0%	90.0%	90.0%	-	-	-	90.0%
Home Energy Report	100.0%	-	-	-	-	-	100.0%
HVAC	90.6%	90.5%	90.4%	-	-	-	90.5%
Lighting	64.1%	64.3%	64.6%	-	-	-	64.3%
Multifamily Market Rate	90.0%	90.0%	90.0%	-	-	-	90.0%
Residential Demand Response	100.0%	100.0%	100.0%	-	-	-	100.0%
Res Total	**87.2%**	**82.5%**	**83.0%**	**-**	**-**	**-**	**84.5%**
Business							
Custom	94.0%	94.0%	94.0%	-	-	-	94.0%
New Construction	94.0%	94.0%	94.0%	-	-	-	94.0%
Retro-Commissioning	94.0%	94.0%	94.0%	-	-	-	94.0%
Small Business Direct Install	94.0%	94.0%	94.0%	-	-	-	94.0%
Standard	94.0%	94.0%	94.0%	-	-	-	94.0%
Strategic Energy Management	-	-	-	-	-	-	
Business Demand Response	100.0%	100.0%	100.0%	-	-	-	100.0%
Biz Total	**94.0%**	**94.0%**	**94.0%**	**-**	**-**	**-**	**94.0%**

Incremental Market Penetration Rates

Low Income	2019	2020	2021	2022	2023	2024	Total
Multifamily Low Income	2.7%	5.1%	9.6%	17.0%	21.6%	21.0%	12.2%
Single Family Low Income	14.1%	17.6%	22.4%	12.2%	12.5%	12.5%	15.3%
Business Social Services	1.6%	3.0%	2.8%	2.8%	2.6%	2.1%	2.5%
Residential							
Appliance Recycling	14.2%	20.1%	20.2%	-	-	-	18.2%
Efficient Products	10.0%	11.3%	12.1%	-	-	-	11.1%
Energy Efficient Kits	74.4%	77.4%	51.6%	-	-	-	68.1%
Home Energy Report	27.1%	0.0%	0.0%	-	-	-	9.0%
HVAC	26.3%	28.5%	29.3%	-	-	-	28.0%
Lighting	10.7%	11.2%	20.4%	-	-	-	12.7%
Multifamily Market Rate	2.8%	4.0%	5.0%	-	-	-	3.9%
Residential Demand Response	1.1%	1.3%	1.5%	-	-	-	1.3%
Business							
Custom	0.8%	1.7%	2.4%	-	-	-	1.6%
New Construction	77.6%	100.0%	93.3%	-	-	-	92.9%
Retro-Commissioning	4.3%	11.6%	19.3%	-	-	-	11.7%
Small Business Direct Install	2.0%	2.3%	2.6%	-	-	-	2.3%
Standard	1.2%	2.3%	2.8%	-	-	-	2.1%
Strategic Energy Management	-	-	-	-	-	-	0.0%
Business Demand Response	5.1%	5.1%	5.1%	-	-	-	5.1%

Appendix B - Program Templates

The following program templates are a detailed description of the individual programs which compose the MEEIA 2019-21 portfolio. The program templates facts and analysis completed at the time of this filing. Program tariffs are subject to change based on final program designs, as program revisions and modifications may be implemented during MEEIA 2019-21, and as necessary to align with changes to the exemplar tariffs found in Appendix J - Tariffs. The description follows the requirements set forth in 4 CSR 240-20.094(4)(D).

MEEIA 2019-21 programs:

Low-income

Residential

Business

PROGRAM	Residential Multifamily Low-income Program
Objective	The objective of the Multifamily Low-Income ("MFLI") program is to expand participation and increase long-term energy and demand savings and bill reduction opportunities to low-income customers residing in multifamily low-income properties. This will be achieved through education, a variety of directly installed measures, and comprehensive retrofits.
Target Market	The target market will consist of property owners and managers of multifamily properties of three (3) or more dwelling units. This includes eligible customers receiving service under residential rate 1(M) or business customers who take service under small general service rate 2(M), large general service rate 3(M), and small primary service rate 4(M) within the Company's service territory. Approved participants will be required to meet one of the following income eligibility requirements: 1. Participation in federal, state, or local subsidized housing program. 2. Proof of resident income levels at or below 80% of area median income ("AMI") or 200% of federal poverty level. 3. Fall within a census tract included on Company's list of eligible low-income census tracts. Proof of income may be accomplished in multiple ways, including but not limited to submission of rent rolls or documentation of being on the Department of Energy ("DOE") Weatherization Assistance Program waitlist. Where a multifamily property does not meet one of the eligibility criteria listed above but has a combination of qualifying tenants and non-qualifying tenants, at least 50% of the tenants must be eligible to qualify the entire property.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2024.
Program Description	This program will provide a helpful one-stop-shop approach to increase program participation and provide for more extensive retrofits and larger energy savings per property. This results in further benefits to MFLI property managers and tenants by improving the value of the property, reducing utility bills and O&M costs, and making the property healthier, more comfortable, and safe. Incentives under this program will be provided for multifamily low-income properties, dwelling units, common areas, and whole-building improvements. Measures for dwelling units may include: • LEDs • High efficiency faucet aerators • High efficiency showerheads • Electric domestic hot water pipe wrap • Electric domestic hot water tank wrap • Programmable thermostat installation • Energy Star® room AC or thru-the-wall unit • Energy Star® refrigerators (manufactured in 2001 or prior) • Furnace whistle • HVAC tune-ups Note: Any direct installation of measures includes: 1. Removal, decommissioning, recycling, and disposal of the existing item for which the new measure will substitute, and 2. Acquisition and functioning installation of the new measures complete with all accessories and appurtenances required for its intended use and safe operation. In addition to the dwelling unit measures, standard and custom measures will be offered. The following measures are indicative of incentives that may be offered for the whole-building and common areas: • Hard wired fixtures and exterior lighting • Electric heating and domestic water heating measures • Ventilation and air conditioning ("HVAC") • Motors and envelope improvements The program may allocate funds for minor repairs that facilitate installation of energy efficient improvements. For measures such as air sealing, to ensure the health and safety of the customer, the program may perform combustion tests and/or install carbon monoxide detectors.

Eligible Measures & Services	Eligible measures are included in the Technical Resource Manual ("TRM"). The direct install incentives reflect the full incremental cost. Additional incentives will consist of energy and demand saving measures designed to achieve greater energy savings. These measures will include the following end-use categories: building shell, cooling, HVAC, lighting, refrigeration, water heating, and miscellaneous. Measures installed through this program are not eligible for incentives through any of the Company's other energy efficiency and demand response programs. Refined data will be provided after the measures have been vetted through the program implementation team. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a Contractor to administer this program. In addition to project incentives, the program will seek to drive property owners to achieve maximum savings possible by offering seamless access to financing and other alternatives to reduce financial barriers to investing in energy efficiency upgrades. All eligible properties can participate. However, in order to focus its outreach efforts, the Company will create a plan for identifying the worst performing buildings. This will be done using building characteristics and other available data such as energy usage, account age, and tenant payment data (i.e., high arrears and delinquencies). In addition, the Company will review data from over 40,000 tenant unit upgrades and building assessments that did not lead to common area or whole-building energy efficiency upgrades performed in prior program years. The program provider will engage building owners and operators to have energy assessments conducted on their properties to encourage the installation of standard and custom whole-building improvements and direct install measures in tenant spaces. The process steps include: • Outreach efforts to recruit MFLI properties. • Communication with property regarding energy assessment and scheduling. • Complete MFLI property energy assessment. • Presentation of audit findings to property owner/manager to ensure selection of appropriate measure options. • Assist with applications to secure financing and other funding options. • Finalize scope of work for installation of measures per the property owner's request including rebate and other incentives. • Project setup – create scope, budget, and timeline and launch the installation project at the MFLI property. • Inspection to ensure quality installation of measures; perform corrective action if required. • Customer survey after completion of measure installs, to ensure satisfaction and continuous improvement of the program. • Customer final approval. • Provide technical assistance and support to benchmark the property using ENERGY STAR® Portfolio Manager. • Provide incentives for participating properties to defray the cost to attend Building Operator Certification ("BOC") Training. Where possible, the Company will seek to collaborate with the natural gas and water companies for co-delivery. In the event this is not possible, the MFLI program administrator will ensure participants are aware of all available utility incentives and will assist participants in claiming them. After a property has signed up to participate in the program, the contractor will initiate a communication campaign to inform and educate building tenants about the energy efficiency improvements implemented in their units. The Company will monitor installations. The first set of projects performed would be site-verified, with random site verifications thereafter to ensure installations are being performed properly and equipment is being installed as reported. According the Uniform Methods Project, net-to-gross for this program is assumed to be 1, so minimizing free ridership and maximizing spillover are not issues for this program.

Market Transformation Elements	This program will conduct individual and/or group educational meetings with participating low-income customers to increase awareness of energy efficiency habits and measures, such as purchasing ENERGY STAR® certified products to encourage market transformation. The Company will also assist managers of participating multifamily properties in maintaining their improved building efficiency and boost market transformation by providing incentives to defray the cost to attend Building Operator Certification Training. The plan for estimating, measuring, and verifying energy and demand savings from the market transformation efforts is included in Appendix E – EM&V[1] Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure the program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.

Promotional/ Marketing Strategy	The program will use marketing communications appropriate to the distinct needs of the low-income market, which may include the following:
	• Materials to create awareness and understanding of the program, its benefits, and its sponsor, among occupants of participating properties.
	• General background material and information for tenants to improve their home's energy efficiency.
	• Sales "kit" folder for property owners, managers and Program Partners to include:
	    o Program overview brochure
	    o Program application
	    o Sell sheet/flyer showing program marketing collateral available including banner, door hangtag, yard sign and window cling
	    o Pre- and post-install tenant letter samples
	    o Building specific flyers depicting statistics and cost savings when applicable
	    o Online program overview on Ameren Missouri website
	• Materials for building tenants/residents:
	    o On-site signage and pre-install letter templates announcing/advertising the energy efficient upgrades being installed
	    o Doorknob hangtags with fill-in-the-blank areas for building owners to write in day of install and items being installed
	    o Online program overview on Ameren Missouri

EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process[2] will allow stakeholder input and facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and changing market conditions.

[1] Evaluation, Measurement, and Verification.
[2] The Change Process is detailed in UEC E Sheet No. 221 Energy Efficiency Global Tariff and UEC E Sheet No. 247 DR Global Tariff.

Estimated Participation

Multifamily Low-Income – Estimated Annual Installations							
End-Use	2019	2020	2021	2022	2023	2024	Total
Bldg. Shell BUS	900,000	1,650,000	2,680,000	4,644,000	5,760,000	5,760,000	21,394,000
Total	900,000	1,650,000	2,680,000	4,644,000	5,760,000	5,760,000	21,394,000

Estimated Budget

Multifamily Low-Income – Estimated Annual Budget* ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive**	$0.68	$1.32	$1.91	$2.99	$3.78	$3.80	$14.48
Admin***	$0.86	$0.95	$1.56	$2.39	$2.90	$2.87	$11.54
Total	$1.54	$2.27	$3.47	$5.38	$6.68	$6.68	$26.02

**Incentive received by customer.

***EM&V and Miscellaneous Costs are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation, costs see the DSMore Workbook.

Savings Targets

Multifamily Low-Income – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	900	1,650	2,680	4,644	5,760	5,760	21,394
MW Target/ Savings	0.40	0.73	1.19	2.06	2.56	2.56	9.50
Net-to-Gross	100%	100%	100%	100%	100%	100%	100%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Multifamily Low-Income - 6 Year Program Cost-Effectiveness (2019-24)				
Program	TRC	UCT	PCT	RIM*
Residential Income Eligible	0.83	0.88	1.72	069

*Represents net fuel.

PROGRAM	Residential Single Family Low-Income Program
Objective	The objective of this program is to expand participation and increase long-term energy savings and bill reduction opportunities to low-income Ameren Missouri customers by delivering energy efficiency services through multiple channels.
Target Market	The target market will consist of low-income Residential Rate 1(M) customers who live in single-family detached houses, duplexes and mobile homes (wood-frame bolted to steel chassis, designed to be transported) within the Ameren Missouri service territory. Approved participants will be required to meet one of the following income eligibility requirements: 1. Participation in federal, state, or local subsidized housing program. 2. Proof of resident income levels at or below 80% of area median income (AMI) or 200% of federal poverty level. 3. Fall within a census tract included on Company's list of eligible low-income census tracts.
Program Schedule	Program will launch March 2019 and continue through December 2024.
Program Description	The Residential Single Family Low-Income Program is designed to serve eligible participants through multiple channels to encourage participation and overcome the specific hurdles of each property type. Multiple delivery channels will ensure a diversity of participants and equitable delivery across Ameren Missouri's service territory. The single-family delivery channel options are described below. **Single Family Low-Income** For residential customers residing in single-family detached housing, duplexes, or mobile homes, the program will use a neighborhood approach to identify income-eligible areas with the greatest need. Occasionally, an individual home may be referred to the program by a qualified low-income assistance agency. The program will perform energy assessments and/or diagnostic testing and direct installation of energy saving measures and may provide incentives for whole house measures. Note: Any direct installation of measures includes: 1. Removal, decommissioning, recycling, and disposal of the existing item for which the new measure will substitute and 2. Acquisition and functioning installation of the new measures complete with all accessories and appurtenances required for its intended use and safe operation. **Low-income Efficiency Housing Grant** This distribution channel will further develop the successful social marketing distribution approach utilized for lighting in past MEEIA portfolios. In addition to providing free energy saving LED bulbs for distribution through organizations such as foodbanks, this channel will make energy saving measure packages or incentives directly available to organizations that can provide qualified installation of measures to income eligible residential end users. Participants will apply for grants and receive assistance to ensure measure installation meets program requirements. Where possible the Company will seek to partner with the natural gas and water companies for co delivery.

Eligible Measures & Services	Eligible measures are included in the TRM. The direct install incentives reflect the full incremental cost. The additional incentivized measures may consist of energy and demand saving measures designed to achieve deep energy savings. These measures will include the following end-use categories: building shell, cooling, HVAC, lighting, refrigeration, water heating and miscellaneous. The program may allocate funds for minor repairs that facilitate installation of energy efficient improvements. For measures such as air sealing, to ensure the health and safety of the customer, the program may perform combustion tests and/or install carbon monoxide detectors. Measures installed through this program are not eligible for Incentives through any of the Company's other Energy Efficiency and Demand Response Programs. Refined data will be provided after the measures have been vetted through the program implementation team. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a contractor to administer this program. Multiple participant channels are utilized to reduce housing specific barriers to becoming more energy efficient. Each channel will be managed proactively through a dedicated point of contact. **Single family Low-Income** The program will use a neighborhood approach to identify low-income areas with the greatest need, such as those with high energy usage or high incidence of arrearages or payment delinquencies, to group participants and focus on a single geographic area at a time. The program will also work with assistance agencies to accept referrals when possible. The program will seek to partner with familiar community-based organizations to stage cooperative recruitment drives and/or education events. This approach of utilizing trusted, familiar organizations generates enthusiasm and momentum behind the effort. **Low-Income Efficiency Housing Grant** Ameren Missouri is seeking to facilitate even greater portfolio participation by providing energy saving measure packages directly to organizations that can provide education and qualified installation of measures to income eligible residential end users. According to the Uniform Methods Project, net-to-gross for this program is assumed to be 1, so minimizing free ridership and maximizing spillover are not an issue for this program.
Market Transformation Elements	These programs will conduct individual and/or group educational meetings with participating low-income customers to increase awareness of energy efficiency habits and measures, such as purchasing ENERGY STAR® certified products to encourage market transformation. The plan for estimating, measuring, and verifying energy and demand savings from the market transformation efforts is included in Appendix E – EM&V Plan
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure, mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.

Promotional/ Marketing Strategy	The program will use marketing communications appropriate to the distinct needs of low-income customers, which may include the following: • Materials to create awareness and understanding of the program, its benefits, and its sponsor, among occupants of participating neighborhoods. • General background material and specific suggestions and learning opportunities for homeowners and renters on improving their home's energy efficiency. • Program overview brochure. • Program participation agreements. • The Company will consult with various community organizations to communicate the benefits of the program within their respective social circles. Informing these community leaders about how the program works and the benefits of energy efficiency and providing them with program information will provide a trusted network of Company spokespersons that the communities can identify with. They can promote the program in their community meetings, seminars, weekly sports leagues, etc. to reach a broad audience in a concentrated environment.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and changing market conditions.
Estimated Participation	(see table below)

Single Family Low-Income – Estimated Annual Installations

End-Use	2019	2020	2021	2022	2023	2024	Total
Bldg. Shell RES	334	394	470	564	579	624	2,965
Cooling RES	1,032	1,517	1,541	1,537	1,530	1,540	8,696
HVAC RES	536	706	919	1,041	1,088	1,113	5,402
Lighting RES	165,000	188,460	188,460	130,962	127,211	127,211	927,304
Misc RES	70	70	70	80	80	80	450
Refrig. RES	200	200	200	200	100	100	1,000
Water Heat. RES	1,065	1,525	1,725	1,970	2,160	3,195	11,640
Total	168,237	192,872	193,384	136,353	132,748	133,863	957,457

Estimated Budget

Single Family Low-Income – Estimated Annual Budget* ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive**	$1.76	$2.05	$2.15	$2.01	$1.93	$1.96	$11.86
Admin***	$1.77	$1.94	$1.95	$1.86	$1.86	$1.89	$11.26
Total	$3.53	$3.98	$4.09	$3.87	$3.79	$3.85	$23.11

**Incentive received by customer.

***EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation, costs see the DSMore Workbook.

Savings Targets

Single Family Low-Income – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	8,556	10,415	10,822	5,776	5,773	5,891	47,232
MW Target/ Savings	1.83	2.34	2.47	1.77	1.77	1.82	12.00
Net-to-Gross	100%	100%	100%	100%	100%	100%	100%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Single Family Low-Income - 6 Year Program Cost-Effectiveness (2019-24)				
Program	TRC	UCT	PCT	RIM*
Residential Low-Income	1.47	1.55	6.72	0.61

*Represents net fuel.

PROGRAM	Business Social Services Program
Objective	The Business Social Services ("BSS") Program is designed to promote the installation of energy efficient technologies in social service businesses by removing participation barriers such as: • Lack of time/resources to investigate and review energy efficiency improvement; • Skepticism that participating will actually be of value; • Lack of financing; • Belief energy conservation is not integral to their business strategy; and • Belief that adopting energy conservation measures is a complicated, time-consuming, and potentially a costly process. Energy efficient technologies may include but are not limited to lighting, HVAC, smart thermostats, motors, water heating, refrigeration and HVAC tune-ups. Measures included within this program are common in multiple marketplaces and have deemed savings calculation values associated with their energy performance. This program encourages social service business customer participation through a simple, immediate and streamlined program process.
Target Market	Commercial, nonprofit, and tax-exempt business customers in the Small General Service (2M) and Large General Service (3M) rate classes, that are doing business to provide social services to the low-income public, including food banks, food pantries, soup kitchens, homeless shelters, employment services, worker training, job banks, and childcare facilities.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2024.
Program Description	The BSS Program will provide lighting measures and installation at no cost and HVAC, smart thermostats, motors, water heating, refrigeration and HVAC tune-up measures at low-cost and/or no-cost to social services business customers with qualifying facilities. Program providers will supply, install, and finalize paperwork for eligible participants and identify additional energy efficiency opportunities not covered under the BSS Program. Measures within this program will be included in the Deemed Savings Table and have fixed incentive levels associated with them, although these incentive values may be altered as program budget and performance change throughout the term. Upon receipt of completed documentation, Ameren Missouri will distribute incentive payments.
Eligible Measures & Services	The BSS Program energy efficient eligible measures include but not limited to, lighting, HVAC, smart thermostats, motors, water heating, refrigeration and services. Ameren Missouri and Program Administrator will combine national best practice with actual experience to set an adequate payback period to drive customer adoption. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.

Implementation Strategy	Responsibilities of the Program Administrator hired to implement the program, include final program design, measure lists, and implementation plan. Implementation plan will include but be not limited to: • Developing a Social Services-targeted market plan for lighting, HVAC, smart thermostat and other measures that may be included in program; • Lead generation (introduction channels, customer outreach and lead qualification); • Developing a program provider structure to effectively support lighting, HVAC, smart thermostat and other measure savings opportunities; and • Developing a mobile sales tool utilized with customer for load assessment, energy savings and customer return on investment. Electronic or hard copy summary made available to customers. In order for program providers to effectively promote and communicate the benefits of the program, the implementation team will provide applicable training and marketing materials. Upon submission of project documentation, projects will be reviewed and must be approved before an incentive is distributed. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.
Market Transformation Elements	The BSS Program will play an important role in market transformation by training and educating social services businesses with direct outreach and through low-income associations. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.

Promotional/ Marketing Strategy	Marketing efforts will focus on program awareness through direct outreach. Key pillars of the marketing strategy for the BSS Program include but are not limited to: • **Lead generation**: Introduction channels, customer outreach and lead qualification managed by Program Administrator and program providers. • **Mobile Sales Tool:** Program provider mobile sales tool utilized with customer for load assessment, energy savings and customer return on investment. Electronic or hard copy summary made available to customers. • **Education:** Program Administrator will play an important role in training and educating the program provider sales staff. The Program Administrator will assist program provider in identification of measures qualifying for incentives, project financing options, identify additional energy savings opportunities, and how to effectively sell all measures to customers. • **Marketing Materials:** Materials will be provided to customers and program provider to further enhance program awareness and increase market penetration. • **Direct Mail - USPS and electronic:** This marketing vehicle will require a targeted approach, identifying potential efficient installs based on business operating characteristics and building types. • **Community Outreach:** Program awareness for Social Services can be promoted through community outreach associations. Along with promoting the design and customer benefits, this approach will help overcome skepticism of a program offering being delivered through a program provider. • **Highlight successfully completed projects**: Projects will be selectively chosen to display the process and benefits of the program. This type of marketing will spur the customer's competitors to improve building performance and increase business process efficiency. This marketing strategy also allows the selected customer promotional and marketing opportunities. • **Program Providers:** Ameren Missouri will utilize program providers as an additional sales/marketing channel for the program. Continual training will be provided to these providers to ensure that any business development activities are conducted to achieve program goals. • **Inter-program Marketing**: The Program Administrator will maintain a portfolio of programs and will increase customer's awareness across programs as part of the application and education process. This is an opportunity to direct the customer to other possible energy savings incentives. Aiding customers in identifying the appropriate Business programs is important in maintaining high levels of customer satisfaction, creating spillover and reaching energy savings opportunities. • **Market Segmentation:** To more effectively penetrate the Ameren Missouri markets, a targeted marketing approach will be used. Separating the program's marketing campaign to focus on specific social services types (food banks, food pantries, soup kitchens, homeless shelters, employment services, worker training, job banks, and childcare facilities) will increase customer interest and drive installations. Also segment market targets by identifying inefficient facilities based on business type, facility size and actual energy usage.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Business Social Services Program – Estimated Annual Installations							
End-Use	2019	2020	2021	2022	2023	2024	Total
Cooking Bus	6	11	8	3	8	7	43
Ext Light Bus	28	47	41	45	38	29	227
Cooling Bus	187	320	1,358	1,050	1,063	709	4,686
Motors Bus	23	42	40	40	37	30	212
HVAC Bus	3	6	20	22	20	14	86
Lighting Bus	3,539	6,448	5,136	5,012	4,794	3,872	28,801
Misc Bus	75	136	102	113	102	81	610
Refrigeration BUS	23	46	141	150	136	111	607
Water Heat. BUS	2	3	3	3	3	2	17
Total	3,885	7,060	6,848	6,438	6,202	4,855	35,290

Estimated Budget

Business Social Services Program – Estimated Annual Budget ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive	$0.25	$0.45	$0.49	$0.46	$0.44	$0.34	$2.41
Admin*	$0.10	$0.15	$0.14	$0.15	$0.14	$0.11	$0.78
Total	$0.34	$0.60	$0.63	$0.60	$0.57	$0.45	$3.19

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Business Social Services – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	987	1,793	1,700	1,692	1,582	1,263	9,017
MW Target/ Savings	0.19	0.34	0.39	0.38	0.36	0.28	1.95
Net-to-Gross	94%	94%	94%	94%	94%	94%	94%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Business Social Services Program - 6 Year Program Cost-Effectiveness (2019-21)				
Program	**TRC**	**UCT**	**PCT**	**RIM***
Social Services Program	**1.53**	**1.64**	**3.34**	**0.71**

*Represents net fuel.

PROGRAM	Residential Appliance Recycling Program
Objective	The primary goal of the Residential Appliance Recycling ("RAR") Program is to promote the retirement and recycling of inefficient refrigerators, freezers, dehumidifiers, and/or room ACs from households by offering a turn-in incentive, free pickup of working equipment, and information and education on the cost of keeping an inefficient unit in operation.
Target Market	Residential electric customers with working refrigerators, freezers, dehumidifiers, and/or room ACs manufactured on or before a cutoff date to be determined when the contractor is engaged and program design finalized.
Program Schedule	Program will launch March 1, 2019, and run through December 31, 2021.
Program Description	The Company will hire an implementation contractor to provide turnkey implementation services that include verification of customer eligibility, scheduling of pick-up appointments, appliance pick-up, recycling and disposal activities, and incentive processing. Recycling/disposal practices will be designed to prevent the release of chlorofluorocarbons ("CFCs"). Turnkey program implementation through an appliance recycling contractor will simplify program delivery, reduce the Company's administrative costs, and ensure a streamlined participation process. The program will be designed to minimize barriers to participation by offering incentives, convenient scheduling of appointments, and cost-free pick-up of qualifying equipment. The program may also include pick-up and recycling of other appliances such as working dehumidifiers and window air conditioners in conjunction with a pick-up of a refrigerator or freezer. The program may also be used as a delivery channel for other low or no cost measures such as LEDs and hot water measures, where applicable, to capture additional energy savings from participants.
Eligible Measures & Services	The program will provide eligible customers incentives to retire working inefficient refrigerators, freezers, dehumidifiers, and room air conditioners. In addition to free pick-up of eligible equipment, the program will provide turn-in incentives. As the Appliance Recycling Program evolves and ongoing EM&V activities track program performance, the Company may revise incentive amounts or qualification criteria for appliances as the market dictates. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	Key elements of the RAR Program implementation strategy include: • **Outsourcing implementation**: The Company will contract with a prime contractor or regional/national appliance recycling company to provide comprehensive, turnkey implementation services from eligibility verification to proper disposal/recycling of turned-in appliances. • **Customer education/recruitment**: The Contractor will develop and implement the program marketing strategy. There will be consumer marketing and education components emphasizing how much it costs to operate an old, energy-inefficient refrigerator as well as information regarding the availability of program incentives and pick-up services. The marketing messages will vary depending on seasonality and program performance towards meeting statutory energy savings goals. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.
Market Transformation Elements	The program will employ a resource for customers to easily remove, recycle and dispose of inefficient refrigerators and appliances removing barriers for customers to dispose of inefficient appliances. The program includes an education component to encourage the removal of inefficient appliances. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.

Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.
Promotional/ Marketing Strategy	The program will employ strong consumer education and marketing components emphasizing the savings associated with retiring old, inefficient refrigerators and freezers and the importance of ensuring proper disposal/recycling. Call Center staff will be trained and provided with program collateral. Marketing materials may include: • Web content; • Bill stuffers and other direct mail; • Limited mass market advertising around special promotions; • Print (newspaper, newsletter, etc.); • TV, radio; • Garage sale ads, promotional handouts to Low-income Home Energy Assistance Project (LIHEAP) agencies, realtors, and appliance retailers; • Door-hangers; • Billboards; and • Bill messages. Additional strategies will likely be deployed to maximize spillover.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.
Estimated Participation	(see table below)

Residential Appliance Recycling– Estimated Annual Installations

End-Use	2019	2020	2021	2022	2023	2024	Total
Cooling Res	105	105	140	N/A	N/A	N/A	350
Freezer Res	560	770	770	N/A	N/A	N/A	2,100
HVAC Res	105	105	140	N/A	N/A	N/A	350
Refrigeration Res	2,450	3,500	3,500	N/A	N/A	N/A	9,450
Total	3,220	4,480	4,550	N/A	N/A	N/A	12,250

Estimated Budget

Residential Appliance Recycling– Estimated Annual Budget* ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive**	$0.15	$0.22	$0.22	N/A	N/A	N/A	$0.59
Admin***	$0.36	$0.38	$0.38	N/A	N/A	N/A	$1.12
Total	$0.52	$0.60	$0.60	N/A	N/A	N/A	$1.71

**Incentive received by customer.

***EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Residential Appliance Recycling – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	2,358	3,333	3,345	N/A	N/A	N/A	9,037
MW Target/ Savings	0.34	0.47	0.48	N/A	N/A	N/A	1.30
Net-to-Gross	77%	77%	77%	N/A	N/A	N/A	77%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Residential Appliance Recycling - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Residential Appliance Recycling	1.59	1.59	∞	0.47

*Represents net fuel.

PROGRAM	Residential Efficient Products Program
Objective	The objective of the Residential Efficient Products ("REP") Program is to raise customer awareness of the benefits of "high-efficiency" products (ENERGY STAR®, Consortium for Energy Efficiency ("CEE") Tiers, or better) and to educate residential customers about energy use in their homes and to offer information, products, and services to residential customers to save energy cost-effectively.
Target Market	All residential customers within the Ameren Missouri service territory.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The REP Program is meant to be an umbrella program, incorporating various program partners, products, and program delivery strategies. Some aspects of the program will be encouraged through an on-line marketplace and mail-in and instant rebates, while others may be packaged together and delivered through program partners and contractors or through a midstream rebate approach. To the extent possible, Ameren Missouri will attempt to leverage opportunities with both federal and state programs. Ameren Missouri will also leverage the CEE to identify efficiency tiers above ENERGY STAR® for products. As appropriate, Ameren Missouri will support these tiers with higher incentives. Depending on specific product parameters, this may provide greater per unit and customer savings and developing and supporting these tiers helps accelerate future ENERGY STAR® specification revisions and code changes.
Eligible Measures & Services	Measures may consist of qualified ENERGY STAR® appliances, power management, water heaters, window air conditioning units, pool pumps, various building shell measures, connected home products and learning thermostats. As the REP Program evolves and ongoing EM&V activities track program performance, the Company may revise eligible measures, incentive amounts or qualification criteria for appliances as the market dictates. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a Contractor to administer this program. Customers will purchase some program-qualified products at participating retailers, or on-line through Ameren Missouri's marketplace or other retail websites. Participants may have building shell measures installed through program partners and contractors. Once the rebate request has been received by the program, it is processed, and a rebate check will be sent to the customer or participating partner as appropriate. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.
Market Transformation Elements	The program will include education elements designed to educate customers on the benefits of energy efficiency and will provide incentives to reduce the upfront cost of energy efficient products which can be a barrier to the adoption of energy efficiency absent the program. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.

Promotional/ Marketing Strategy	The Company and its implementation contractors will follow a multi-faceted approach to marketing highly efficient appliances, electronics and products with an emphasis on ENERGY STAR®. In addition to direct advertising targeted at residential customers, the Company expects to leverage national ENERGY STAR® marketing campaigns and to work collaboratively with industry partners and trade allies at all levels of the retail supply chain. Marketing activities include but are not limited to: • Retail marketing and POP displays; • TV, radio, print. Billboard advertising; • The Ameren Missouri website; • Leveraging marketing budgets through cooperative promotions with retailers, distributors, contractors, and manufacturers including special events at retail stores and in communities; • Training and supporting retail sales staffs so they are able to tell customers about the benefits of ENERGY STAR® appliances and products and to help customers choose the best products to meet their needs; and • Utilizing the knowledge and experience of the contractor trade ally network to promote the installation of high-efficiency products and educate the customer on energy efficiency. Additional strategies may be deployed to maximize spillover.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Residential Efficient Products – Estimated Annual Installations

End-Use	2019	2020	2021	2022	2023	2024	Total
Cooling RES	13,266	14,785	16,069	N/A	N/A	N/A	44,120
Misc RES	2,100	2,030	2,310	N/A	N/A	N/A	6,440
Pool Spa RES	972	1,225	1,225	N/A	N/A	N/A	3,422
Water Heating RES	225	225	225	N/A	N/A	N/A	676
Total	16,563	18,266	19,829	N/A	N/A	N/A	54,658

Estimated Budget

Residential Efficient Products – Estimated Annual Budget* ($ millions)

Year	2019	2020	2021	2022	2023	2024	Total
Incentive**	$1.12	$1.28	$1.36	N/A	N/A	N/A	$3.77
Admin***	$0.96	$0.75	$0.78	N/A	N/A	N/A	$2.50
Efficient Products	$2.09	$2.03	$2.14	N/A	N/A	N/A	$6.26

**Incentive received by customer.

***EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Residential Efficient Products– Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/Savings	8,222	9,188	9,800	N/A	N/A	N/A	27,209
MW Target/Savings	2.14	2.43	2.61	N/A	N/A	N/A	7.18
Net-to-Gross	72.5%	72.6%	72.4%	N/A	N/A	N/A	72.5%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Residential Efficient Products- 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Residential Efficient Products	1.30	2.21	3.06	0.67

*Represents net fuel

PROGRAM	Residential Energy Efficiency Kits
Objective	The objective of the Energy Efficiency Kits ("EEK") Program is to increase customer awareness of the benefits of "high-efficiency" products (ENERGY STAR®, CEE Tiers, or better); to educate residential customers about energy consumption in their homes; and offer information, products, and services to residential customers to encourage saving energy cost-effectively.
Target Market	All eligible residential customers within the Ameren Missouri service territory.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The EEK Program provides energy efficiency kits and education materials to electric water heating customers through multiple channels including: • An educational channel to secondary schools; • Single family home customers with electric water heating; and • Community based events in select areas.
Eligible Measures & Services	Eligible products are selected specifically to encourage energy savings at home and engage families in activities that support and reinforce the energy saving concepts. The program will include these types of products: • High-efficiency shower heads; • Kitchen faucet aerators; • Bathroom faucet aerators; • ENERGY STAR® LED light bulbs; • Electric domestic hot water pipe wrap; and • Filter alarm A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a Contractor to administer this program. Distribution channels for the EEK may include: 1) educational channel to secondary schools; 2) single family home customers with electric water; and 3) community based events. Where possible the company will seek to deliver the kits in conjunction with the natural gas and water companies. **School Education Kits** The School Education Kit program offering is a turnkey program that combines a set of classroom activities with projects in the home to install energy efficient products. During the school year this program will be targeted, but not limited to, sixth grade students in Ameren Missouri's service area. Students will receive a take-home kit containing previously mentioned energy efficiency information. Along with the kit, students will read and work through an educational workbook with the assistance of their parent, to identify and install energy saving products throughout their home and track and record what they are doing as part of a homework activity. This will allow them to gather valuable data about their home and report it back to the Company in a survey. The students are encouraged to share the learning experience with all family members. Students work on subjects required by national and state learning standards to understand and appreciate the value of electricity in daily life. The program shapes new behaviors and achieves immediate savings results through an innovative and effective mix of new measure installations and energy and water efficiency knowledge. **Single Family Kits** Single-family kits will target single-family homes with electric water heating. Customers will receive educational material along with installation instructions. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.

Market Transformation Elements	The program will include elements designed to educate secondary school students and customers on the benefits of energy efficiency. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.
Promotional/ Marketing Strategy	The EEK program messaging will focus on the value proposition of saving energy through low-cost energy efficiency measures, using the products in the kit as an example. This message will encourage participants to seek information about the opportunities available from other portfolio programs. The end users will be encouraged to learn more about the energy efficiency programs by visiting amerenmissouri.com. The successful result of the marketing plan will be having the homeowner participate in one or more of the other programs. For education kits, the marketing collateral included in the kits, and the container itself, will serve as the primary marketing channel for this program. These materials will include several calls to action, such as: encouraging the participants to install the energy efficiency products provided; directing them to contact the program to learn more about energy efficiency programs; and to provide household information, and product installation verification. Additional strategies may be deployed to maximize spillover.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.
Estimated Participation	(see table below)

Residential Energy Efficiency Kits– Estimated Annual Installations

End-Use	2019	2020	2021	2022	2023	2024	Total
HVAC RES	18,000	18,000	18,000	N/A	N/A	N/A	54,000
Lighting RES	121,500	121,500	108,000	N/A	N/A	N/A	351,000
Miscellaneous RES	-	-	-	N/A	N/A	N/A	-
Water Heating RES	134,100	134,100	134,100	N/A	N/A	N/A	402,300
Total	273,600	273,600	260,100	N/A	N/A	N/A	807,300

Estimated Budget

Residential Energy Efficiency Kits – Estimated Annual Budget* ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive**	$0.82	$0.82	$0.76	N/A	N/A	N/A	$2.41
Admin***	$0.56	$0.48	$0.39	N/A	N/A	N/A	$1.43
Total	$1.38	$1.31	$1.15	N/A	N/A	N/A	$3.83

**Incentive received by customer.

***EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Residential Energy Efficiency Kits – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/Savings	6,551	6,551	4,199	N/A	N/A	N/A	17,301
MW Target/Savings	1.16	1.16	0.81	N/A	N/A	N/A	3.13
Net-to-Gross	90%	90%	90%	N/A	N/A	N/A	90%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Residential Energy Efficiency Kits - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Residential Energy Efficient Kits	2.09	2.53	7.96	0.62

*Represents net fuel.

PROGRAM	Residential Home Energy Reports Program
Objective	The Residential Home Energy Reports ("RHEP") program focuses on promoting changes in energy consumption behavior that result in reduced electricity through customer behavior modification.
Target Market	Residential customers identified by the Company and implementation contractor.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The Home Energy Report provides customers with a comparison of their energy usage to that of similar homes within proximity of the report recipient. A similar home does not necessarily refer to a next-door neighbor but rather someone who has similar characteristics in terms of size of home and location demographics. Customers will be chosen by Ameren Missouri and the Program Administrator to participate. Customers are eligible to opt-out of program and/or are able to opt-in for electronic communications. A control group of non-participating customers will be identified and maintained for the program period, based on program design needs. The Ameren Missouri program website will provide customers online access to their Home Energy Report, an interactive portal and access to additional energy efficiency information beyond that presented on the mailed report. Additional program support could include bill alerts and other communication to engage the customer. Reports may be mailed, emailed or both and may include additional communication channels.
Eligible Measures & Services	The program focuses on energy consumption behavior changes that result in reduced electricity consumption. As such, the overall metric is reduced monthly/annual energy consumption. There are no specific energy efficiency measures associated with the program however; there may be incentives or rewards for behavioral modifications. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a contractor to administer this program. The selected implementation contractor will provide the necessary services to effectively implement the program and obtain the energy savings goals outlined in the Plan while adhering to the planned budget. Key implementation aspects include: • Identify customers for participation; • Identify customers for the control group; • Mailed and emailed Home Energy reports to targeted residential customers on a preset frequency and may include additional delivery channels for engagement; and • Online access for customers to a portal and an interactive audit-like functionality ("best tips for me," etc.), and access to additional energy efficiency information beyond that presented on the report. The analysis by the independent evaluator will determine net savings, so minimizing free ridership and maximizing spillover are not an issue for this program.
Market Transformation Elements	The program will include education elements designed to educate customers on the benefits of energy efficiency. The program will also provide tools and resources designed to encourage the adoption of energy efficiency and conservation. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.

Promotional Marketing Strategy	Energy use, housing, disaggregation methods, demographic data, and available past program participation data will be used to design a multi-dimensional segmentation plan of potential customers based on: • Energy consumption patterns (e.g. normalized high seasonal peak, high base load, etc.); • Housing data (e.g. age of house, size of house, value of home, type of construction, presence of a pool, presence of a garage); • Past and current program participation & rebate redemption (e.g. ENERGY STAR® and other rebates; rate programs, etc.) if available; and • Demographic data (e.g. renter vs. homeowner, presence of children in the household, indicators of interest in environmental issues, age of customer, duration of residence, socioeconomic/income levels, as available); and additional disaggregation methods. Identify high-potential prospects for program marketing by profiling historical participants and available historical marketing campaign results.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Residential Home Energy Report – Estimated Annually

End-Use	2019	2020	2021	2022	2023	2024
Building Shell RES	235,000	235,000	235,000	N/A	N/A	N/A

An estimate of 235,000 participants will receive the Home Energy Report throughout the 6-year term.

Estimated Budget

Residential Home Energy Report – Estimated Annual Budget ($ millions)

Year	2019	2020	2021	2022	2023	2024	Total
Incentive	$1.38	$1.48	$1.48	N/A	N/A	N/A	$4.34
Admin*	$0.52	$0.49	$0.50	N/A	N/A	N/A	$1.51
Total	$1.90	$1.97	$1.98	N/A	N/A	N/A	$5.85

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Residential Home Energy Report– Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	35,250	35,250	35,250	N/A	N/A	N/A	35,250
MW Target/ Savings	16.43	16.43	16.43	N/A	N/A	N/A	16.43
Net-to-Gross	100%	100%	100%	N/A	N/A	N/A	100%

Behavioral savings have a 1 year estimated life. The chart reflects savings for the 6-year term with no incremental savings each year.

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Residential Home Energy Report - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT*	RIM**
Residential HER	1.07	1.07		0.47

*Since the incremental costs of measures are negligible, the PCT approaches a very large value.

**Represents net fuel.

PROGRAM	Residential HVAC Program
Objective	The objective of the Residential Heating, Ventilation, and Air Conditioning ("HVAC") Program is to obtain energy and demand savings through improvements in the operating performance of existing residential cooling units or replacement of central air conditioning ("AC") units and heat pumps.
Target Market	The program will target residential customers with central AC units or heat pumps. The program will be available to both single and multifamily residential electric customers. To be eligible for participation in the program, the dwelling unit must be one of the following: • Single-family residence; • Multifamily building with four units or fewer, in any configuration; • Row house, which is defined as a single-family dwelling unit that shares common vertical walls only with other single-family dwelling units; and • Multistory, multifamily dwelling units with greater than four units that also share a horizontal surface (floor or ceiling) with another dwelling unit.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	This program covers virtually every aspect of air conditioners and heat pumps including commissioning and retro-commissioning, rated unit efficiency, actual unit efficiency, and retrofit and replacement upgrades. The program may also conduct a pilot or limited implementation of targeted mid-stream incentives to promote adoption of efficient systems, and may use the local HVAC contractor base to promote installation of heat pump water heaters and learning thermostats. The program includes marketing concepts that, when successful, can be used for other programs in the Company's service area. The Company will utilize a marketing approach containing multiple data sets including billing, census, and county/municipality data to target the best opportunities for participation. The Residential HVAC Program improves the efficiency of new and existing central air conditioning systems, including heat pumps, by replacing legacy-cooling systems and by promoting the use of new high-efficiency systems in both existing homes and in new construction. The baseline efficiency conditions for new and replacement-cooling systems are the operating efficiency of existing systems or applicable federal equipment standards and applicable building codes. The baseline conditions for existing air conditioning systems usually include age-related degradation, improper refrigerant charge, and airflow across the coils.
Eligible Measures & Services	Eligible measures are cost-effective measures included in the TRM, which include new and replacement central AC units and heat pumps for single and multifamily properties and tune-ups. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a contractor to administer this program. The Contractor will provide the necessary services to effectively implement the program and obtain the energy and demand savings goals outlined in the Plan while adhering to the planned budget. Key implementation aspects include: • Targeted marketing approach for contractor recruitment and training. Developing a consistent and robust educational component will help deliver an effective program. Training will commence once contractors enter into the participation agreement. • Specific areas of training include measure testing protocols, calibration requirements, procedures for various conditions, and acceptable tolerances. For equipment, the protocols will specify efficiency standards and other elements such as a matching indoor and outdoor coil requirement for new air conditioning equipment. • Once contractors are trained, they can utilize the techniques and incentives provided by the Company to improve sales of highly efficient HVAC equipment and effectively diagnose and improve existing system inefficiencies. Ameren Missouri will provide incentives to encourage sales of energy efficient products and for properly installed HVAC energy saving upgrades.

Implementation Strategy	The program will employ the implementation contractor's preferred protocols to verify refrigerant charge and airflow optimization and quality installations. The components of this process include: *1.* Units will be qualified for early replacement based on operational status and unit nameplate efficiency. This step provides the technician with the information they need to initiate the sale of a new high efficiency unit immediately, while they are still at the jobsite; and 2. Replacement systems efficiency ratings are verified through the Air Conditioning, Heating, and Refrigeration Institute ("AHRI") certification database and are commissioned using the implementation contractor's preferred protocol. This step verifies the rated efficiency of the new system, and that it is properly installed and operating. This closes the loop in documenting the energy savings delivered by the replacement. Once the replacement or tune-up has been completed, an informational package will be provided to the customer. This package will certify the improvements made, provide educational literature describing efficiency maintenance and benefits, and seek the completion of a satisfaction survey. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.
Market Transformation Elements	The program will train a network of HVAC contractors on the concept of including energy efficiency as a tactic in their sales strategy. Contractors will have access to tools and marketing materials to support those efforts. The program also includes elements designed to educate customers on the benefits of purchasing high efficiency equipment and will provide incentives to reduce the upfront cost which can be a barrier to adoption of energy efficient HVAC equipment absent the program. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.
Promotional/ Marketing Strategy	Marketing to customers must help to overcome barriers to their participation, especially: a) lack of awareness, understanding, or trust of the new measures, b) lack of awareness and trust as to which suppliers can provide the new measures, and c) higher first costs. Program messaging will be designed to address the lack of awareness regarding the optimal performance of HVAC equipment and the benefits of high efficiency new equipment. The following methods will be employed to maximize customer attention, receptivity, and action: • In conjunction with Ameren Missouri, the contractor will analyze utility customer usage data, weather data, and demographic data to target the 10-15% of Ameren Missouri residential customers who are most likely to have inefficient heating and cooling systems. Utilizing this data, the Contractor will send target tactics to these customers identifying potential HVAC improvements tailored to their specific situation as defined by the data analysis. • The contractor will work with HVAC contractors to target their existing customers and to prospect for new customers. The Contractor will work with the HVAC contractors to identify existing customers that may qualify for the program and provide assistance to those contractors to help them identify and develop new clients. • The program will develop marketing materials to support all aspects of the program, especially materials for customers and contractor. • Post-service materials will be used to inform the customer of system performance and provide opportunities for the Company to cross-sell other efficiency programs. HVAC contractor training will not only provide avenues to improve the qualified installation/retrofit community of HVAC professionals, but also provide information and education on Ameren Missouri's portfolio of residential energy efficiency programs. Additional strategies may be deployed to maximize spillover.

EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Residential HVAC – Estimated Annual Installations

End-Use	2019	2020	2021	2022	2023	2024	Total
Cooling RES	12,698	13,546	13,871	N/A	N/A	N/A	40,114
HVAC RES	7,498	9,549	10,131	N/A	N/A	N/A	27,178
Total	20,196	23,094	24,002	N/A	N/A	N/A	67,292

Estimated Budget

Residential HVAC – Estimated Annual Budget* ($ millions)

Year	2019	2020	2021	2022	2023	2024	Total
Incentive**	$6.91	$7.43	$7.62	N/A	N/A	N/A	$21.96
Admin***	$5.74	$5.87	$6.09	N/A	N/A	N/A	$17.71
Total	$12.65	$13.30	$13.72	N/A	N/A	N/A	$39.68

**Incentive received by customer.

***EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Residential HVAC – Estimated Annual Net Savings at Meter

Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/Savings	44,361	47,594	48,350	N/A	N/A	N/A	140,305
MW Target/Savings	23.28	25.40	26.07	N/A	N/A	N/A	74.76
Net-to-Gross	90.6%	90.5%	90.4%	N/A	N/A	N/A	90.5%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Residential HVAC - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Residential HVAC	1.93	3.49	3.09	0.92

*Represents net fuel.

PROGRAM	Residential Lighting Program
Objective	Increase sales and awareness of ENERGY STAR® qualified lighting products.
Target Market	The target market will consist of all residential customers within the Ameren Missouri service territory.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The program will be run through a Program Administrator and its subcontractors with significant experience in markdown and rebate processing and working with national and local retail outlets. The subcontractors will offer incentives to local, national and online retail partners to increase sales of qualified lighting. Through these incentives, the end-user receives a discount on the price of highly efficient, ENERGY STAR® or better, qualified lighting products. There will be an emphasis on training the retail outlet sales staff to discuss the benefits of efficient lighting as well as increased Point of Purchase (POP) marketing materials to increase consumer awareness. Ameren Missouri will also offer an Online Marketplace store to ensure availability to customers who do not have a retailer near their location. The program will continue to leverage past program partners but also build on national best practices for consumer marketing opportunities.
Eligible Measures & Services	Cost-effective lighting measures included in the TRM. Markdowns incentives are price reductions offered by retailers to increase sales of a specific product. The goal of the markdown is to develop a cost reduction, making the lighting product more appealing to the consumer while at the same time creating an opportunity to educate consumers on the benefits and applications of LEDs. Each Participant will receive a rebate as an instant credit at check out from the Retailer or an online marketplace. Incentive levels are not fixed and will likely change to reflect market conditions and drive the market participation. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.

Implementation Strategy	The Company will hire a contractor to administer this program. The selected implementation contractor will provide the necessary services to effectively implement the program and obtain the energy savings goals outlined in the Plan while adhering to the budget identified by the Company. Key implementation aspects include:
	• Create marketing material leveraging the Company's brand image, including coupons, POP marketing materials, and other materials to be used to support the sales staff;
	• Rebate processing and payment;
	• A tracking system database will be utilized to collect and monitor sales data from the field, segmented by retail partner, geographical locations, and sales volume;
	    ○ The database will have components to track field work as well, identifying stores visited, marketing materials left at store, and retailer feedback among other items;
	• Develop reports to display the program's progress in relation to meeting budgets and savings goals on a regular basis;
	    ○ There will be other reporting, which will identify operational details on progress with field representatives;
	    ○ Quarterly and annual reporting summarizing program milestones and achievements will be provided to the Company for review and to inform program redesign;
	• The contractor will hire, train, and develop field representatives to educate and monitor retail outlet partners;
	    ○ These field representatives will be responsible for delivering marketing materials, training the retailers' sales staff, and reporting their findings;
	• Depending on level of sales and budget availability, additional delivery channels may be employed;
	• Provide instant rebates online through the online stores of participating retailers; and
	• Implement strategies to minimize free riders

	The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.
Market Transformation Elements	The program will include education elements designed to educate customers on the benefits of energy efficiency and will provide incentives and markdowns on lighting products to reduce the upfront costs which can be a barrier to the adoption of energy efficiency absent the program. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.
Promotional/ Marketing Strategy	The primary marketing efforts will be separated into customer awareness and sales staff education. Recruitment of retail partners will be critical to the success of this program. Identifying the benefits of providing more efficient lighting products to customers as well as outlining the corresponding incentives will help to build the retail trade ally network. Various marketing materials will be delivered to the participating retail stores to inform end-use customers about efficient lighting. These materials include but are not limited to point of purchase materials (hangtags, stickers, etc.). Other types of marketing that may be employed include but are not limited to lighting clinics and events at retailers, pop-up retail, proximity mobile marketing, on-line advertising, Co-op advertising, coupons, print, radio, television commercials, Web placement, billboards, and on-bill messaging. The second component of the marketing will consist of training and educating the sales staff on effectively promoting and endorsing ENERGY STAR® or other high efficiency lighting products. Field representatives will deliver marketing materials to staff, train and educate the sales staff surrounding the ENERGY STAR® brand and its benefits, and provide a point of contact for retail partners to ask questions and receive any further clarification as needed. Additional strategies will be deployed to maximize spillover.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.
Estimated Participation	(see table below)

Residential Lighting – Estimated Annual Installations

End-Use	2019	2020	2021	2022	2023	2024	Total
Lighting RES	580,450	644,297	599,461	N/A	N/A	N/A	1,824,208

Estimated Budget

Residential Lighting – Estimated Annual Budget* ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive**	$0.96	$1.12	$0.90	N/A	N/A	N/A	$2.99
Admin***	$0.97	$0.99	$0.78	N/A	N/A	N/A	$2.74
Total	$1.94	$2.11	$1.68	N/A	N/A	N/A	$5.73

**Incentive received by customer.

***EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Residential Lighting – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	12,659	13,203	11,238	N/A	N/A	N/A	37,100
MW Target/ Savings	1.89	1.97	1.68	N/A	N/A	N/A	5.54
Net-to-Gross	64.1%	64.3%	64.6%	N/A	N/A	N/A	64.3%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Residential Lighting - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT*	RIM**
Residential Lighting	4.02	4.02		0.63

*Since the incremental costs of measures are negligible, the PCT approaches a very large value.

**Represents net fuel.

PROGRAM	Residential Multifamily Market Rate Program
Objective	The objective of this program is to deliver long-term energy savings and bill reductions to multifamily properties that do not qualify for the low-income program by delivering energy efficiency services to Ameren Missouri customers who are tenants, property owners and operators of eligible multifamily properties. This will be achieved through education, outreach and a variety of no-cost and low-cost energy saving measures.
Target Market	Eligible customers taking service under the Company's Service Classifications, Residential Rate 1(M), Small General Service Rate 2(M), Large General Service Rate 3(M), and Small Primary Service Rate 4(M). The Multifamily Market Rate ("MFMR") program will target owners and operators of multifamily properties residing within the Company's service territory. For this program, a property's eligibility will be determined by the income qualification of the tenant occupants. If a property does not qualify for the Multifamily low-income program then it will qualify for the Multifamily Market Rate Program.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The Multifamily Market Rate program provides select bundled energy efficiency measures ("kits") and education materials to multifamily properties for the benefit of their electric water-heating customers. The property facility manager installs the measures included in the kits in rental units. The program will conduct group, and when necessary, individual educational meetings with property managers and tenants to prepare them for the use of the installed measures. Educational meetings will explain the purpose of the program and provide opportunities for tenants to learn about energy efficiency and offer feedback to the Company and the program. The program will also provide incentives for multifamily market rate whole-building and common area measures. The program will offer a basic energy assessment to develop a list of recommended measures that would provide savings. Financing support for whole-building, common area, and dwelling unit projects in this segment will be essential for program success. Therefore, assistance to identify additional and alternative financial support such as grants, loans and other available options will be made available to property owners/management. Incentives under this program will only be provided toward multifamily market rate properties, dwelling units and common areas. Measures installed through the program are not eligible for Incentives through any of the Company's other energy efficiency programs. The Program Kits may include the various measures for dwelling units, but not limited to: • LEDs; • High efficiency faucet aerators; • High efficiency showerheads; • Electric domestic hot water pipe wrap; and • Furnace whistle. In addition to the dwelling unit measures the following measures are indicative of what may be incentivized for the whole-building and common areas: • Additional lighting; • HVAC; • Electric heating and Domestic water heating upgrades; and • Motors and envelope improvements. Ameren Missouri will also offer HVAC rebates to MFMR properties, defined as multistory dwelling units with greater than four units that also share a horizontal surface (floor or ceiling) with another dwelling unit. Where possible the Company will seek to partner in conjunction with the natural gas and water companies for co-delivery.

Eligible Measures & Services	Eligible measures are energy efficient measures defined in the TRM. Direct install incentives reflect the full incremental cost as they will be directly installed. The additional incentivized measures will consist of cost-effective measures associated with the following end-use categories: building shell, cooling, HVAC, lighting, refrigeration, water heating, etc. More refined data will be provided after the measures have been vetted through the implementation team. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a contractor to administer this program. An initial outreach effort will be the primary component of this program. The contractor will identify multifamily market rate properties and develop marketing materials suitable for this market segment, solicit building owners and managers directly, and finally meet with decision makers, in person, to identify opportunities. The program participants will include owners, operators, managers, developers and re-developers of program-eligible residential properties. The program will provide owners and tenants of multifamily buildings a single point of contact ("Coordinator") for communication. The Coordinator's duties will include: • Determining eligibility and ensuring eligible customers are aware of the available incentives from all utilities; • Assisting in the application process for improvements. In addition, where other utilities are participating, assisting with those applications; • Providing a seamless point of contact for navigating the various incentive offers provided by the Company and other utilities; • Maintaining a relationship with the existing business trade ally network and providing information and guidance to assist them with the bid process for installation work; • Providing case studies and education, and working with business development teams to ensure proper outreach is occurring; • Coordinating marketing materials to provide an easy to understand process for participation; and • Maintaining working relationships with and providing outreach and education to stakeholders such as lenders, Missouri agencies, and other identified parties. The program may provide a kit of specific energy efficiency measures as described in the Program Description that shall be installed in tenant units, in compliance with program requirements. Training and follow-up with properties' maintenance crew to ensure proper installment. The first set of projects performed would be site-verified, with random site verifications thereafter to ensure that installations are being performed properly and that equipment is being installed as reported. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, increasing marketing, and adding or removing measures.
Market Transformation Elements	These programs will conduct individual and/or group educational meetings with participating low-income customers to increase awareness of energy efficiency habits and measures, such as purchasing ENERGY STAR® certified products to encourage market transformation. The plan for estimating, measuring, and verifying energy and demand savings from the market transformation efforts is included in Appendix E – EM&V Plan.

Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.

Promotional/ Marketing Strategy	The program will use marketing communications appropriate to the distinct needs of the multifamily market and may include the following but not limited to:
	• Materials to create awareness and understanding of the program, its benefits, and its sponsor, among occupants of participating properties.
	• General background material on specific suggestions and learning opportunities to tenants for improving their home's energy efficiency.
	• Sales "bundle" folder for property owners, managers and Program Partners to include:
	    o Program overview brochure
	    o Program application
	    o Sell sheet/flyer showing program marketing collateral available including banner, door hangtag, yard sign and window cling
	    o Pre- and post-install tenant letter samples
	    o Building specific flyers depicting statistics and cost savings when applicable
	    o Online program overview on Ameren Missouri website
	• Materials for building tenants/residents:
	    o On-site signage and pre-install letter templates announcing/advertising the energy efficient upgrades being installed
	    o Doorknob hangtags with fill-in-the-blank areas for building owners to write in day of install and items being installed
	On-line program overview

EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Residential Multifamily Market Rate – Estimated Annual Installations							
End-Use	2019	2020	2021	2022	2023	2024	Total
Bldg. Shell RES	80	140	140	N/A	N/A	N/A	360
Cooling RES	776	1,173	1,435	N/A	N/A	N/A	3,383
HVAC RES	1,658	2,450	3,081	N/A	N/A	N/A	7,189
Lighting RES	19,542	14,999	18,771	N/A	N/A	N/A	53,312
Misc RES	407	610	793	N/A	N/A	N/A	1,810
Pool Spa RES	7	11	14	N/A	N/A	N/A	32
Water Heat. RES	8,136	12,204	15,865	N/A	N/A	N/A	36,204
Bldg. Shell BUS	14	22	24	N/A	N/A	N/A	60
Cooling BUS	7	18	21	N/A	N/A	N/A	46
Ext Lighting BUS	70	280	350	N/A	N/A	N/A	700
HVAC BUS	7	17	17	N/A	N/A	N/A	41
Lighting BUS	112	308	350	N/A	N/A	N/A	770
Misc. BUS	112	308	350	N/A	N/A	N/A	770
Motors BUS	1	1	1	N/A	N/A	N/A	3
Refrig. BUS	4	6	6	N/A	N/A	N/A	15
Total	30,931	32,546	41,218	N/A	N/A	N/A	104,696

Estimated Budget

Residential Multifamily Market Rate – Estimated Annual Budget* ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive**	$0.28	$0.43	$0.52	N/A	N/A	N/A	$1.23
Admin***	$0.69	$0.88	$0.97	N/A	N/A	N/A	$2.55
Total	$0.97	$1.32	$1.49	N/A	N/A	N/A	$3.78

***EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Residential Market Rate – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	2,292	3,270	4,064	N/A	N/A	N/A	9,626
MW Target/ Savings	0.67	1.04	1.26	N/A	N/A	N/A	2.97
Net-to-Gross	90%	90%	90%	N/A	N/A	N/A	90%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Residential Multifamily Market Rate - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Residential Multifamily Market Based	1.23	1.62	4.01	0.62

*Represents net fuel.

PROGRAM	Residential Demand Response
Objective	The objective of the Residential Demand Response ("DR") program is to build a resource available to Ameren Missouri to reduce the peak demand during a peak event for the Ameren Missouri system. The program will obtain demand savings by providing residential electric customers incentives to allow the program to control program approved devices, reducing their demand during demand response events. The Company's program design includes annual energy savings from custom smart thermostat programming that achieves energy savings throughout the year that are above and beyond the inherent energy savings from smart thermostats. The program will use an integrated, data-informed approach to customer engagement and marketing of available demand response offerings.
Target Market	All residential electric customers within the Ameren Missouri service territory.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The Residential DR program will engage residential customers to control a variety of energy loads, which may include but will not be limited to heat pumps, central air conditioners, electric water heaters, and pool pumps through, program-approved devices. The Company will provide incentives to encourage customers to enroll in the program and agree to allow Ameren Missouri to cycle or set back the customer's specific energy loads during DR events. The program may also reduce energy usage by utilizing a continuous load shaping strategy during non-peak periods. Ameren Missouri will devise an approach to maximize customer satisfaction and the available load under control by the program.
Eligible Measures & Incentive Strategy	Eligible cost-effective measures include enrollment, installation, and annual incentives. Program approved devices may include, but are not limited to; smart thermostats that are Wi-Fi connected and control a central air conditioner, or professionally installed switches that control water heaters, pool pumps, and central air conditioners. Customers also will receive incentives to enroll their existing devices in the program, purchase and install a new device and enroll in the program, or to have a device professionally installed and enrolled in the program. In addition to an enrollment incentive, customers may also be incentivized per event that they participate or once for an event season that they participate. Behavioral actions that result in demand savings could also be a part of the program. Costs, participation, measure mix, and incentive dollars will be refined after engagement with the Program Administrator. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a contractor to administer this program. The Program Administrator will provide the necessary services to effectively implement the program and obtain the demand savings goals outlined in the plan while adhering to the planned budget. Key implementation aspects include: • **Customer education/recruitment:** The Program Administrator will develop and implement the marketing strategy. Participant acquisition cost per channel will be balanced with recurring program costs; • **Identify customers for the control group:** Control groups will be identified as needed by the EM&V Contractor, the Program Administrator, and Ameren Missouri; • **Participant communication strategy: Communications regarding** enrollment, education, DR events, program season, and any ongoing communications will be refined after engagement with the Program Administrator. Communications will include education on program benefits and timely information regarding DR events, and will leverage the Program Administrator's best practices; and • **Event management:** Processes and protocols associated with DR event identification and execution will be refined after engagement with the Program Administrator. Demand Response programs expect a net-to-gross of 100%. There will not be any free ridership or spillover.
Market Transformation Elements	There are no market transformation elements associated with Residential DR.

Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure the program achieves its demand savings goals. If, through changing market conditions, it is determined the program will no longer provide demand savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and demand savings into the other programs
Promotional/ Marketing Strategy	Ameren Missouri and its Program Administrator will develop and execute a multifaceted marketing approach that utilizes existing customer data to target customers with a high propensity to participate in the Residential DR programs. Due to the unique nature of the Residential DR program, which includes ongoing incentives for participants, Ameren Missouri will seek to control initial program participation and resulting recurring program costs. The program will balance ongoing participation costs with costs of recruitment per different marketing channels, such as existing learning thermostat owners, energy efficiency participants, and time of sale recruitment during purchase of program approved devices. Activities that may be utilized to acquire customers include but are not limited to direct mail, e-mail, web messaging, social media, and on-bill messaging, cross selling from energy efficiency programs. As the program becomes more saturated door-to-door and outbound calling can be utilized to deeply penetrate certain geographies or customer segments. Local and cable TV, radios, tabling, trade shows, seminars and other retail channel partnering can increase customer education and awareness.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.
Estimated Participation	(see table below)
Estimated Budget	(see table below)

Estimated Participation

Residential Demand Response – Estimated Annually

	2019	2020	2021	2022	2023	2024	Total
Incremental Participants	6,533	7,905	9,206	N/A	N/A	N/A	23,645

Estimated Budget

Residential Demand Response – Estimated Annual Budget ($ millions)

	2019	2020	2021	2022	2023	2024	Total
Budget*	$4.28	$4.75	$5.60	N/A	N/A	N/A	$14.63

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Residential Demand Response – Estimated Annual Net Savings at Meter							
	2019	2020	2021	2022	2023	2024	Total
Incremental MWH Target/Savings	1,130	1,311	1,471	N/A	N/A	N/A	3,912
Incremental MW Target/Savings	11.50	13.33	14.96	N/A	N/A	N/A	39.79
Net-to-Gross	100%	100%	100%	N/A	N/A	N/A	100%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Residential Demand Response – 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM
Residential Demand Response	1.27	1.27	∞	1.17

EDUCATION	**Residential Energy Efficiency Education Channels**
Objective	The objective of this program is to educate customers on energy use and the benefits of energy efficiency. Education channels will encourage actions to lower energy use and promote participation in energy efficiency programs with associated energy and demand savings.
Program Description	Education channels will be designed to educate customers on energy use, tactics to reduce energy consumption and to promote long-term energy savings. The selected implementation contractor will provide the necessary services to implement selected strategies and meet the goal of the core programs while adhering to the planned budget. Education channels will be refined after engagement with the Contractor. Channels may include but are not limited to the following: <u>Science, Technology, Engineering, and Mathematics ("STEM") Education:</u> The implementation contractor will work with STEM partners at an education level to be determined in conjunction with the implementation contractor to provide a curriculum to be incorporated in existing lesson plans. The curriculum will focus on aspects of energy generation and delivery with particular emphasis on consumption and energy efficient equipment and behaviors. <u>Code Compliance:</u> Education will focus on targets high-energy impact measures that are commonly missed in residential code compliance. The implementation contractor will develop and facilitate a territory-wide energy codes collaborate with building industry stakeholders to discuss barriers of code compliance and develop methods and resources required to improve code compliance. The program will include an energy code expert to serve as a circuit rider across the Ameren Missouri service territory to provide information types on non-compliance typically found and offer practical solutions for improvement. Targeted in-person training sessions will be held based on findings and outcomes of collaborative sessions and circuit rider feedback. Examples of measures targeted in the program include: • Basement insulation; • Window U-factor; • Duct leakage; • High-efficacy lighting; • Ceiling insulation; and • Wall insulation installation. <u>Smart Home Energy Management</u> Smart Home Energy Management ("SHEM") technology is rapidly evolving and expanding; initially focused on energy feedback monitoring and control of a single product they have advanced to incorporate sensing, communication, actuation components and even multiple technologies working together and communicating with one another. SHEM technologies have the potential to deliver a variety of benefits to both customers who engage with them and Ameren Missouri. The goal is to increase adoption of these technologies. The products themselves can deliver demand reductions (e.g., through more efficient delivery of services such as heating, cooling, lighting, etc.), and can also support customers to reduce or shift their load, saving both energy and money. These technologies also have the potential to inform customers about how their decisions can impact their energy consumption and create long-term behavioral changes that can positively impact energy use.

Real Estate Audits – Real Estate audits are designed to use real estate institutions as a channel to encourage the use of home energy audits. A portion of a home audit may be paid to encourage realtors pursue energy audits and energy efficient improvements with the intent to improve home energy performance prior to a customer's purchase of a new home.

Employee Education:

The Employee Education initiative will leverage the energy savings successes of local businesses that have participated in Ameren Missouri's MEEIA Programs. This initiative will inform the local business employees about the businesses energy savings success of current and future energy efficiency efforts within their workplace and place an emphasis on making it easy for employees to take action under the residential programs to save energy within their homes.

Note: Because this program is a campaign that seeks to educate customers, through various channels, general information about the value of lowering energy use and adopting cost-effective energy savings measures, Ameren Missouri does not believe certain of the Commission's filing requirements apply. However, if the Commission believes a formal variance or waiver of one or more rules is required, the Company will file such a request.

Estimated Budget

Residential Education – Estimated Annual Budget

Year	2019	2020	2021	2022	2023	2024	Total
Admin	$0.85	$1.00	$1.00	N/A	N/A	N/A	$2.68

PROGRAM	Business Custom Incentive Program
Objective	The Business Custom Incentive Program provides energy awareness, efficiency expertise, services, and financial incentives to encourage nonresidential customers to install energy efficient equipment that lies outside other programs with pre-defined energy efficiency measures and/or guidelines. Some custom projects are complex and require detailed savings calculations to arrive at the appropriate custom incentive level.
Target Market	Nonresidential customers including commercial, industrial, and institutional. (Multifamily and low-income customers in the Residential Program are excluded from this program.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The Business Custom Incentive Program applies to processes, technologies, and energy efficiency measures that do not fall within the other pre-defined programs. These projects are sometimes complex and always unique, requiring customer-specific incentive applications and calculations of estimated energy savings.
Eligible Measures & Services	Cost- effective measures falling outside of the scope of the other pre-defined programs, including Combined Heat and Power, will be included in the Business Custom Incentive Program. Financial incentives will be provided to offset the higher costs associated with installation of new, higher efficiency equipment retrofits, process improvements, or building system upgrades. Incentive levels will be calculated based on energy savings estimates for each proposed measure, and will be subject to modification and adjustment based on implementation experience and current market conditions and in order to balance the program's financial requirements and savings targets. Project funding may be capped at a predetermined per facility and per customer levels per program year. Incentive levels may vary based on the technologies used for each customer-specific measure and as needed to adhere to budgetary limits and achieve program goals. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.

Implementation Strategy	The customer will submit an application outlining their potential efficiency upgrades. The Program Administrator, hired to implement the program, will perform a thorough desk review of all applications, which will focus on engineering specifications, project cost, and estimated energy savings, to pre-approve qualifying installations. A pre-inspection of the site may be required. The installation of efficiency measures is the responsibility of the customer. To qualify, potential projects must satisfy the following common screening criteria: • **Facility eligibility** – The facility must meet the program requirements (e.g., appropriate rate class, located in Ameren Missouri service territory, equipment must be new and installed at business rate class location). • **Project eligibility** – The project must involve installation of new, energy efficient equipment or incorporation of energy efficient designs. Proposed measures cannot qualify for another pre-defined Incentive program, and all proposed equipment must be approved by Ameren Missouri prior to purchase or installation. • **Application submittal** – The customer will submit the project application to Ameren Missouri for analysis and pre-installation approval. • **Customer implements project** – The customer has primary responsibility to install the pre-approved measures and improvements. • **Post installation documents** – The customer will provide data, including invoices, receipts, and any engineering analysis (if the project was altered from original application). Changes from original application will be reviewed and incentive offer may be modified accordingly. For projects exceeding a specified incentive threshold, which will be defined in final program guidelines, on-site visits will be required to verify baseline data, energy savings estimates, and post-installation measuring capabilities. Program guidelines and market outreach will be designed to minimize free riders. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.
Market Transformation Elements	A primary role in market transformation is the training and educating of marketing and sales staff of trade allies including contractors, wholesale retailers and distributors. The program also assist customers and trade allies on energy benchmarking tools, identification of measures qualifying for incentives, project financing options, identify the different application submittal channels. Another element is education of the program through professional associations and directly to market segments. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.

Promotional/ Marketing Strategy	Marketing efforts will focus on trade allies and program partners. Key pillars of the marketing strategy for the Business Custom Incentive Program include, but are not limited to: • **Education:** The Program Administrator will train and educate the trade ally sales staff and customers to identify energy benchmarking tools and measures that qualify for incentives, to identify different application and project financing options, and to effectively sell the program to customers. • **Marketing Materials:** To increase market penetration, materials will be provided to customers and trade allies, via direct mail and electronic communication channels, to enhance customer knowledge and awareness of energy savings opportunities and program availability. • **Highlight successfully completed projects**: Ameren Missouri will identify and publicize successful projects to promote the program and its benefits. This type of marketing will spur the customer's competitors to improve building performance and increase business process efficiency. This strategy also provides promotional and marketing opportunities for customers participating in the program. • **Trade Allies:** Ameren Missouri will continue to utilize the growing trade ally network, including trade organizations and associations, as a marketing/distribution channel for the program. Continual training will be provided to these program partners to ensure that any business development activities are conducted to achieve program goals. • **Inter-program Marketing**: Program Administrator will maintain a portfolio of programs and will increase customer awareness across programs as part of the application and education process. This is an opportunity to direct the customer to other possible energy savings incentives. Aiding customers in identifying the appropriate Business programs is important in maintaining high levels of customer satisfaction, creating spillover, as well as increasing the probability of meeting statutory energy savings goals. • **Market Segmentation**: To more effectively penetrate the Ameren Missouri markets, a targeted marketing approach will be used. Segmenting the program's marketing campaign to focus on specific customer types (e.g., grocers, hospitals, lodging, municipalities, state and federal government, utilities, education, agriculture, restaurants, and retail chains, etc.) will increase customer interest and drive installations. Market segmentation also makes it easier to identify inefficient facilities based on business type, facility size and actual energy usage.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Business Custom – Estimated Annual Installations							
End-Use	2019	2020	2021	2022	2023	2024	Total
Air Comp Bus	723	1,870	3,626	N/A	N/A	N/A	6,219
Bldg. Shell Bus	84	181	263	N/A	N/A	N/A	528
Cooling Bus	5,970	13,785	17,368	N/A	N/A	N/A	37,123
Ext Light Bus	6,174	13,305	15,474	N/A	N/A	N/A	34,953
HVAC Bus	1,269	3,010	4,375	N/A	N/A	N/A	8,654
Lighting Bus	61,553	125,151	171,025	N/A	N/A	N/A	357,728
Misc. Bus	713	1,537	2,235	N/A	N/A	N/A	4,485
Motors Bus	1,047	2,256	4,100	N/A	N/A	N/A	7,403
Process Bus	20,396	22,778	31,257	N/A	N/A	N/A	74,431
Refrigeration Bus	567	1,223	1,777	N/A	N/A	N/A	3,567
Total	104,229	195,869	266,138	N/A	N/A	N/A	1,441,484

Estimated Budget

Business Custom – Estimated Annual Budget ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive	$3.75	$7.82	$11.03	N/A	N/A	N/A	$22.60
Admin*	$3.46	$5.32	$6.83	N/A	N/A	N/A	$15.62
Total	$7.21	$13.14	$17.86	N/A	N/A	N/A	$38.22

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Business Custom - Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	34,247	69,882	100,445	N/A	N/A	N/A	204,573
MW Target/ Savings	9.89	21.39	29.20	N/A	N/A	N/A	60.48
Net-to-Gross	94%	94%	94%	N/A	N/A	N/A	94%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Business Custom - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Business Custom	1.91	3.97	2.71	1.10

*Represents net fuel.

PROGRAM	Business New Construction
Objective	The primary goal of this program is to capture energy savings available in new building construction, major renovations, or tenant build-outs. Due to limited access to capital, many companies default to least cost equipment and materials. To help encourage customer to move ahead with construction or renovation projects using efficient equipment, materials, and practices, Ameren Missouri will utilize several resources to educate customer on new construction incentives and savings opportunities for their project, such as design and construction firms, trade allies, and authorities having jurisdiction.
Target Market	Nonresidential customers including commercial, industrial, and institutional, including owners of multifamily market and low-income properties.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The Business New Construction program is meant to encourage energy efficient building practices within the Ameren Missouri service territory. There are several market barriers that must be addressed, including high first cost of high energy efficiency measures in building construction and renovation and market adoption of these high efficiency building design and construction practices. Through increased education, training, and financial incentives, the New Construction program will influence the market and promote efficient building design and construction. It is vital to work closely with the design/construction community to identify adoption barriers, clarify needs of the industry, and propose solutions to overcome these barriers. Targeted marketing and training will be utilized to further move the market and transform building practices. It is important to offer the building community multiple options for their specific projects. This program will be available for new building construction and major build-outs/renovations to existing facilities. The program will accommodate any phase of construction where program incentives can drive incremental energy efficiency improvements.
Eligible Measures & Services	Measures and associated incentives will reflect common measures found in new construction projects. Common measures include but not limited to lighting, heating and cooling equipment and ventilation. Ameren Missouri and Program Administrator will combine national best practice with actual experience to set an adequate payback period to drive customer adoption. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.

Implementation Strategy	The Program Administrator hired to implement the program will be responsible for project management, design and technical assistance, and program recruiting. Key implementation steps include:
	• Identifying new construction projects within the developer/design markets through targeted marketing and incentive strategies (may include designer and customer incentive) and focused networking events and training sessions;
	• Designing and making available to developer/designers and customers easy to use savings and incentive tools;
	• Providing one-on-one assistance with the savings incentive tools and program application;
	    • The Program Administrator will assist developer/designers and customers in evaluating potential energy savings and in the application process to ensure all potential savings are recognized and the application is properly filled out;
	    • This approach fosters a positive image of the program within the construction/design industry;
	• Once the application is approved, the customer can begin construction;
	• After completion, the Program Administrator will verify proper measure installation and ensure the project meets the necessary project design specifications and building code stipulations; and
	• Incentive payments may be paid as one time project completion payment or partial payments based on construction stages, with final payment made after proper quality assurance and quality control (QA/QC) of completed project.
	Program guidelines and market outreach will be designed to minimize free riders.
	The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.

Market Transformation Elements	The program will transform markets by educating developer/designers, contractors, professional associations in customers on new construction savings with an easy to use savings and incentive tool. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.
Promotional/Marketing Strategy	Marketing efforts will focus on developer/designers, economic development organizations, building commission authorities and trade allies. Key pillars of the marketing strategy for Business New Construction program include but are not limited to: • **Education:** Program Administrator will play an important role in training and educating developer/designers, economic development organizations, trade allies and building commission authorities, and will assist trade allies in use of savings and incentive tools, identification of measures qualifying for incentives, identifying the different application submission options, and identifying how to effectively sell the program to customers. • **Marketing Materials:** To maximize market penetration, materials will be provided to outreach groups and customers via direct mail and electronic communications to further enhance program awareness and increase market penetration. • **Highlight successfully completed projects**. Ameren Missouri will identify and publicize successful projects to promote the program and benefits. This type of marketing will spur the customer's competitors to improve building performance and increase business process efficiency. This strategy also provides the selected customer promotional and marketing opportunities. • **Trade Allies:** Ameren Missouri will continue to utilize the growing trade ally network, including trade organizations and associations, as a marketing/distribution channel for the program. Continual training will be provided to these program partners to ensure that any business development activities are conducted to achieve program goals. • **Inter-program Marketing**: Program Administrator will maintain a portfolio of programs and increase customer's awareness across programs as part of the application and education process. This is an opportunity to direct the customer to other possible energy savings incentives. Aiding customers in identifying the appropriate Business programs is important in maintaining high levels of customer satisfaction, creating spillover, as well as increasing the probability of meeting statutory energy savings goals. • **Market Segmentation**: To more effectively penetrate the Ameren Missouri markets, a targeted marketing approach will be used. Segmenting the program's marketing campaign to focus on specific customer types (e.g. grocers, hospitals, lodging, municipalities, state and federal government, utilities, education, agriculture, restaurants, and retail chains, etc.) will increase customer interest and drive installations. Market segmentation also makes it easier to identify inefficient facilities based on business type, facility size and actual energy usage.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Business New Construction – Estimated Annual Installations							
End-Use	2019	2020	2021	2022	2023	2024	Total
Air Comp Bus	239	618	862	N/A	N/A	N/A	1,719
Bldg Shell Bus	3	7	10	N/A	N/A	N/A	20
Cooling Bus	355	917	1,279	N/A	N/A	N/A	2,551
HVAC Bus	202	522	728	N/A	N/A	N/A	1,451
Lighting Bus	4	11	15	N/A	N/A	N/A	29
Motors Bus	120	310	433	N/A	N/A	N/A	863
Process Bus	179	462	644	N/A	N/A	N/A	1,285
Total	1,101	2,847	3,970	N/A	N/A	N/A	7,919

Estimated Budget

Business New Construction – Estimated Annual Budget ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive	$0.41	$1.07	$1.49	N/A	N/A	N/A	$2.98
Admin*	$0.39	$0.77	$0.97	N/A	N/A	N/A	$2.12
Total	$0.80	$1.84	$2.46	N/A	N/A	N/A	$5.10

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Business New Construction– Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	3,349	8,660	12,076	N/A	N/A	N/A	24,085
MW Target/ Savings	0.89	2.30	3.20	N/A	N/A	N/A	6.39
Net-to-Gross	94%	94%	94%	N/A	N/A	N/A	94%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Business New Construction - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Business New Construction	1.61	3.40	2.43	1.01

*Represents net fuel

PROGRAM	Business Retro-Commissioning
Objective	This program will deliver energy savings by helping customers retro-commission existing facilities – i.e. benchmark existing system performance levels at those facilities, identify operating system performance optimization improvements, and, where applicable, provide financial incentives to assist with the implementation of the recommended efficiency improvements.
Target Market	Nonresidential customers including commercial, industrial, and institutional. Multifamily and low-income customers in the Residential Program are excluded from this program.
Program Schedul	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The program will seek to identify efficiency opportunities associated with existing mechanical, electrical and thermal systems in nonresidential buildings by providing energy management optimization and options for retrofitting equipment that is inefficient and outdated, and will utilize qualified contractors and marketing partners to deliver measureable energy savings. This program also assists occupants in improving their operation and maintenance practices via compressed air and process system upgrades.
Eligible Measures & Services	Retro-commissioning projects most common optimization equipment measures include lighting, space conditioning and process. Ameren Missouri and Program Administrator will combine national best practice with actual experience to set an adequate payback period to drive customer adoption. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.

Implementation Strategy	The Program Administrator, hired to manage implementation of the program, oversee survey and implementation of efficiency measures, and provide engineering review and incentive fulfillment for each project. Project qualification process will follow this methodology:
	
	• Retro-commissioning Program Provides ("RPP") primarily identifies potential candidates for the program;
	• After a program application is submitted, study is conducted to assess the viability of the project and to determine energy savings and cost estimates;
	    • After engineering analysis and verification of estimated savings has been completed, the Program Administrator will work with building owners and trade allies to conduct an engineering audit based on industry best practice to benchmark the building's energy profile;
	• Following the facility audit, efficiency upgrades will be recommended by the RPP, reviewed and approved by the Program Administrator and completed by the customer;
	    • Potential efficiency improvements include but are not limited to: compressed air leak identification, system controls calibration, energy management systems including monitoring, and variable speed drive tune-ups; and
	• After the implementation stage, an ex post verification will take place to ensure proper installation and adherence to stipulated implementation guidelines.
	• Once the project is completed and approved by the Program Administrator, an incentive check will be delivered to the customer.
	
	The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.

Market Transformation Elements	As part of this program, a facility energy study is completed on optimization of equipment and as part of the process customers are educated to increase their awareness of maintaining equipment efficiency. Program will also support market transformation by making customers aware of incentives to defray the cost to attend Building Operator Certification training. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.

Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.
Promotional/ Marketing Strategy	Marketing strategy will include components associate with the business type and size. Key pillars of the marketing strategy for the Business Retro-Commissioning Program include but are not limited to: • **Education:** Program Administrator will play an important role in training and educating the trade ally sales staff. The Program Administrator will assist trade allies and customers on energy benchmarking tools, identification of measures qualifying for incentives, identify the different application submittal options, and how to effectively sell the program to customers. • **Marketing Materials:** Materials will be provided to customers and trade allies to further enhance customer energy awareness, program awareness and increase market penetration. • **Direct Mail - USPS and electronic:** This marketing vehicle will require a targeted approach, identifying potential efficient installs based on business operating characteristics, size and building types. • **Associations:** A unique opportunity exists in trade organizations and various associations. Businesses rely on these associations to represent that industry's best interests in lobbying, growth, and identification of business opportunities. Ameren Missouri will coordinate with specific associations to highlight program offerings suitable for their respective industry. • **Highlight successfully completed projects:** Ameren Missouri will selectively choose projects to display the process and benefits of the program. This type of marketing will spur the customer's competitors to improve building performance and increase business process efficiency. This marketing strategy also allows the selected customer promotional and marketing opportunities. • **Trade Allies and Program Providers:** Ameren Missouri will continue to utilize trade ally network and Program Providers as a marketing/distribution channel for the program. Continual training will be provided to ensure that any business development activities are conducted to achieve program goals. • **Inter-program Marketing**: Program Administrator will maintain a portfolio of programs and increase customer's awareness across programs as part of the application and education process. This is an opportunity to direct the customer to other possible energy savings incentives. Aiding customers in identifying the appropriate Business programs is important in maintaining high levels of customer satisfaction, creating spillover, as well as increasing the probability of meeting statutory energy savings goals. • **Market Segmentation:** To more effectively penetrate the Ameren Missouri markets, a targeted marketing approach will be used. Separating the program's marketing campaign to focus on specific business types will increase customer interest and drive installations. Also segment market targets by identifying inefficient facilities based on business type, facility size and actual energy usage.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Business RCx – Estimated Annual Installations							
End-Use	2019	2020	2021	2022	2023	2024	Total
Air Comp Bus	130	349	584	N/A	N/A	N/A	1,063
Cooling Bus	109	295	493	N/A	N/A	N/A	898
HVAC Bus	2,523	6,797	11,374	N/A	N/A	N/A	20,695
Process Bus	716	1,929	3,227	N/A	N/A	N/A	5,872
Total	3,478	9,370	15,679	N/A	N/A	N/A	28,527

Estimated Budget

Business RCx – Estimated Annual Budget ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive	$0.32	$0.87	$1.45	N/A	N/A	N/A	$2.64
Admin*	$0.27	$0.56	$0.84	N/A	N/A	N/A	$1.67
Total	$0.59	$1.42	$2.29	N/A	N/A	N/A	$4.31

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Business RCx – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/Savings	2,679	7,217	12,076	N/A	N/A	N/A	21,972
MW Target/Savings	0.98	2.65	4.43	N/A	N/A	N/A	8.06
Net-to-Gross	94%	94%	94%	N/A	N/A	N/A	94%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Business RCx - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Business Retro-Commissioning	3.19	3.66	4.76	1.28

*Represents net fuel.

PROGRAM	Small Business Direct Install Program
Objective	The Small Business Direct Install ("SBDI") Program is designed to promote the installation of energy efficient technologies in small businesses by removing participation barriers such as: • Lack of time/resources to investigate and review energy efficiency improvement; • Skepticism that participating will actually be of value; • Lack of financing; • Business facility is often leased rather than owner occupied; • Energy is not integral to their business strategy; and • Belief that adopting energy conservation measures is a complicated, time-consuming, and potentially a costly process. Small business energy efficient technologies may include but not limited to, lighting, HVAC, smart thermostats, motors, water heating, refrigeration and HVAC tune-ups. Measures included within this program are common in multiple marketplaces and have deemed savings calculation values associated with their energy performance. This program encourages small business customer participation through a simple, immediate and streamlined program process.
Target Market	Small nonresidential customers including commercial and institutional (Small General Service, 2M). Excluding multifamily market and low-income, which is part of the Residential Program.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The SBDI Program will use a group of program providers to deliver energy efficient measures at low-cost and/or no-cost to small business customers. Program providers will supply, install, and finalize paperwork for eligible participants, and identify additional energy efficiency opportunities not covered under the SBDI Program. Measures within this program will be included in the Deemed Savings able and have fixed incentive levels associated with them, although these incentive values may be altered as program budget and performance change throughout the term. Upon receipt of completed documentation, Ameren Missouri will distribute incentives payments.
Eligible Measures & Services	Small business energy efficient eligible measures include but not limited to, lighting, HVAC, smart thermostats, motors, water heating, refrigeration and services. Ameren Missouri and Program Administrator will combine national best practice with actual experience to set an adequate payback period to drive customer adoption. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	Responsibilities of the Program Administrator, hired to implement the program, include final program design, measure lists, and implementation plan. Implementation plan will include but not limited to: • Small Business targeted market plan for lighting, HVAC, smart thermostat and other measures that may be included in program; • Lead generation (introduction channels, customer outreach and lead qualification); • Program provider structure to effectively support lighting, HVAC, smart thermostat and other measure savings opportunities; and • Mobile sales tool for load assessment, energy savings and customer return on investment, with electronic or hard copy summary made available to customers. In order for program providers to effectively promote and communicate the benefits of the program, applicable training and marketing materials will be provided by the Implementation team. Upon submittal of project documentation, projects will receive a review and approval before an incentive is distributed. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.

Market Transformation Elements	SBDI Program will play an important role in market transformation by training and educating small businesses through targeted business types and professional associations such as Chamber of Commerce. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs
Promotional/ Marketing Strategy	Marketing efforts will focus on program awareness through direct outreach. Key pillars of the marketing strategy for the SBDI Program include but are not limited to: • **Lead generation**: Introduction channels, customer outreach and lead qualification managed by Program Administrator and program providers. • **Mobile Sales Tool:** Program provider mobile sales tool utilized with customer for load assessment, energy savings and customer return on investment. Electronic or hard copy summary made available to customers. • **Education:** Program Administrator will play an important role in training and educating the program provider sales staff. The Program Administrator will assist program provider in identification of measures qualifying for incentives, project financing options, identify additional energy savings opportunities, and how to effectively sell all measures to customers. • **Marketing Materials:** Materials will be provided to customers and program provider to further enhance program awareness and increase market penetration. • **Direct Mail - USPS and Electronic:** This marketing vehicle will require a targeted approach, identifying potential efficient installs based on business operating characteristics and building types. • **Community Outreach:** Program awareness for the small business segment can be handled through community outreach events such as Chamber of Commerce meetings and events. Along with promoting the design and customer benefits, this approach will help overcome skepticism of a program offering being delivered through a program provider. • **Highlight successfully completed projects:** Projects will be selectively chosen to display the process and benefits of the program. This type of marketing will spur the customer's competitors to improve building performance and increase business process efficiency. This marketing strategy also allows the selected customer promotional and marketing opportunities. • **Program providers:** Ameren Missouri will utilize program providers as a sales/marketing channel for the program. Continual training will be provided to these providers to ensure that any business development activities are conducted to achieve program goals. • **Inter-program Marketing:** Program Administrator will maintain a portfolio of programs and increase customer's awareness across programs as part of the application and education process. This is an opportunity to direct the customer to other possible energy savings incentives. Aiding customers in identifying the appropriate Business programs is important in maintaining high levels of customer satisfaction, creating spillover and reaching energy savings opportunities. • **Market Segmentation:** To more effectively penetrate the Ameren Missouri markets, a targeted marketing approach will be used. Separating the program's marketing campaign to focus on specific customer types (grocers, hospitals, lodging, municipalities, state and federal government, utilities, education, agriculture, restaurants, and retail chains, etc.) will increase customer interest and drive installations. Also segment market targets by identifying inefficient facilities based on business type, facility size and actual energy usage.

EM&V Requirements

Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.

Program Design Flexibility

At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Business SBDI – Estimated Annual Installations

End-Use	2019	2020	2021	2022	2023	2024	Total
Cooling Bus	1,011	1,169	1,319	N/A	N/A	N/A	3,499
Ext. Lighting Bus	1,027	1,188	1,322	N/A	N/A	N/A	3,538
Lighting Bus	18,561	21,488	23,945	N/A	N/A	N/A	63,994
Misc Bus	3	3	3	N/A	N/A	N/A	9
Refrig. BUS	328	380	426	N/A	N/A	N/A	1,134
Water Heating BUS	19	23	26	N/A	N/A	N/A	67
Total	20,949	24,250	27,041	N/A	N/A	N/A	72,241

Estimated Budget

Business SBDI – Estimated Annual Budget ($ millions)

Year	2019	2020	2021	2022	2023	2024	Total
Incentive	$1.41	$1.63	$1.83	N/A	N/A	N/A	$4.87
Admin*	$0.99	$0.91	$0.92	N/A	N/A	N/A	$2.82
Total	$2.40	$2.55	$2.75	N/A	N/A	N/A	$7.69

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Business SBDI – Estimated Annual Net Savings at Meter

Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	8,702	10,118	11,340	N/A	N/A	N/A	30,160
MW Target/ Savings	1.51	1.75	1.97	N/A	N/A	N/A	5.22
Net-to-Gross	94%	94%	94%	N/A	N/A	N/A	94%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Business SBDI - 3 Year Program Cost-Effectiveness (2019-21)				
Program	**TRC**	**UCT**	**PCT**	**RIM***
Business SBDI	**1.57**	**2.10**	**3.61**	**0.71**

*Represents net fuel.

PROGRAM	Business Standard Incentive Program
Objective	The Business Standard Program is designed to promote energy awareness and installation of energy efficient technologies or services that may include but is not limited to lighting, motors, controls, HVAC, and refrigeration in nonresidential properties. This program encourages customer participation through simple and streamlined program processes.
Target Market	Nonresidential customers including commercial, industrial, and institutional. Excluding multifamily market and low-income, which will be part of Residential Program.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021.
Program Description	The Business Standard Program will provide incentives to customers to purchase energy efficient products. Measures included within this program will be included in the Deemed Savings Table and have fixed incentive levels associated with them (although these incentive values may change as program budgets and performances are altered throughout the program's term). Trade allies will be channel partners promoting the program and educating customers. Applications can be submitted by contractors/distributor or wholesale retailers of energy-efficient technologies or services or by their customers. Most program measures will require only a simple calculation to identify savings. Incentives will be fixed regardless of individual project characteristics.
Eligible Measures & Services	Business Standard Incentive Program eligible measures are typically common across business types such as lighting, space conditioning equipment and water heating. Ameren Missouri and Program Administrator will combine national best practice with actual experience to set an adequate payback period to drive customer adoption. A complete list of eligible program measures are included in Appendix D – Incentive Ranges.
Implementation Strategy	Program Administrator, hired to implement the program, will focus on numerous market segments, including but not limited to grocers, hospitals, lodging, municipalities, state and federal government, utilities, education, agriculture, restaurants, and retail chains. The main program distribution channel will be trade allies, including contractors, distributors, wholesale retailers, and where applicable, local economic development and professional associations, who will be trained and supported by the program implementation staff. In order for these allies to effectively promote and communicate the benefits of the program, applicable training and marketing materials will be provided by the Implementation team. Standard program applications will be reviewed and approved before incentive distribution. Proposed projects with an anticipated incentive greater than a defined amount will require pre-approval prior to installation and purchase of equipment. An individual project implementation timeline process will be utilized to encourage prompt installation and maintain accurate tracking of program savings and relative budgets. Components of the implementation plan will include but are not limited to: • Customer financial incentives; • Upstream, midstream, or bounty incentives structure; • Stocking programs; • E-commerce market place and customer validation; • Educational; and • Savings evaluative tools and programs easily used by trade allies and customers. The implementation team will use free ridership and spillover data determined annually by an independent evaluator to make program improvements to minimize free ridership and maximize spillover. Program improvements could include things such as adjusting incentives, improving marketing, and adding or removing measures.

Market Transformation Elements	A primary role in market transformation is the training and educating the marketing and sales staff of trade allies including contractors, wholesale retailers and distributors. The program also assist customers and trade allies on energy benchmarking tools, identification of measures qualifying for incentives, project financing options, identify the different application submittal channels. Another element is the programs education through professional associations and customer market segments. The plan for estimating, measuring, and verifying energy and demand savings the market transformation efforts is included in Appendix E – EM&V Plan.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure program achieves its energy savings goals. If, through changing market conditions, it is determined the program will no longer provide energy savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and energy savings into the other programs.

Promotional/ Marketing Strategy	Marketing efforts will focus on trade allies and program partners. Key pillars of the marketing strategy for the Business Program include but are not limited to: • **Education:** Program Administrator will play an important role in training and educating the marketing and sales staff of trade allies including contractors, wholesale retailers and distributors. The Program Administrator will assist customers and trade allies on energy benchmarking tools, identification of measures qualifying for incentives, project financing options, identify the different application submittal channels, and how to effectively sell the program to customers. • **Marketing Materials:** Materials will be provided to customers and trade allies to further enhance customer energy awareness, program awareness and increase market penetration. • **Direct Mail - USPS and electronic:** This marketing vehicle is a targeted approach, identifying potential efficient installs based on business segments, operating characteristics and/or building types. • **Associations:** A unique opportunity exists in trade organizations and various associations. Businesses rely on these associations to represent that industry's best interests in lobbying, growth, and identification of business opportunities. Ameren Missouri will coordinate with specific associations to highlight program offerings suitable for their respective industry. • **Highlight successfully completed projects:** Ameren Missouri will selectively choose projects to display the process and benefits of the program. This type of marketing will spur the customer's competitors to improve building performance and increase business process efficiency. This marketing strategy also allows the selected customer promotional and marketing opportunities. • **Trade Allies:** Ameren Missouri will continue to utilize the growing trade ally network as a marketing/distribution channel for the program. Ameren Missouri will maintain a diverse trade ally advisory board to collaborate on program improvement opportunities. Continual training will be provided to all trade allies to ensure business development activities are promoting program savings opportunities and conducted within program guidelines. Trade allies will be educated on the value of promoting savings opportunities across all programs. • **Inter-program Marketing:** Program Administrator will maintain a portfolio of programs and increase customer's awareness across programs as part of the application and education process. This is an opportunity to direct the customer to other possible energy savings incentives. Aiding customers in identifying the appropriate Business programs is important in maintaining high levels of customer satisfaction, creating spillover and achieving energy savings opportunities. • **Market Segmentation:** To more effectively penetrate the Ameren Missouri markets, a targeted marketing approach will be used. Separating the program's marketing campaign to focus on specific customer types (grocers, hospitals, lodging, municipalities, state and federal government, utilities, education, agriculture, restaurants, and retail chains, etc.) will increase customer interest and drive installations. Also segment market targets by identifying inefficient facilities based on business type, facility size and actual energy usage.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.
Program Design Flexibility	At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Business Standard – Estimated Annual Installations							
End-Use	2019	2020	2021	2022	2023	2024	Total
Cooking BUS	173	340	327	N/A	N/A	N/A	841
Cooling BUS	11,637	17,536	19,296	N/A	N/A	N/A	48,469
Ext Light. BUS	712	1,318	1,718	N/A	N/A	N/A	3,748
HVAC BUS	303	558	674	N/A	N/A	N/A	1,534
Lighting BUS	83,930	165,710	202,177	N/A	N/A	N/A	451,817
Misc. BUS	1,934	3,783	4,650	N/A	N/A	N/A	10,367
Motors BUS	3,483	6,586	8,855	N/A	N/A	N/A	18,924
Refrig. BUS	2,090	4,117	4,950	N/A	N/A	N/A	11,158
Water Heat BUS	110	221	259	N/A	N/A	N/A	589
Total	104,373	200,170	242,905	N/A	N/A	N/A	547,447

Estimated Budget

Business Standard – Estimated Annual Budget ($ millions)							
Year	2019	2020	2021	2022	2023	2024	Total
Incentive	$3.31	$6.35	$7.70	N/A	N/A	N/A	$17.36
Admin*	$2.50	$3.67	$4.00	N/A	N/A	N/A	$10.17
Total	$5.80	$10.03	$11.71	N/A	N/A	N/A	$27.54

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary. For details on estimated equipment and installation costs see the DSMore Workbook.

Savings Targets

Business Standard – Estimated Annual Net Savings at Meter							
Year	2019	2020	2021	2022	2023	2024	Total
MWh Target/ Savings	29,220	56,470	68,607	N/A	N/A	N/A	154,296
MW Target/ Savings	6.10	11.40	13.59	N/A	N/A	N/A	31.08
Net-to-Gross	94%	94%	94%	N/A	N/A	N/A	94%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Business Standard - 3 Year Program Cost-Effectiveness (2019-21)				
Program	TRC	UCT	PCT	RIM*
Business Standard	1.69	3.02	3.13	0.83

*Represents net fuel.

PROGRAM	Business Demand Response
Objective	The objective of the Business Demand Response ("DR") program is to achieve demand and energy savings and a capacity resource reductions through the Midwest Independent System Operator, Inc. ("MISO") market by providing customers the resources necessary to identify and take advantage of demand response opportunities. This is intended to provide a long-term, low-cost resource for customers.
Target Market	All business customers that have interval metering. Customers that are opted out of MEEIA programs are not eligible as this will not be an interruptible or curtailable rate.
Program Schedule	Program will launch March 1, 2019 and run through December 31, 2021. The Company will begin recruiting participants after approval of MEEIA 2019-21 and before March 2019. No events will be called before the program season of 2019.
Program Description	The Business DR program will hire a Program Administrator to engage customers to participate in DR events through direct load control, manual response and the use of behind the meter assets. Participants will benefit from a customized energy reduction plan and may receive enhanced control technology.
Eligible Measures & Services	A customized load curtailment strategy will be developed for each participating facility. Energy loads such as lighting, HVAC, chillers, motors, production/processing equipment, refrigeration systems, pumps, and water heating can be utilized to curtail load during a DR event. The curtailment may be a direct load control by the utility, a manual curtailment, or a behind the meter resource. Participating facilities will be paid, by the Program Administrator, a capacity payment based on the average MW performance across all events in a given program year, and an energy payment based on each MWh of performance during dispatches. There are no defined measures for Business DR. Each participant is unique and may have a variety of response mechanisms to achieve their reduction in demand. A list of Program measure categories are included in Appendix D – Incentive Ranges.
Implementation Strategy	The Company will hire a Program Administrator to implement this program. The Program Administrator will provide the necessary services to effectively implement the program and obtain the demand savings goals outlined in the plan while adhering to the planned budget. Demand Response programs expect a net-to-gross of 100%. There will not be any free ridership or spillover.
Market Transformation Elements	There are no market transformation elements associated with DR.
Program Response to Evolving Markets	Due to the unpredictable and changing nature of the marketplace, the Company and its contractors will maintain flexibility within the program. Various market factors, including new codes and standards, energy legislation, and consumer attitudinal shifts, will affect the measure mix, and program delivery strategy. The Company will alter incentive levels and qualification criteria as necessary to ensure the program achieves its demand savings goals. If, through changing market conditions, it is determined the program will no longer provide demand savings or drive value to the customer, the Company will take the necessary steps to withdraw the program from the portfolio and reallocate funds and demand savings into the other programs.
Promotional/ Marketing Strategy	Ameren Missouri and its Program Administrator will develop and execute a multifaceted marketing approach that utilizes existing customer relationships to target customers with a high propensity to participate in the business DR programs. Program Administrator relationships with national customers and utility relationships with local contacts will be utilized for targeted leads. Specific types of customers can be operationally good candidates for reliable load reduction. Direct mail, e-mail, and digital content can be used to introduce the DR program to new customers. Case studies can be developed to help customers understand the impact and benefits of enrolling.
EM&V Requirements	Detailed plans to analyze program performance through EM&V can be found in Appendix E - Sample Evaluation Plans.

Program Design Flexibility

At their core, energy efficiency programs are marketing programs that must respond to a changing marketplace and keep up with new technology offerings, delivery channels, and customer preferences. The Change Process will allow stakeholder input on program changes and at the same time facilitate successful implementation of necessary changes. This level of flexibility at the implementation team level is important to make appropriate modifications to respond to program and market condition changes.

Estimated Participation

Business Demand Response – Estimated Annually

	2019	2020	2021	2022	2023	2024	Total
Incremental Participants	50	50	50	N/A	N/A	N/A	150

Estimated Budget

Business Demand Response – Estimated Annual Budget ($ million)

	2019	2020	2021	2022	2023	2024	Total
Budget*	$1.26	$2.52	$3.78	N/A	N/A	N/A	$7.56

*EM&V and Miscellaneous Cost are included.

For detailed allocation of administrative costs, EM&V costs, and miscellaneous costs see Appendix A – Portfolio and Programs Summary.

Savings Targets

Business Demand Response – Estimated Annual Net Savings at Meter

	2019	2020	2021	2022	2023	2024	Total
Incremental MWH Target/Savings	500	500	500	N/A	N/A	N/A	1,500
Incremental MW Target/Savings	25	25	25	N/A	N/A	N/A	75
Net-to-Gross	100%	100%	100%	N/A	N/A	N/A	100%

Projected Gross MWh Savings and projected gross MW Savings can be found in the DSMore workbook.

Net-to-gross factors, the size of the potential market, and projected penetration rates are included in Appendix A – Portfolio and Programs Summary.

Cost-Effectiveness

Business Demand Response – 3 Year Program Cost-Effectiveness (2019-21)

Program	TRC	UCT	PCT	RIM
Business Demand Response	**1.81**	**1.81**	∞	**1.74**

EDUCATION	**Business Energy Efficiency Education Channels**
Objective	To educate customers on energy use and the benefits of energy efficiency. Education channels will encourage actions to lower energy use and promote participation in energy efficiency programs with associated energy and demand savings.
Program Description	Education channels will be designed to educate customers on energy use, tactics to reduce energy consumption and to promote long-term energy savings. The selected implementation contractor will provide the necessary services to implement selected strategies and meet the goal of the core programs while adhering to the planned budget. Education channels will be refined after engagement with the contractor. Channels may include but are not limited to the following: Building Operator Certification: Ameren Missouri will coordinate with Midwest Energy Efficiency Alliance ("MEEA") to offer BOC to business customers participating in MEEIA 2019-21. BOC is competency-based training and certification program for operations and maintenance staff working in commercial, institutional, or industrial buildings. BOC achieves measurable energy savings in the operation of public facilities and commercial buildings by training individuals directly responsible for day-to-day operations.
Estimated Budget	See table below

Business Education – Estimated Annual Budget

Year	2019	2020	2021	2022	2023	2024	Total
Admin	$0.08	$0.08	$0.08	N/A	N/A	N/A	$0.23

Avoided Costs

For the cost effectiveness analysis of its MEEIA 2019-21 measures, programs, and portfolio, Ameren Missouri used avoided costs from its 2017 Integrated Resource Plan ("IRP) (File No. EO-2018-0038) as shown in the table below. The process for developing the avoided energy and avoided capacity costs is described in Chapter 2 - Planning Environment of the 2017 IRP, and the process for developing the avoided transmission and avoided distribution costs is described in Chapter 7 – Transmission and Distribution of the 2017 IRP.

Table 1 - 2017 IRP Avoided Costs

	Avoided Energy $/MWh	Avoided Capacity $/kW-yr	Avoided Transmission $/kW-yr	Avoided Distribution $/kW-yr
2019	$26	$20	$6	$17
2020	$28	$25	$6	$17
2021	$29	$31	$6	$18
2022	$30	$41	$6	$18
2023	$32	$52	$6	$18
2024	$33	$62	$6	$19
2025	$35	$71	$7	$19
2026	$37	$79	$7	$20
2027	$38	$86	$7	$20
2028	$40	$91	$7	$20
2029	$42	$95	$7	$21
2030	$44	$98	$7	$21
2031	$48	$99	$7	$22
2032	$48	$100	$8	$22
2033	$49	$100	$8	$22
2034	$50	$100	$8	$23
2035	$52	$100	$8	$23
2036	$53	$100	$8	$24
2037	$55	$101	$8	$24

Acronyms
HER – Home Energy Report
SBDI - Small Business Direct Install
SFLI – Single Family Low Income
MFLI – Multifamily Low Income
MFMR – Multifamily Market Rate

	Business Program Measures	Low Incentive Level ($/1st Yr kWh)	High Incentive Level ($/1st Yr kWh)
	Air Conditioning	$0.06	$0.27
	Air-Cooled Chiller	$0.05	$0.27
	Anti-Sweat Heater Control	$0.05	$0.22
	Barrel Wraps - Injection Mold and Extruders	$0.05	$0.22
	Beverage Vending Machine Control	$0.05	$0.22
	Built-in Lighting Fixtures	$0.05	$0.27
	Central Lighting Control	$0.06	$0.27
	Ceramic Metal Halide	$0.05	$0.27
	Chilled Water reset	$0.05	$0.22
	Compressed Air Optimization	$0.05	$0.22
	Compressor Controls	$0.05	$0.22
	Compressor Optimization	$0.05	$0.22
	Custom	$0.05	$0.27
	Daylight Sensor controls	$0.05	$0.27
	Demand Controlled Ventilation	$0.06	$0.27
	Dual Technology Sensors	$0.05	$0.27
	Electronically Commutated Motors (ECM)	$0.05	$0.22
	Efficient Condenser	$0.06	$0.27
	Electronics - Monitor Power Management	$0.06	$0.27
	Energy Management Systems	$0.06	$0.27
	Energy Efficient Blower	$0.05	$0.22
	ENERGY STAR Commercial Glass Door Freez/Refrig	$0.05	$0.27
	ENERGY STAR Commercial Solid Door Freezers	$0.06	$0.27
	ENERGY STAR Hot Holding Cabinets Full Size - Electric	$0.06	$0.27
	ENERGY STAR Ice Machines	$0.05	$0.27
	Energy Star Laptop	$0.05	$0.22
	Energy Star POS Terminal	$0.05	$0.22
	Energy Star Server	$0.05	$0.22
	ENERGY STAR Steam Cookers	$0.06	$0.27
	ENERGY STAR Vending Machine	$0.05	$0.22
	Engineered Commercial Kitchen Ventilation hood	$0.06	$0.27
	Engineered Nozzles Compressed Air	$0.05	$0.22
	Floating Head Pressure Control	$0.05	$0.22
	Garage HID replacement retrofit	$0.06	$0.27
	Ground Source heat Pump	$0.06	$0.27
	Head Pressure Control	$0.05	$0.22
	Heat Pump	$0.06	$0.27

	Business Program Measures	Low Incentive Level ($/1st Yr kWh)	High Incentive Level ($/1st Yr kWh)
	Heat Pump Water Heater	$0.05	$0.22
	HVAC	$0.05	$0.27
	HVAC - Ventilation	$0.05	$0.27
	HVAC - Controls	$0.05	$0.27
	HVAC - Occupancy Sensors	$0.06	$0.27
	Induction Street Lighting	$0.05	$0.22
	Infrared Heater	$0.05	$0.22
	LED Case lighting	$0.06	$0.27
	LED Lamps	$0.05	$0.28
	LED Linear	$0.05	$0.28
	LED or Electroluminescent Exit Sign	$0.06	$0.27
	Lighted Snack Dispensing Machine	$0.05	$0.22
	Linear Fluorescents	$0.05	$0.28
	Low Flow Faucet Aerator - Electric water heater	$0.05	$0.22
	Low Flow Showerhead	$0.06	$0.27
	Motors	$0.05	$0.27
	Occupancy Sensors	$0.06	$0.27
	Office Electronics	$0.05	$0.22
	Office Equipment - Plug Load Occupancy Sensors	$0.05	$0.22
	Optimizing Process Cooling	$0.05	$0.22
	Optimizing Process Heating	$0.05	$0.22
	Passive Infrared or Ultrasonic Sensors	$0.05	$0.22
	Pool Pumps	$0.05	$0.22
	Pool Pump - Timer	$0.05	$0.22
	Pre Rinse Sprayers - Electric water heater	$0.05	$0.22
	Pulse Start Metal Halide retrofit only	$0.06	$0.27
	Pumps	$0.05	$0.22
	Radiant Barrier	$0.06	$0.27
	Refrigerator - Door Gasket Replacement	$0.05	$0.22
	Repair Leaks - Air	$0.05	$0.22
	Retro-commissioning	$0.05	$0.28
	Retro-commissioning, Lighting	$0.05	$0.22
	Strategic Energy Management	$0.05	$0.27
	Strip Curtain for Walk-in Cooler or Freezer	$0.05	$0.22
	Switching Controls for Multilevel Lighting	$0.06	$0.27
	Tractor Heater Timers	$0.05	$0.22
	Variable Frequency Drives	$0.05	$0.22
	Variable Speed Drives - Air Compressors	$0.05	$0.22
	Wall Insulation	$0.05	$0.27
	Water Heater Timer	$0.06	$0.27
	Window Film	$0.06	$0.27
	Window Replacement	$0.06	$0.27
	Windows-High Efficiency	$0.06	$0.27
	Water Loop Heat Pump	$0.06	$0.27
	Water-Cool Centrifugal Chiller	$0.05	$0.27
	Water-Cool Screw Chiller	$0.06	$0.27

	Business Program Measures	Low Incentive Level ($/1st Yr kWh)	High Incentive Level ($/1st Yr kWh)
SBDI	Lighting	$0.05	$0.39
SBDI	Controls	$0.05	$0.39
SBDI	Smart Thermostats	$0.05	$0.39
SBDI	Variable Frequency Drives	$0.05	$0.39
SBDI	Motors	$0.05	$0.39
SBDI	Refrigeration/Freezer	$0.05	$0.39
SBDI	Water Heating	$0.05	$0.39
SBDI	HVAC	$0.05	$0.39
Social Services	Lighting	$0.05	Full Cost
Social Services	Controls	$0.05	Full Cost
Social Services	Smart Thermostats	$0.05	Full Cost
Social Services	Variable Frequency Drives	$0.05	Full Cost
Social Services	Motors	$0.05	Full Cost
Social Services	Refrigeration/Freezer	$0.05	Full Cost
Social Services	Water Heating	$0.05	Full Cost
Social Services	HVAC	$0.05	Full Cost

Any direct installation of residential measures will have the following costs added to the stated incentive amount:

1. Labor for installation.
2. Removal, decommissioning, recycling and disposal of the existing item for which the new measure will substitute and
3. Acquisition and functioning installation of the new measures complete with all accessories and appurtenances required for its intended use and safe operation.

Any shipped or mailed residential measures will have the shipping and handling costs added to the stated incentive amount.

	Residential Program Measures	Low Incentive Level ($/Measure)	High Incentive Level ($/Measure)
	ENERGY STAR Air Purifiers	$20.00	$100.00
	Air Source Heat Pump (ASHP)	$75.00	$2,000.00
	Central AC	$50.00	$1,100.00
	Dehumidifier recycling	$5.00	$45.00
	Dirty Filter Alarm	$0.50	$10.00
	Dual Fuel Heat Pump (DFHP)	$50.00	$1,100.00
	Ductless AC	$100.00	$800.00
	Ductless Air Source Heat Pump (ASHP)	$300.00	$2,000.00
	Electronically Commutated Motor (ECM)	$20.00	$200.00
	ENERGY STAR Dehumidifier	$15.00	$100.00
	ENERGY STARRoom ACs	$20.00	$100.00
	ENERGY STAR Water Coolers	$10.00	$100.00
	Freezer recycling	$20.00	$75.00
	Ground Source Heat Pump (GSHP)	$400.00	$3,000.00
	Heat Pump Strip Installed	$25.00	$135.00
	Heat Pump Strip Reset	$5.00	$25.00
	Heat Pump Water Heater	$100.00	$750.00
	High Efficiency Faucet Aerator	$.50	$6.00
	High Efficiency Showerhead	$1.50	$20.00
	Indoor Coil Cleaning	$10.00	$65.00
	LED Nightlight	$0.15	$3.25
	Lighting (Standard)	$0.50	$5.00
	Specialty Connected LEDs	$0.50	$10.00
	Outdoor Coil Cleaning	$5.00	$30.00
	Pipe Insulation	$0.25 per ft	$5.00
	ENERGY STAR Pool Pump	$50.00	$450.00
	Power Strip	$10.00	$30.00
	Refrigerator recycling	$20.00	$75.00
	Refrigerant Charge	$25.00	$100.00
	Room AC recycling	$10.00	$100.00
	Smart Thermostat	$25.00	$150.00

	Residential Program Measures	Low Incentive Level ($/Measure)	High Incentive Level ($/Measure)
	Tune Up	$30.00	$150.00
	VFD on Pool Pump	$50.00	$500.00
MFMR	Packaged Terminal Air Conditioners (PTAC)	$30.00	$120.00
MFMR	Packaged Terminal Heat Pumps (PTHP)	$30.00	$140.00
SFLI/MFLI	Air Sealing	$0.11 per sf	Full Cost
SFLI/MFLI	Air Source Heat Pump (ASHP)	$800.00	Full Cost
SFLI	Ceiling Insulation	$.05 per sf x ΔR	Full Cost
SFLI/MFLI	Central AC	$500.00	Full Cost
SFLI/MFLI	Dirty Filter Alarm	$2.00	Full Cost
SFLI	Duct Insulation	$100.00	Full Cost
SFLI	Duct Repair	$200.00	Full Cost
SFLI	Duct Sealing	$100.00	Full Cost
SFLI/MFLI	Ductless AC	$200.00	Full Cost
SFLI/MFLI	Electronically Commutated Motor (ECM)	$100.00	Full Cost
SFLI/MFLI	ENERGY STAR Refrigerator	$200.00	Full Cost
SFLI/MFLI	ENERGY STAR Room AC	$150.00	Full Cost
SFLI/MFLI	ENERGY STAR Thru-the-Wall AC	$150.00	Full Cost
SFLI/MFLI	ENERGY STAR Clothes Washer	$100.00	Full Cost
SFLI	Floor Insulation	$.05 per sf	Full Cost
SFLI	Heat Pump Water Heater	$100.00	Full Cost
SFLI/MFLI	Indoor Coil Cleaning	$50.00	Full Cost
SFLI/MFLI	LED Nightlight	$0.15	Full Cost
SFLI/MFLI	LED bulb	$1.00	Full Cost
SFLI/MFLI	High Efficiency Faucet Aerator	$2.00	Full Cost
SFLI/MFLI	High Efficiency Showerhead	$20.00	Full Cost
SFLI/MFLI	Outdoor Coil Cleaning	$25.00	Full Cost
MFLI	Packaged Terminal Air Conditioner (PTAC)	$30.00	Full Cost
MFLI	Packaged Terminal Heat Pump (PTHP)	$30.00	Full Cost
SFLI/MFLI	Pipe Insulation	$0.25 per ft	Full Cost
SFLI/MFLI	Programmable Thermostat	$25.00	Full Cost
SFLI/MFLI	Refrigerator Coil Cleaning Brush	$0.25	Full Cost
SFLI/MFLI	Refrigerant Charge	$45.00 per lb	Full Cost
SFLI/MFLI	Shower Start	$5.00	Full Cost
SFLI/MFLI	Smart Strip	$5.00	Full Cost
SFLI/MFLI	Smart Thermostat	$25.00	Full Cost
SFLI/MFLI	Tune Up	$30.00	Full Cost
SFLI/MFLI	Electric Water Heater Tank Wrap	$30.00	Full Cost
SFLI/MFLI	Window Film	$1.00 per sf	Full Cost
SFLI/MFLI	Window Replacement	$0.30 per sf	Full Cost

	Residential Program Measures	Low Incentive Level ($/1st Yr kWh)	High Incentive Level ($/1st Yr kWh)
MFMR	Lighting	$0.05	$0.30
MFMR	Controls	$0.05	$0.30
MFMR	Building Shell	$0.05	$0.30
MFMR	Smart Thermostats	$0.05	$0.30
MFMR	Variable Frequency Drives	$0.05	$0.30
MFMR	Motors	$0.05	$0.30
MFMR	Refrigeration/Freezer	$0.05	$0.30
MFMR	Water Heating	$0.05	$0.30
MFMR	Cooling	$0.05	$0.40
MFMR	Custom	$0.05	$0.30
MFMR	HVAC	$0.05	$0.30
MFLI	Lighting	$0.10	Full Cost
MFLI	Controls	$0.10	Full Cost
MFLI	Building Shell	$0.10	Full Cost
MFLI	Smart Thermostats	$0.10	Full Cost
MFLI	Variable Frequency Drives	$0.10	Full Cost
MFLI	Motors	$0.10	Full Cost
MFLI	Refrigeration/Freezer	$0.10	Full Cost
MFLI	Water Heating	$0.10	Full Cost
MFLI	HVAC	$0.10	Full Cost
MFLI	Miscellaneous	$0.10	Full Cost
MFLI	Custom	$0.10	Full Cost

	Residential Behavior Program Measures	Incentive Level (annual$/ customer)	High Incentive Level (annual$/ customer)
HER	Home Energy Report – Gamification component	$0.00	$20.00

DEMAND RESPONSE PROGRAM MEASURES

Residential Demand Response	Enrollment incentive*		Equipment incentive*		Installation incentive*		Annual Participation incentive*	
	Low	High	Low	High	Low	High	Low	High
Demand Response Advanced Thermostat	$0	$200	$0	$200	$0	$200	$0	$100

*Residential DR incentives may be applied by the program per household or per advanced thermostat.

Business Demand Response	**Annual Incentive**		**Event Incentive**	
Measure Category	Low	High	Low	High
kW payment for the average kW savings during all events during a season	Varies by Customer		$0	
kWh payment for the energy savings during each dispatch event in a season	$0		Varies by Customer	

Residential Energy Efficiency Program-Specific Evaluation Plans

Energy Efficient Lighting

The Residential Lighting Program continues Ameren Missouri's long-standing efforts to increase the presence of energy efficient lighting in the market. Through the program, Ameren Missouri offers discounts for LEDs through the markdown channel (including online store) to reach a broad range of customers.

The table below outlines potential evaluation approaches, some or all of which will be used for the Evaluation, Measurement, and Verification ("EM&V") process.

Evaluation Component	Potential Methods
Gross Impacts	• Review measure savings algorithms and associated inputs (Technical Reference Manual ("TRM") Review) • Update savings algorithm input parameters based on market evaluation activities and secondary sources as appropriate • Review program tracking data to verify measure quantities • In-home metering and lighting product inventory research via market evaluation • Geo-mapping or store intercepts to determine leakage
Net Impacts	• Estimate based on preponderance of evidence leveraging mixed method approach • Participant interviews via in-store intercepts to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, in-home saturation studies, supplier interviews to estimate non-participant spillover • Demand modeling to estimate price elasticity of demand for program eligible products based on the changes in sales during periods of differing prices
Process Evaluation	• Program theory/logic model review, program staff interviews, customer journey mapping, website usability testing, vendor interviews, participant surveys, market study surveys, and a program materials review
Market Evaluation	• Participating and non-participating customer surveys • In-home audits • Supply side research (e.g. market actor interviews/Delphi panels, sales data analysis, secondary market data research/analysis, product stocking studies)

Energy Efficient HVAC

The Efficient HVAC Program offers incentives for retrofit and replacement upgrades of air conditioners and heat pumps, ductless heat pumps, and variable speed blower motor fans (electronically commutated motors), as well as system tune ups.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Database and TRM review, all savings algorithms and input parameters – update as appropriate • Participant surveys for measure verification and baseline information • Metering for several categories of measures (e.g. heat pumps, central a/c systems) • Verification through engineering desk review of representative sample of projects • Monthly consumption analysis using matched comparison group
Net Impacts	• Estimate based on preponderance of evidence leveraging mixed method approach • Participant survey to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, in-home saturation studies • Contractor/distributor interviews to estimate non-participant spillover
Process Evaluation	• Program logic review, data tracking and program material review, program staff interviews, program implementer interviews, • Participating and non-participating trade ally interviews, ride-alongs, and focus groups • Participant surveys
Market Evaluation	• Participating and non-participating customer surveys • In-home audits • Supply side research (e.g. market actor interviews/Delphi panels, sales data analysis, secondary market data research/analysis, product stocking studies)

Energy Efficient Products

The Residential Efficient Products Program continues Ameren Missouri's long-standing efforts to increase the presence of energy efficient products in the market. The program is an umbrella offering, incorporating various partners, products, and delivery strategies with the goal of increasing customer awareness of the benefits of high-efficiency products (ENERGY STAR®, Consortium for Energy Efficiency ("CEE") Tiers, or better). Through the program, Ameren Missouri will offer incentives for efficient products including ENERGY STAR® appliances, water heaters, window air conditioning units, pool pumps, and learning thermostats (also called smart thermostats).

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Review measure savings algorithms and associated inputs (TRM Review) • Update savings algorithm input parameters based on market evaluation activities and secondary sources as appropriate • Review of program tracking data to verify measure quantities • In-home product inventory research via market evaluation • Energy consumption analysis with matched comparison group for select measures as appropriate
Net Impacts	• Estimate based on preponderance of evidence leveraging mixed method approach • Participant surveys to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, in-home saturation studies, supplier interviews to estimate non-participant spillover
Process Evaluation	• Program theory/logic model review, program staff interviews, customer journey mapping, website usability testing, vendor interviews, participant surveys, market study surveys, and a program materials review
Market Evaluation	• Participating and non-participating customer surveys • In-home audits • Supply side research (e.g. market actor interviews/Delphi panels, sales data analysis, secondary market data research/analysis, product stocking studies)

Home Energy Reports Evaluation Plan

The Home Energy Reports (Residential Behavior Program) provide Ameren Missouri customers with personalized reports focused on behavioral changes that reduce energy consumption and peak demand. The program does not include financial incentives.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Gross impacts are typically not applicable to behavioral programs given the randomized control trial research design
Net Impacts	• Regression analysis using energy consumption data • Usage equivalency analysis to assess equivalence of baseline energy consumption between treatment and control group customers • Joint savings adjustment analysis to avoid double-counting savings associated with participation in other Ameren Missouri programs • Assessment of net savings persistence (Effective Useful Life) via selective stoppage of treatment and regression analysis using energy consumption data
Process Evaluation	• Program theory/ logic model review, program staff interviews, participant and control group surveys, and review of customer reports • Multi-level modeling to identify customer types and characteristics that drive participant savings
Market Evaluation	• Participating and non-participating customer surveys • In-home audits

Single and Multifamily Low-Income Evaluation Plan

The Residential Low-Income Programs provide holistic energy savings to income qualified households (both single family and multifamily) through direct installation services, incentives for standard and custom common area and whole building efficiency improvements, one-stop-shop engagement and services, and qualified installations of energy efficiency measures by grant receiving organizations.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Program tracking database and TRM review, all savings algorithms and input parameters – update as appropriate • Participant surveys (on-site, telephone, web) for measure verification and baseline information • Engineering desk reviews and analyses of savings based on TRM algorithms • On-site audit for measure verification and short-term metering of common area and HVAC measures as deemed appropriate • Weather normalized regression analysis of participant consumption data using matched comparison (will provide net impact estimate)
Net Impacts	• Apply net-to-gross ratio ("NTGR") of 1.0 to gross savings per UMP Chapter 17
Process Evaluation	• Review and evaluate program materials, program theory/logic models, implementation plans, implementer progress reports, program Quality Assurance or Quality Control ("QA/QC") procedures and associated documentation • Contractor ride-along to observe program delivery • Tenant and property manager interviews • In-depth interviews with Ameren Missouri program staff, program implementation staff • Analysis of census program tracking data to assess historic participation rates in income-qualified communities • Non-participant interviews to assess barriers to participation
Non-Energy Benefits Assessment	• Estimate non-energy benefits associated with reduced arrearages and disconnections among program participants

Multi-family Market Rate Evaluation Plan

The Multi-family Market Rate Program provides energy savings to multi-family households through distribution of no and low-cost energy efficiency measures, and provides incentives for common area and whole building efficiency improvements.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Program tracking database and TRM review, all savings algorithms and input parameters – update as appropriate • Participant surveys for measure verification and baseline information • Engineering desk reviews and analyses of savings based on TRM algorithms • On-site audit for measure verification and short-term metering of common area and HVAC measures as deemed appropriate • Weather normalized regression analysis of participant consumption data using matched comparison • Building modeling
Net Impacts	• Self-report NTGR questions in surveys with participating property managers, and tenants (if applicable), to calculate free ridership and participant spillover.
Process Evaluation	• Program theory/ logic model review, program process mapping, program staff interviews, implementer interviews, multi-family property manager surveys, and tenant surveys • Program materials, delivery and QA/QC process review • Customer journey mapping
Market Evaluation	• Participating and non-participating customer surveys • In-home audits • Supply side research (e.g. market actor interviews/Delphi panels, secondary market data research/analysis)

Energy Efficient Kits Evaluation Plan

The Residential Energy Efficiency Kits Program was designed with the goals of increasing customer awareness of the benefits of high-efficiency products (ENERGY STAR®, CEE Tiers, or better), educating residential customers and their families about energy use, and providing resources for cost-effective energy savings. Through the program, Ameren Missouri provides energy efficiency kits containing energy efficient items through schools and property managers of multifamily buildings.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Program tracking database and TRM review, all savings algorithms and input parameters – update as appropriate • Participant surveys (on-site, telephone, web) for measure verification and baseline information • Engineering desk reviews and analyses of savings based on TRM algorithms
Net Impacts	• Self-report NTGR questions in participant surveys to calculate free ridership and participant spillover.
Process Evaluation	• Survey research to evaluate participant knowledge gain, participant satisfaction with experience and measures, and teacher satisfaction with program support and curriculum (school kits only) • Program theory/ logic model review, program staff interviews, program partner and/or implementer interviews, and teacher interviews • Program materials, delivery and QA/QC process review
Market Evaluation	• N/A

Appliance Recycling Evaluation Plan

The Appliance Recycling Program offers Ameren Missouri customers incentives and free pick-up service for recycling operable refrigerators and standalone freezers. All participating appliances are generally decommissioned in an environmentally responsible manner and permanently removed from within a utility's service territory.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Program tracking database and TRM review, all savings algorithms and input parameters – update as appropriate • Participant surveys to verify appliance pick up and operating condition • Regression modeling per UMP protocol
Net Impacts	• Self-report NTGR questions in participant surveys to calculate free ridership
Process Evaluation	• Participant survey research • Program theory/ logic model review, program staff interviews, program partner and/or implementer interviews • Program materials, delivery and QA/QC process review
Market Evaluation	• Supply side research (e.g. market actor interviews/Delphi panels, secondary market data research/analysis)

In the first year, we will have laid the groundwork for an effective evaluation in 2019 with evaluability assessments and the quarterly program monitoring dashboard. We can then assign and prioritize process and impact evaluation tasks strategically.

Demand Response – Residential Smart Thermostat Demand Response Program

This Residential Smart Thermostat Demand Response Program will provide Ameren Missouri with peak demand capacity from residential customers. It is expected that in return for a bill credit or a rebate towards the purchase of a smart thermostat, participating customers will allow Ameren Missouri to adjust the thermostat setting during a limited number of demand response events.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Process Evaluation	• Interviews with program and implementer staff to develop program theory narrative, assess program evaluability and data requirements • Participant surveys to assess program experience, barriers to reducing energy use during peak periods and validate load impact results
Load Impact Analysis	• Data request, processing, aggregation of participant usage, device run time, weather and event data • Sample design and regression analysis to estimate ex ante (forecasted) and ex post (actual) load reductions associated with dispatchable events • Mine device run-time data (such as smart thermostat logs or two-way switch logs) to identify opt-out, failure rate, and customer engagement patterns to optimize program delivery
Market Evaluation	• Leverage market evaluation data from customers and relevant trade allies regarding program interest, barriers, and motivations regarding DR technology adoption

Business Program-Specific Evaluation Plans

Business Standard Incentive Program

The Business Standard Incentive Program provides rebates for energy efficient products that are readily available in the marketplace and for which there are savings opportunities for a large number of customers. Commercial, government, institutional, and industrial customers of all sizes will be eligible for the program, but it is expected that many participants will be smaller customers undertaking simpler, single-measure projects. Measures targeted through the program are of two types.

- Measures for which energy savings can be reliably deemed or stipulated (e.g., premium efficiency motors, vending machine sensors, many lighting measures).
- Measures for which energy savings can be calculated using simple threshold criteria (e.g., variable frequency drives, air compressors, refrigeration measures).

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Database and TRM review, all savings algorithms and input parameters – update as appropriate • Participant surveys (telephone or on-site) for measure verification and baseline information • Measure verification through engineering desk review of representative sample of projects • Engineering desk reviews and analysis of savings based on TRM algorithms • On-site Measurement and Verification ("M&V") including short term metering • Regression analysis of building consumption data as appropriate
Net Impacts	• Participant survey to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, on-site saturation studies • Contractor/distributor/key trade ally interviews to estimate non-participant spillover
Process Evaluation	• Program logic review, data tracking and program material review, program staff interviews, program implementer interviews • Participant surveys • Participating and non-participating trade ally interviews and focus groups
Market Evaluation	• Participating and non-participating customer surveys • On-site facility audits • Supply side research (e.g. market actor interviews/Delphi panels, sales data analysis, secondary market data research/analysis, product stocking studies)

Business Custom Incentive Program

The Custom Incentive Program provides incentives for energy efficient products and services that reduce Commercial and Industrial ("C&I") customers' electricity use. Customized incentives are based on calculated savings for specific customer projects that can involve multiple measures with interactive effects, process improvements, and/or complex measures for which ex ante deemed savings/simple savings algorithms combined with standard incentives are not appropriate.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Database and custom project application review • Participant surveys (telephone or on-site) for measure verification and baseline information • Savings and measure verification through engineering desk review of representative sample of projects • On-site M&V including short term metering • Regression analysis of building consumption data or building/system simulation modeling as appropriate
Net Impacts	• Participant survey to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, on-site saturation studies • Contractor/distributor/key trade ally interviews to estimate non-participant spillover
Process Evaluation	• Program logic review, data tracking and program material review, program staff interviews, program implementer interviews • Participant surveys • Participating and non-participating trade ally interviews and focus groups
Market Evaluation	• Participating and non-participating customer surveys • On-site facility audits • Supply side research (e.g. market actor interviews/Delphi panels, sales data analysis, secondary market data research/analysis, product stocking studies)

Small Business Direct Install Program

The Small Business Direct Install Incentive Program offers incentives (discounts) to encourage the completion of energy efficient equipment retrofits for facilities under the Small General Service (2M) rate class. The incentives allow for small business customers to implement low-cost and/or no-cost measures in their facilities through a group of pre-approved service providers. The objective of this program is to reduce participation barriers for small business through a simple and streamlined process[1]. Eligible measures include HVAC, lighting, refrigeration, motors, and water heating.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Database and TRM review, all savings algorithms and input parameters – update as appropriate • Participant surveys (telephone or on-site) for measure verification and baseline information • Measure verification through engineering desk review of representative sample of projects • Engineering desk reviews and analysis of savings based on TRM algorithms • On-site M&V including short term metering • Regression analysis of building consumption data as appropriate
Net Impacts	• Participant survey to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, on-site saturation studies • Contractor/distributor/key trade ally interviews to estimate non-participant spillover
Process Evaluation	• Program logic review, data tracking and program material review, program staff interviews, program implementer interviews • Participant surveys • Participating and non-participating trade ally interviews and focus groups
Market Evaluation	• Participating and non-participating customer surveys • On-site facility audits • Supply side research (e.g. market actor interviews/Delphi panels, sales data analysis, secondary market data research/analysis, product stocking studies)

[1] Ameren Missouri UEC Sheet 206, https://q9u5x5a2.ssl.hwcdn.net/-/Media/Missouri-Site/Files/rates/UECSheet206EEBusSmallBusinessDirectInstall.pdf?la=en

New Construction Program

The New Construction Program is targeted at any new C&I building, major renovation, or tenant build-out project in the planning or design stage. The program goal is to promote higher energy efficiency products and systems than required by the local building jurisdiction for the design and construction of new buildings, major renovations, and tenant build-outs.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Database and new construction project application review • Tenant, developer, design engineer, architect interviews (telephone or on-site) for measure verification and baseline information • Savings and measure verification through engineering desk review of project documentation • On-site M&V including short term metering • Regression analysis of building consumption data or building/system simulation modeling as appropriate
Net Impacts	• Participant survey to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, on-site saturation studies • Contractor/developer/design engineer/architect and other key trade ally interviews to estimate non-participant spillover
Process Evaluation	• Program logic review, data tracking and program material review, program staff interviews, program implementer interviews • Participant surveys • Program logic review, data tracking and program material review, program staff interviews, program implementer interviews • Participant surveys • Participating and non-participating contractor/developer/design engineer/architect and other key trade ally interviews and focus groups
Market Evaluation	• Participating and non-participating customer surveys • On-site facility audits • Supply side research (e.g. market actor interviews/Delphi panels, secondary market data research/analysis)

Retro-Commissioning/Continuous Commissioning Incentive Program

The Retro-Commissioning/Continuous Commissioning Incentive Program will help C&I building owners identify building operating system performance improvements, and, where applicable, provide incentives to assist with their implementation.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Database and custom project application review • Participant surveys (telephone or on-site) for measure verification and baseline information • Savings and measure verification through engineering desk review of representative sample of projects • On-site M&V including short term metering • Regression analysis of building consumption data or system energy simulation modeling as appropriate
Net Impacts	• Participant survey to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, on-site saturation studies • Contractor/distributor/key trade ally interviews to estimate non-participant spillover
Process Evaluation	• Program logic review, data tracking and program material review, program staff interviews, program implementer interviews • Participant surveys • Participating and non-participating trade ally interviews and focus groups
Market Evaluation	• Participating and non-participating customer surveys • On-site facility audits • Supply side research (e.g. market actor interviews/Delphi panels, sales data analysis, secondary market data research/analysis, standard O&M practice research)

Business Social Services Program

The Business Social Services Program provides rebates for energy efficient products that are readily available in the marketplace and for which there are savings opportunities. Organizations that are eligible for the program include those that are predominately doing business to provide social services to the under-privileged and low-income public, including food banks, food pantries, soup kitchens, homeless shelters, employment services, worker training, job banks, and childcare facilities.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Gross Impacts	• Database and TRM review, all savings algorithms and input parameters – update as appropriate • Participant surveys (telephone or on-site) for measure verification and baseline information • Measure verification through engineering desk review of representative sample of projects • Engineering desk reviews and analysis of savings based on TRM algorithms • On-site M&V including short term metering • Regression analysis of building consumption data as appropriate
Net Impacts	• Participant survey to estimate free ridership and participant spillover • Leverage market evaluation studies for non-participant surveys, on-site saturation studies • Contractor/distributor/key trade ally interviews to estimate non-participant spillover
Process Evaluation	• Program logic review, data tracking and program material review, program staff interviews, program implementer interviews • Participant surveys • Participating and non-participating trade ally interviews and focus groups
Market Evaluation	• Participating and non-participating customer surveys • On-site facility audits • Supply side research

Business Demand Response Program

This Business Demand Response will provide Ameren Missouri with peak demand capacity reductions from business customers. The business Demand Response ("DR") program will engage customers to participate in DR events through direct load control, manual response and the use of behind the meter assets. Participants will benefit from a customized energy reduction plan and may receive enhanced control technology.

The table below outlines potential evaluation approaches, some or all of which will be used for the EM&V process.

Evaluation Component	Potential Methods
Process Evaluation	• Interviews with program and implementer staff to develop program theory narrative, assess program evaluability and data requirements • Participant surveys to assess program experience, barriers to reducing energy use during peak periods and validate load impact results • Eligible customer surveys to elicit barriers, perceptions, and characteristics of nonparticipating eligible customers to improve program targeting and marketing
Load Impact Analysis	• Conduct regression analysis or individual verification of baseline to estimate ex ante (forecasted) and ex post (actual) load reductions associated with dispatchable events (depending on program and business type). Data request, processing, aggregation of participant usage, weather and event data
Market Evaluation	• Leverage market evaluation data from customer and relevant trade ally data regarding program interest, barriers, and motivations regarding DR technology adoption

Residential and Business Deemed Savings Table

MEEIA 2019-21

Ameren Missouri Deemed Savings Table Revision Log

Ameren Missouri Deemed Savings Table	Date	Ameren Missouri TRM			Description
		Volume 1: Overview and User Guide	Volume 2: C&I Measures	Volume 3: Residential Measures	
Revision		Revision	Revision	Revision	
1.0	05/30/2018	1.0	1.0	1.0	Initial version filed for Commission approval.

BUSINESS PRESCRIPTIVE MEASURES

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PROGRAMS: All

Lighting

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	LED <=11 Watt Lamp Replacing Interior Halogen A 28-52 Watt Lamp	87.5	Lighting BUS	0.0001899635	0.0166	17.0	$15.64	per measure
C&I	LED 7-20 Watt Lamp Replacing Interior Halogen 53-70 Watt Lamp	153.1	Lighting BUS	0.0001899635	0.0291	17.0	$19.64	per measure
C&I	LED <=14 Watt Lamp Replacing Interior Halogen BR/R 45-65 Watt Lamp	201.5	Lighting BUS	0.0001899635	0.0383	11.0	$48.27	per measure
C&I	LED <=13 Watt Lamp Replacing Interior Halogen MR-16 35-50 Watt Lamp	178.1	Lighting BUS	0.0001899635	0.0338	11.0	$36.64	per measure
C&I	LED <=20 Watt Lamp Replacing Interior Halogen PAR 48-90 Watt Lamp	257.8	Lighting BUS	0.0001899635	0.0490	11.0	$74.64	per measure
C&I	LED <=80 Watt Lamp or Fixture Replacing Interior HID 100-175 Watt Lamp or Fixture	576.5	Lighting BUS	0.0001899635	0.1095	11.0	$191.39	per measure
C&I	LED 62 - 130 Watt Lamp or Fixture Replacing Interior HID 176-300 Watt Lamp or Fixture	703.0	Lighting BUS	0.0001899635	0.1335	11.0	$233.64	per measure
C&I	LED 85 - 225 Watt Lamp or Fixture Replacing Interior HID 301-500 Watt Lamp or Fixture	1,209.1	Lighting BUS	0.0001899635	0.2297	11.0	$361.64	per measure
C&I	LED <=80 Watt Lamp or Fixture Replacing Garage or Exterior <24/7 HID 100-175 Watt	439.5	Ext Lighting BUS	0.0000056160	0.0025	14.0	$191.39	per measure
C&I	LED 62 - 130 Watt Lamp or Fixture Replacing Garage or Exterior <24/7 HID 176-300 Watt	1,047.5	Ext Lighting BUS	0.0000056160	0.0059	9.0	$233.64	per measure
C&I	LED 85 - 225 Watt Lamp or Fixture Replacing Garage or Exterior <24/7 HID 301-500 Watt	956.2	Ext Lighting BUS	0.0000056160	0.0054	15.0	$361.64	per measure
C&I	LED <=80 Watt Lamp or Fixture Replacing Garage or Exterior 24/7 HID 100-175 Watt Lamp or Fixture Misc.	1,077.5	Miscellaneous BUS	0.0001379439	0.1486	6.0	$191.39	per measure
C&I	LED 62 - 130 Watt Lamp or Fixture Replacing Garage or Exterior 24/7 HID 176-300 Watt Lamp or Fixture Misc.	1,314.0	Miscellaneous BUS	0.0001379439	0.1813	6.0	$233.64	per measure
C&I	LED 85 - 225 Watt Lamp or Fixture Replacing Garage or Exterior 24/7 HID 301-500 Watt Lamp or Fixture Misc.	2,452.8	Miscellaneous BUS	0.0001379439	0.3383	6.0	$361.64	per measure
C&I	LED or Electroluminescent Replacing Interior Incandescent/CFL Exit Sign	253.1	Lighting BUS	0.0001899635	0.0481	16.0	$45.25	per measure
C&I	LED Replacing Interior T5 Fluorescent	222.6	Lighting BUS	0.0001899635	0.0423	8.0	$29.64	per measure
C&I	LED Replacting Interior T8 Fluorescent	82.4	Lighting BUS	0.0001899635	0.0157	9.0	$29.64	per measure
C&I	LED Replacing Interior T12 Fluorescent	124.6	Lighting BUS	0.0001899635	0.0237	11.0	$29.64	per measure
C&I	LED Specialty Lamp	102.2	Lighting BUS	0.0001899635	0.0194	11.0	$11.94	per measure

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Fixture Mounted Occupancy Sensor Controlling >50 and <=200 Watts	107.6	Lighting BUS	0.0001899635	0.020433823	10.0	$116.33	per measure
C&I	Fixture Mounted Occupancy Sensor Controlling >=201 and <=500 Watts	309.8	Lighting BUS	0.0001899635	0.05884941	10.0	$116.33	per measure
C&I	Single Technology Occupancy Sensor Controlling Lighting Circuit >50 and <=120 Watts	86.1	Lighting BUS	0.0001899635	0.016347058	11.0	$42.35	per measure
C&I	Single Technology Occupancy Sensor Controlling Lighting Circuit >120 Watts	444.9	Lighting BUS	0.0001899635	0.084514291	11.0	$119.56	per measure
C&I	Dual Technology Occupancy Sensor Controlling Lighting Circuit >150 Watts	444.9	Lighting BUS	0.0001899635	0.084514291	8.0	$128.00	per measure

Commercial Solid and Glass Door Refrigerators & Freezers

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	0 < V < 15 - Vertical Closed - Solid Door Refrigerator	379.9	Refrigeration BUS	0.0001357383	0.0516	12.0	$150.00	per measure
C&I	15 ≤ V < 30 - Vertical Closed - Solid Door Refrigerator	626.4	Refrigeration BUS	0.0001357383	0.0850	12.0	$400.00	per measure
C&I	30 ≤ V < 50 - Vertical Closed - Solid Door Refrigerator	982.5	Refrigeration BUS	0.0001357383	0.1334	12.0	$550.00	per measure
C&I	V ≥ 50 - Vertical Closed - Solid Door Refrigerator	1,311.2	Refrigeration BUS	0.0001357383	0.1780	12.0	$700.00	per measure
								per measure
C&I	0 < V < 15 - Vertical Closed - Glass Door Refrigerator	354.3	Refrigeration BUS	0.0001357383	0.0481	12.0	$250.00	per measure
C&I	15 ≤ V < 30 - Vertical Closed - Glass Door Refrigerator	217.3	Refrigeration BUS	0.0001357383	0.0295	12.0	$500.00	per measure
C&I	30 ≤ V < 50 - Vertical Closed - Glass Door Refrigerator	226.5	Refrigeration BUS	0.0001357383	0.0307	12.0	$1,307.00	per measure
C&I	V ≥ 50 - Vertical Closed - Glass Door Refrigerator	372.6	Refrigeration BUS	0.0001357383	0.0506	12.0	$2,300.00	per measure
								per measure
C&I	Horizontal Closed - Solid or Glass Door Refrigerator - All Volumes	1,219.9	Refrigeration BUS	0.0001357383	0.1656	12.0	$525.00	per measure
								per measure
								per measure
C&I	0 < V < 15 - Vertical Closed - Solid Door Freezer	348.8	Refrigeration BUS	0.0001357383	0.0473	12.0	$150.00	per measure
C&I	15 ≤ V < 30 - Vertical Closed - Solid Door Freezer	1,307.6	Refrigeration BUS	0.0001357383	0.1775	12.0	$400.00	per measure
C&I	30 ≤ V < 50 - Vertical Closed - Solid Door Freezer	2,403.3	Refrigeration BUS	0.0001357383	0.3262	12.0	$550.00	per measure
C&I	V ≥ 50 - Vertical Closed - Solid Door Freezer	2,951.2	Refrigeration BUS	0.0001357383	0.4006	12.0	$700.00	per measure
								per measure
C&I	0 < V < 15 - Vertical Closed - Glass Door Freezer	1,430.0	Refrigeration BUS	0.0001357383	0.1941	12.0	$220.00	per measure
C&I	15 ≤ V < 30 - Vertical Closed - Glass Door Freezer	3,186.8	Refrigeration BUS	0.0001357383	0.4326	12.0	$950.00	per measure
C&I	30 ≤ V < 50 - Vertical Closed - Glass Door Freezer	5,150.0	Refrigeration BUS	0.0001357383	0.6991	12.0	$1,307.00	per measure
C&I	V ≥ 50 - Vertical Closed - Glass Door Freezer	5,884.2	Refrigeration BUS	0.0001357383	0.7987	12.0	$2,300.00	per measure
								per measure
C&I	Horizontal Closed - Solid or Glass Door Freezer - All Volumes	5,265.1	Refrigeration BUS	0.0001357383	0.7147	12.0	$595.00	per measure

Refrigerators & Freezers Controls

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost (per door)	Units
C&I	Anti-Sweat Heater Controls Refrigerator	668.1	Refrigeration BUS	0.0001357383	0.0907	12.0	$151.00	per door
C&I	Anti-Sweat Heater Controls Freezer	770.9	Refrigeration BUS	0.0001357383	0.1046	12.0	$151.00	per door

BUSINESS PRESCRIPTIVE MEASURES

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PROGRAMS: All

Heat Pump Water Heaters

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Heat Pump Water Heater w/ 98% Efficiency 2.9-14.6 kW (10 to 50 MBH)	21,156.0	Water Heating BUS	0.0001811545	3.8325	15.0	$4,000.00	per measure
C&I	Heat Pump Water Heater w/ 98% Efficiency 14.7-29.3 kW (50 to 100 MBH)	52,890.0	Water Heating BUS	0.0001811545	9.5813	15.0	$7,000.00	per measure
C&I	Heat Pump Water Heater w/ 98% Efficiency 29.4-87.9 kW (100 to 300 MBH)	141,041.0	Water Heating BUS	0.0001811545	25.5502	15.0	$10,000.00	per measure
C&I	Heat Pump Water Heater w/ 98% Efficiency 88-146.5 kW (300 to 500 MBH)	282,081.0	Water Heating BUS	0.0001811545	51.1002	15.0	$14,000.00	per measure
C&I	Heat Pump Water Heater w/ 98% Efficiency >146.6 kW (above 500 MBH)	423,122.0	Water Heating BUS	0.0001811545	76.6505	15.0	$18,000.00	per measure

Heat Pump Pool Heater

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost (per unit)	Units
C&I	Pool Heater Heat Pump (Uncovered)	35,272.9	Water Heating BUS	0.0001811545	6.3898	15.00	$1,000.00	per measure
C&I	Pool Heater Heat Pump (Covered)	6,206.9	Water Heating BUS	0.0001811545	1.1244	15.00	$1,000.00	per measure

Pool Pump

Program/ Channel	Measure	Gross kWh Annual Savings (per HP)	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Pool Pump w/ Variable Frequency Drive	1,747.0	Motors BUS	0.0001379439	0.2410	15.00	$246.00	per measure

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Pool Pump Timer	601.3	Motors BUS	0.0001379439	0.0829	10.00	$100.00	per measure

Steam Cookers

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	3 Pan ENERGY STAR® Steam Cooker	7,856.3	Cooking BUS	0.0001998949	1.5704	12.0	$4,150.00	per measure
C&I	4 Pan ENERGY STAR® Steam Cooker	9,213.5	Cooking BUS	0.0001998949	1.8417	12.0	$4,150.00	per measure
C&I	5 Pan ENERGY STAR® Steam Cooker	10,513.0	Cooking BUS	0.0001998949	2.1015	12.0	$4,150.00	per measure
C&I	6 Pan ENERGY STAR® Steam Cooker	11,818.6	Cooking BUS	0.0001998949	2.3625	12.0	$4,150.00	per measure

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PROGRAMS: All

Holding Cabinet

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	ENERGY STAR® Hot Holding Cabinet (0 < V <13)	709.5	Cooking BUS	0.0001998949	0.1418	12.00	$1,783.00	per measure
C&I	ENERGY STAR® Hot Holding Cabinet (13 ≤ V <28)	2,772.2	Cooking BUS	0.0001998949	0.5542	12.00	$1,783.00	per measure
C&I	ENERGY STAR® Hot Holding Cabinet (28 ≤ V)	4,438.3	Cooking BUS	0.0001998949	0.8872	12.00	$1,783.00	per measure

HVAC

Program/ Channel	Measure	Cooling Gross kWh Annual Savings (per Ton)	Heating Gross kWh Annual Savings (per ton)	Total Gross kWh Annual Savings	End Use	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Learning Thermostat	205.3	233.0	438.3	Cooling BUS	Heating BUS	0.0009106840	0.1870	10.00	$224.00	per measure

Program/ Channel	Measure	Gross kWh Annual Savings (per HP)	End Use	kW Factor	kW	EUL	Inc. Cost (per HP)	Units
C&I	VFD on Chilled Water Pump 1-75HP	1,289.6	Cooling BUS	0.0009106840	1.1745	15.00	$179.00	per Hp
C&I	VFD on Hot Water Pump 1-75HP	1,696.6	HVAC BUS	0.0004439830	0.7533	15.00	$179.00	per Hp

Program/ Channel	Measure	Gross kWh Annual Savings (per HP)	End Use	kW Factor	kW	EUL	Inc. Cost (per HP)	Units
C&I	VFD on HVAC Fans 1-100HP	939.7	HVAC BUS	0.0004439830	0.4172	15.00	$168.00	per Hp

Program/ Channel	Measure	Gross kWh Annual Savings (per ton)	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Packaged DX 135 - 240kbtu	154.0	Cooling BUS	0.0009106840	0.1402	15.0	$100.00	per ton
C&I	Packaged DX 240 - 760kbtu	66.5	Cooling BUS	0.0009106840	0.0606	15.0	$100.00	per ton
C&I	Packaged DX 65 -135kbtu	98.6	Cooling BUS	0.0009106840	0.0898	15.0	$100.00	per ton
C&I	Packaged DX >760kbtu	70.8	Cooling BUS	0.0009106840	0.0645	15.0	$100.00	per ton
C&I	Packaged DX <65kbtu	69.4	Cooling BUS	0.0009106840	0.0632	15.0	$100.00	per ton

Program/ Channel	Measure	Cooling Gross kWh Annual Savings (per ton)	Heating Gross kWh Annual Savings (per ton)	Total Gross kWh Annual Savings	End Use	End Use	kW Factor	kW	EUL	Inc. Cost (per ton)	Units
C&I	GSHP <135kbtu; ≥17EER	36.7	28.0	64.7	Cooling BUS	Heating BUS	0.0009106840	0.0334	15.0	$180.00	per ton
C&I	GSHP <135kbtu; ≥19EER	114.9	28.0	142.9	Cooling BUS	Heating BUS	0.0009106840	0.1047	15.0	$180.00	per ton
C&I	ASHP 65 - 135kbtu	95.7	64.6	160.3	Cooling BUS	Heating BUS	0.0009106840	0.0872	15.0	$100.00	per ton
C&I	ASHP 135 - 240kbtu	43.3	183.9	227.3	Cooling BUS	Heating BUS	0.0009106840	0.0395	15.0	$100.00	per ton
C&I	ASHP >240kbtu	138.0	129.4	267.5	Cooling BUS	Heating BUS	0.0009106840	0.1257	15.0	$100.00	per ton
C&I	ASHP <65kbtu	69.4	61.9	131.4	Cooling BUS	Heating BUS	0.0009106840	0.0632	15.0	$100.00	per ton

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PROGRAMS: All

Program/ Channel	Measure	Gross kWh Annual Savings (per ton)	End Use	kW Factor	kW	EUL	Inc. Cost (per ton)	Units
C&I	Air Cooled Chiller	411.0	Cooling BUS	0.0009106840	0.3743	20.0	$106.23	per ton

Appliances

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Clothes Washer (Electric DHW; Electric Dryer)	907.6	Miscellaneous BUS	0.0001379439	0.1252	11.00	$200.00	per measure
C&I	Clothes Washer (Gas DHW; Electric Dryer)	308.4	Miscellaneous BUS	0.0001379439	0.0425	11.00	$200.00	per measure
C&I	Clothes Washer (Electric DHW; Gas Dryer)	750.8	Miscellaneous BUS	0.0001379439	0.1036	11.00	$200.00	per measure
C&I	Clothes Washer (Gas DHW; Gas Dryer)	151.6	Miscellaneous BUS	0.0001379439	0.0209	11.00	$200.00	per measure

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Clothes Dryer Vented Electric, Standard (≥ 4.4 ft3)	840.7	Miscellaneous BUS	0.0001379439	0.1160	14.00	$75.00	per measure
C&I	Clothes Dryer Vented Electric, Compact (120V) (< 4.4 ft3)	307.3	Miscellaneous BUS	0.0001379439	0.0424	14.00	$105.00	per measure
C&I	Clothes Dryer Vented Electric, Compact (240V) (<4.4 ft3)	340.1	Miscellaneous BUS	0.0001379439	0.0469	14.00	$105.00	per measure
C&I	Clothes Dryer Ventless Electric, Compact (240V) (<4.4 ft3)	428.7	Miscellaneous BUS	0.0001379439	0.0591	14.00	$105.00	per measure
C&I	Clothes Dryer Vented Gas	40.6	Miscellaneous BUS	0.0001379439	0.0056	14.00	$75.00	per measure

Compressed Air

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	No Loss Condensate Drain (Reciprocating - On/off Control)	3,272.3	Air Comp BUS	0.0001379439	0.4514	13.00	$700.00	per measure
C&I	No Loss Condensate Drain (Reciprocating - Load/Unload)	2,418.6	Air Comp BUS	0.0001379439	0.3336	13.00	$700.00	per measure
C&I	No Loss Condensate Drain (Screw - Load/Unload)	2,703.2	Air Comp BUS	0.0001379439	0.3729	13.00	$700.00	per measure
C&I	No Loss Condensate Drain (Screw - Inlet Modulation)	978.1	Air Comp BUS	0.0001379439	0.1349	13.00	$700.00	per measure
C&I	No Loss Condensate Drain (Screw - Inlet Modulation w/ Unloading)	978.1	Air Comp BUS	0.0001379439	0.1349	13.00	$700.00	per measure
C&I	No Loss Condensate Drain (Screw - Variable Displacement)	2,721.0	Air Comp BUS	0.0001379439	0.3753	13.00	$700.00	per measure
C&I	No Loss Condensate Drain (Screw - VFD)	3,165.6	Air Comp BUS	0.0001379439	0.4367	13.00	$700.00	per measure

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Compressed Air Nozzle (Reciprocating - On/off Control)	1,547.2	Air Comp BUS	0.0001379439	0.2134	15.00	$77.00	per measure
C&I	Compressed Air Nozzle (Reciprocating - Load/Unload)	1,203.4	Air Comp BUS	0.0001379439	0.1660	15.00	$77.00	per measure
C&I	Compressed Air Nozzle (Screw - Load/Unload)	1,289.3	Air Comp BUS	0.0001379439	0.1779	15.00	$77.00	per measure
C&I	Compressed Air Nozzle (Screw - Inlet Modulation)	515.7	Air Comp BUS	0.0001379439	0.0711	15.00	$77.00	per measure
C&I	Compressed Air Nozzle (Screw - Inlet Modulation w/ Unloading)	515.7	Air Comp BUS	0.0001379439	0.0711	15.00	$77.00	per measure
C&I	Compressed Air Nozzle (Screw - Variable Displacement)	1,289.3	Air Comp BUS	0.0001379439	0.1779	15.00	$77.00	per measure
C&I	Compressed Air Nozzle (Screw - VFD)	1,547.2	Air Comp BUS	0.0001379439	0.2134	15.00	$77.00	per measure

Program/ Channel	Measure	Gross kWh Annual Savings (per HP)	End Use	kW Factor	kW	EUL	Inc. Cost (per HP)	Units
	VSD Air Compressor ≤ 40 HP	987.0	Air Comp BUS	0.0001379439	0.1362	10.00	$1,573.00	per HP

Combination Oven

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Combination Oven (Pan Capacity < 15)	6,372.3	Cooking BUS	0.0001998949	1.2738	12.0	$4,300.00	per measure
C&I	Combination Oven (Pan Capacity ≥ 15)	11,743.6	Cooking BUS	0.0001998949	2.3475	12.0	$4,300.00	per measure

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PROGRAMS: All

Fryer

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Standard Open Deep-Fat Fryer	952.3	Cooking BUS	0.0001998949	0.1904	12.0	$210.00	per measure
C&I	Large Vat Open Deep-Fat Fryer	2,537.8	Cooking BUS	0.0001998949	0.5073	12.0	$0.00	per measure

Convection Oven

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Convection Oven (Full Size)	1,938.5	Cooking BUS	0.0001998949	0.3875	12.0	$0.00	per measure
C&I	Convection Oven (Half Size)	192.1	Cooking BUS	0.0001998949	0.0384	12.0	$0.00	per measure

Griddle

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Griddle	1,910.4	Cooking BUS	0.0001998949	0.3819	12.0	$0.00	per measure

Kitchen Demand Ventillation Controls

Program/ Channel	Measure	Gross kWh Annual Savings (per HP)	End Use	kW Factor	kW	EUL	Inc. Cost (per HP)	Units
C&I	Kitchen Demand Ventillation Controls	3,331.1	Cooking BUS	0.0001998949	0.6659	15.0	$1,988.00	per HP

Pre-Rinse Spray Valve

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Pre-Rinse Spray Valve	5,786.5	Cooking BUS	0.0001998949	1.1567	5.0	$92.90	per measure

Low Flow Faucet Aerator

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Low Flow Faucet Aerator	86.6	Water Heating BUS	0.0001811545	0.0157	9.0	$8.00	per measure

Circulator Pump

Program/ Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Circulator Pump	651.0	Miscellaneous BUS	0.0001379439	0.0898	15.0	$1,200.00	per measure

Small Commercial Programmable Thermostats

Program/ Channel	Measure	Gross kWh Annual Savings (per sqft)	End Use	kW Factor	kW	EUL	Inc. Cost (per unit)	Units
C&I	Small Commercial Programmable Thermostats	0.0289	Cooling BUS	0.0009106840	0.0000	8.0	$181.00	per measure

Demand Controlled Ventillation

Program/ Channel	Measure	Gross kWh Annual Savings (per sqft)	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Demand Controlled Ventillation (Gas Heat)	0.7	Cooling BUS	0.0009106840	0.0006	10.00	Actual	per sq. ft.
C&I	Demand Controlled Ventillation (Electric Heat)	1.9	Cooling BUS	0.0009106840	0.0017	10.00	Actual	per sq. ft.
C&I	Demand Controlled Ventillation (Heat Pump)	1.1	Cooling BUS	0.0009106840	0.0010	10.00	Actual	per sq. ft.

BUSINESS PRESCRIPTIVE MEASURES

The values in the cells highlighted in this color are values used in the planning process of the portfolio. TRM allows delivery program design to use actual values for these cells, or a default value if actuals are not available.	Cells highlighted in this color are calculated variables

PROGRAMS: All

Advanced RTU Controls

Program/ Channel	Measure	Gross kWh Annual Savings (per HP)	End Use	kW Factor	kW	EUL	Inc. Cost (per unit)	Units
C&I	Advanced RTU Controls	3,779.3	HVAC BUS	0.0004439830	1.6780	15.0	$4,038.00	per measure

PTAC & PTHP

Program/ Channel	Measure	Gross kWh Annual Savings (per ton) first 5 years	Gross kWh Annual Savings (per ton) next ten years	End Use	kW Factor	kW first 5 years	kW first 5 years	EUL	Inc. Cost (per ton)	Units
C&I	PTAC	411.3	10.5	Cooling BUS	0.0009106840	0.3745	0.010	15.0	$1,047.00	per ton
C&I	PTHP	715.4	177.1	Cooling BUS	0.0009106840	0.3745	0.019	15.0	$1,047.00	per ton

Refrigerated Beverage Vending Machine

Program/ Channel	Measure	Gross kWh Annual Savings (per cubicft)	End Use	kW Factor	kW	EUL	Inc. Cost	Units
C&I	Refrigerated Beverage Vending Machine (Class A)	0.1307	Refrigeration BUS	0.0001357383	0.00002	12.0	$140.00	per measure
C&I	Refrigerated Beverage Vending Machine (Class B)	0.3233	Refrigeration BUS	0.0001357383	0.00004	12.0	$140.00	per measure

ECM for Walk-in & Reach-in Coolers/Freezers

Program/ Channel	Measure	Gross kWh Annual Savings (per motor)	End Use	kW Factor	kW	EUL	Inc. Cost (per motor)	Units
C&I	ECM for Walk-in & Reach-in Coolers/Freezers	1,409.0	Miscellaneous BUS	0.0001379439	0.1944	15.0	$177.00	per motor

RESIDENTIAL LIGHTING

Lighting Program

** CFL baseline is Post 2020, EISA baseline is pre-2020 **

Measure Reference No.	Program/ Channel	Measure	Gross kWh Annual Savings	kW	End Use - RES	kW Factor - RES	End Use - BUS	kW Factor - BUS	kWh RES	kWh BUS	KW RES	KW BUS	EUL - RES	EUL - BUS**	Inc. Cost*	Units
	Lighting	LED - 10.5W Downlight E26 (CFL baseline)	12.9	0.0019	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	12.9	0.0000000	0.0019	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 10.5W Downlight E26 (Halogen baseline)	33.2	0.0050	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	33.2	0.0000000	0.0050	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 10W (CFL baseline)	4.0	0.0006	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	4.0	0.0000000	0.0006	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 10W (Halogen baseline)	29.7	0.0044	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	29.7	0.0000000	0.0044	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 12W Dimmable Light Bulb (Replacing CFL)	7.8	0.0012	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	7.8	0.0000000	0.0012	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 12W Dimmable Light Bulb (Replacing Specialty Incandescent) LI DI	61.6	0.0092	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	61.6	0.0000000	0.0092	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 15W (Halogen baseline)	39.1	0.0058	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	39.1	0.0000000	0.0058	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 15W (CFL baseline)	7.7	0.0011	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	7.7	0.0000000	0.0011	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 15W Flood Light PAR30 Bulb (CFL baseline)	4.4	0.0007	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	4.4	0.0000000	0.0007	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 15W Flood Light PAR30 Bulb (Halogen baseline)	47.0	0.0070	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	47.0	0.0000000	0.0070	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 18W Flood Light PAR30 Bulb (CFL baseline)	4.6	0.0007	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	4.6	0.0000000	0.0007	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 18W Flood Light PAR38 Bulb (Halogen baseline)	75.7	0.0113	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	75.7	0.0000000	0.0113	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 20W (CFL baseline)	9.0	0.0013	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	9.0	0.0000000	0.0013	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 20W (Halogen baseline)	52.6	0.0079	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	52.6	0.0000000	0.0079	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 4W Candelabra (CFL baseline)	4.2	0.0006	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	4.2	0.0000000	0.0006	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 4W Candelabra (Replacing Specialty Incandescent)	33.1	0.0049	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	33.1	0.0000000	0.0049	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 8W Globe Light G25 Bulb (Replacing CFL)	4.7	0.0007	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	4.7	0.0000000	0.0007	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 8W Globe Light G25 Bulb (Replacing Specialty Incandescent)	33.4	0.0050	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	33.4	0.0000000	0.0050	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 10W (Halogen baseline) - Specialty Connected Light	29.7	0.0044	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	29.7	0.0000000	0.0044	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 15W (Halogen baseline) - Specialty Connected Light	39.1	0.0058	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	39.1	0.0000000	0.0058	0.0000	19.0	6.0	$ 0.0000010	per bulb
	Lighting	LED - 15W Flood Light PAR30 Bulb (Halogen baseline) - Specialty Connected Light	47.0	0.0070	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	47.0	0.0000000	0.0070	0.0000	19.0	6.0	$ 0.0000010	per bulb

*The present value cost of multiple Halogen or CFL bulbs over the life of the measure is typically at or below $0. For modeling purposes, use $.000001 to model these measures within DSMore.

**EUL-BUS based on MO TRM - 20,000 hours total life; 3,351 annual hours of use for average building type.

RESIDENTIAL EFFICIENT PRODUCTS

Heat Pump Hot Water Heater

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kWh_{cool}	kWh_{heat} - Electric Resistance	kWh_{heat} - Heat Pumps	kW	EUL	Inc. Cost	Units
	Efficient Products	Heat Pump Hot Water Heater	3719.9	Water Heating RES	0.0000887318	1117.18	581.51	342.06	0.3301	13.0	$588.00	per measure

Learning Thermostat / Advanced Thermostat

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Efficient Products	Learning Thermostat - ASHP heating/cooling SF	192.5	Cooling RES	0.0009474181	0.1824	10.0	$175.00	per measure
	Efficient Products	Learning Thermostat - ASHP heating/cooling SF	662.0	Heating RES	0.0000000000	0.0000	10.0		per measure
	Efficient Products	Learning Thermostat - electric furnace heating / central AC MF	192.5	Cooling RES	0.0009474181	0.1824	10.0	$175.00	per measure
	Efficient Products	Learning Thermostat - electric furnace heating / central AC MF	710.4	Heating RES	0.0000000000	0.0000	10.0		per measure
	Efficient Products	Learning Thermostat - electric furnace heating / central AC SF	192.5	Cooling RES	0.0009474181	0.1824	10.0	$175.00	per measure
	Efficient Products	Learning Thermostat - electric furnace heating / central AC SF	1093.0	Heating RES	0.0000000000	0.0000	10.0		per measure
	Efficient Products	Learning Thermostat - Gas Heated / central AC **	192.5	Cooling RES	0.0009474181	0.1824	10.0	$175.00	per measure
	Efficient Products	Learning Thermostat - Gas Heated / central AC **	46.3	Heating RES	0.0000000000	0.0000	10.0		per measure
	Efficient Products	Learning Thermostat - Unknown **	192.5	Cooling RES	0.0009474181	0.1824	10.0	$175.00	per measure
	Efficient Products	Learning Thermostat - Unknown **	377.6	Heating RES	0.0000000000	0.0000	10.0	$175.00	per measure

ENERGY STAR Pool Pump and motor w auto controls - multi speed

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Efficient Products	ENERGY STAR Pool Pump and motor w auto controls - multi speed	1799.7	Pool Spa RES	0.0002354459	0.4237	10.0	$235.00	per measure
	Efficient Products	ENERGY STAR VFDs on Residential Swimming Pool Pumps	2052.8	Pool Spa RES	0.0002354459	0.4833	10.0	$549.00	per measure

Advanced Power Strips Tier 2 / Advanced Control Stategies

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Efficient Products	Advanced Tier 2 Power Strips - A	237.6	Miscellaneous RES	0.0001148238	0.0273	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - B	216.0	Miscellaneous RES	0.0001148238	0.0248	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - C	194.4	Miscellaneous RES	0.0001148238	0.0223	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - D	172.8	Miscellaneous RES	0.0001148238	0.0198	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - E	151.2	Miscellaneous RES	0.0001148238	0.0174	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - F	129.6	Miscellaneous RES	0.0001148238	0.0149	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - G	108.0	Miscellaneous RES	0.0001148238	0.0124	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - H	86.4	Miscellaneous RES	0.0001148238	0.0099	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - Average	162.0	Miscellaneous RES	0.0001148238	0.0186	10.0	$30.00	per measure

ENERGY STAR Air Purifier

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Efficient Products	ENERGY STAR Air Purifier/Cleaner	555.6	Miscellaneous RES	0.0001148238	0.0638	9.0	$70.00	per measure

ENERGY STAR Dehumidifier

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Efficient Products	ENERGY STAR Dehumidifier	204.0	Cooling RES	0.0009474181	0.1933	12.0	$5.00	per measure

RESIDENTIAL EFFICIENT PRODUCTS

Energy Star Room AC

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Efficient Products	ENERGY STAR® Room AC (kWh w inst rate)	40.0	Cooling RES	0.0009474181	0.03787	9.0	$20.00	per measure
	Efficient Products	ENERGY STAR® Room AC (kWh w/o inst rate)	41.0	Cooling RES	0.0009474181	0.03882	9.0	$20.00	per measure
	Low-Income	AC - Energy Star® Room - Thru-Wall_MF: Low Income	41.0	Cooling RES	0.0009474181	0.03882	9.0	$20.00	per measure
	Low-Income	AC - Energy Star® Room - Thru-Wall_SF: Low Income	41.0	Cooling RES	0.0009474181	0.03882	9.0	$20.00	per measure
	Low Income	AC - Energy Star® Room_MF: Low Income	41.0	Cooling RES	0.0009474181	0.03882	9.0	$20.00	per measure
	Low-Income	AC - Energy Star® Room_SF: Low Income	41.0	Cooling RES	0.0009474181	0.03882	9.0	$20.00	per measure

RESIDENTIAL ENERGY EFFICIENCY KITS

Dirty Filter Alarm

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	kW	EUL	Inc. Cost	Units
	School	Dirty Filter Alarm_SF:Kits	68.1	HVAC RES	0.0004660805	43.08	25.03	0.0117	14.0	$5.00	per measure
	School	Dirty Filter Alarm_MF:Kits	79.2	HVAC RES	0.0004660805	50.10	29.10	0.0136	14.0	$5.00	per measure

LEDs (per bulb)

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	School	LED - 10W (CFL baseline)	3.3	Lighting RES	0.0001492529	0.000	19.0	$1.95	per measure
	Multifamily	LED - 10W (CFL baseline)	3.3	Lighting RES	0.0001492529	0.000	19.0	$1.95	per measure
	School	LED - 10W (Halogen baseline)	24.5	Lighting RES	0.0001492529	0.004	19.0	$1.95	per measure
	Multifamily	LED - 10W (Halogen baseline)	24.5	Lighting RES	0.0001492529	0.004	19.0	$1.95	per measure
	School	LED - 10.5W Downlight E26 (CFL baseline)	25.9	Lighting RES	0.0001492529	0.004	19.0	$1.95	per measure
	Multifamily	LED - 10.5W Downlight E26 (CFL baseline)	37.2	Lighting RES	0.0001492529	0.006	19.0	$1.95	per measure

Kit Faucet Aerators (Kitchen)

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	School	Kit Faucet Aerator (Kitchen)	45.9	Water Heating RES	0.0000887318	0.079	0.0041	10.0	$3.00	per measure
	Multifamily	Kit Faucet Aerator (Kitchen)	115.9	Water Heating RES	0.0000887318	0.079	0.0103	10.0	$3.00	per measure

Kit Faucet Aerators (Bathroom)

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	School	Kit Faucet Aerator (Bathroom)	8.0	Water Heating RES	0.0000887318	0.062	0.0007	10.0	$3.00	per measure
	Multifamily	Kit Faucet Aerator (Bathroom)	33.5	Water Heating RES	0.0000887318	0.062	0.0030	10.0	$3.00	per measure

Low Flow Showerheads

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	School	Low Flow Showerheads	73.6	Water Heating RES	0.0000887318	0.109	0.0065	10.0	$7.00	per measure

Pipe Insulation

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
1272	School	Pipe Insulation	10.4	Water Heating RES	0.0000887318	0.0009	12.0	$2.87	per foot
868	Multifamily	Pipe Insulation	16.5	Water Heating RES	0.0000887318	0.0015	12.0	$2.87	per foot

RESIDENTIAL ENERGY EFFICIENCY KITS

Advanced Power Strips Tier 1 / Load Sensing

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	TOS/NC/DI - Home Office	Advanced Tier 1 Power Strips -TOS/NC/DI - Home Office	31.0	Miscellaneous RES	0.0001148238	0.0036	10.0	$20.00	per measure
	Kits - Home Office	Advanced Tier 1 Power Strips -Kits - Home Office	24.2	Miscellaneous RES	0.0001148238	0.0028	10.0	$20.00	per measure
	TOS/NC/DI - Home Entertainment	Advanced Tier 1 Power Strips -TOS/NC/DI - Home Entertainment	75.1	Miscellaneous RES	0.0001148238	0.0086	10.0	$20.00	per measure
	Kits - Home Entertainment	Advanced Tier 1 Power Strips -Kits - Home Entertainment	58.6	Miscellaneous RES	0.0001148238	0.0067	10.0	$20.00	per measure
	TOS/NC/DI - Unknown Location	Advanced Tier 1 Power Strips -TOS/NC/DI - Unknown Location	59.2	Miscellaneous RES	0.0001148238	0.0068	10.0	$20.00	per measure
	Kits - Unknown Location	Advanced Tier 1 Power Strips -Kits - Unknown Location	42.1	Miscellaneous RES	0.0001148238	0.0048	10.0	$20.00	per measure

RESIDENTIAL HVAC

ECM/ Blower Motor

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	Auto kWh	Continous kWh	kW	EUL	Inc. Cost	Units
	HVAC: SF - ROF	ECM Auto Fan EUL Replacement -SF	591.9	HVAC RES	0.0004660805	265.2	4.70	321.99	-	0.0022	20.0	$97.00	per measure
	HVAC: MF - ROF	ECM Auto Fan EUL Replacement -MF	591.9	HVAC RES	0.0004660805	265.2	4.70	321.99	-	0.0022	20.0	$97.00	per measure
	HVAC: SF - ER1	ECM Auto Fan Early Replacement ER 1 (Full Cost) - SF	591.9	HVAC RES	0.0004660805	265.2	4.70	321.99	-	0.0022	6.0	$475.00	per measure
	HVAC: SF - ER2	ECM Auto Fan Early Replacement ER2 (Remaining Life) - SF	591.9	HVAC RES ER2	0.0004660805	265.2	4.70	321.99	-	0.0022	12.0		per measure
	HVAC: MF - ER1	ECM Auto Fan Early Replacement ER 1 (Full Cost) - MF	591.9	HVAC RES	0.0004660805	265.2	4.70	321.99	-	0.0022	6.0	$475.00	per measure
	HVAC: MF - ER2	ECM Auto Fan Early Replacement ER2 (Remaining Life) - MF	591.9	HVAC RES ER2	0.0004660805	265.2	4.70	321.99	-	0.0022	12.0		per measure
	HVAC: SF - ROF	ECM Continous Fan EUL Replacement - SF	3,255.9	HVAC RES	0.0004660805	265.2	4.70	-	2,985.99	0.3409	20.0	$97.00	per measure
	HVAC: MF - ROF	ECM Continous Fan EUL Replacement - MF	3,255.9	HVAC RES	0.0004660805	265.2	4.70	-	2,985.99	0.3409	20.0	$97.00	per measure
	HVAC: SF - ER1	ECM Continous Fan Early Replacement ER 1 (Full Cost) - SF	3,255.9	HVAC RES	0.0004660805	265.2	4.70	-	2,985.99	0.3409	6.0	$475.00	per measure
	HVAC: SF - ER2	ECM Continous Fan Early Replacement ER2 (Remaining Life) - SF	3,255.9	HVAC RES ER2	0.0004660805	265.2	4.70	-	2,985.99	0.3409	12.0		per measure
	HVAC: MF - ER1	ECM Continous Fan Early Replacement ER 1 (Full Cost) - MF	3,255.9	HVAC RES	0.0004660805	265.2	4.70	-	2,985.99	0.3409	6.0	$475.00	per measure
	HVAC: MF - ER2	ECM Continous Fan Early Replacement ER2 (Remaining Life) - MF	3,255.9	HVAC RES ER2	0.0004660805	265.2	4.70	-	2,985.99	0.3409	12.0		per measure

Central Air Conditioners

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units (tons/measure)
	HVAC: SF - ER1	CAC - SEER 14 ER1: HVAC SF	1,612.0	Cooling RES	0.0009474181	1.5273	6	$637	3.00
	HVAC: SF - ER2	CAC - SEER 14 ER2: HVAC SF	925.3	Cooling RES ER2	0.0009474181	0.8766	12		3.00
	HVAC: SF -ROF	CAC - SEER 14 Replace at Fail: HVAC SF	203.4	Cooling RES	0.0009474181	0.1927	18		3.00
	HVAC: MF - ER1	CAC - SEER 14 ER1: HVAC MF	1,047.8	Cooling RES	0.0009474181	0.9927	6	$637	3.00
	HVAC: MF - ER2	CAC - SEER 14 ER2: HVAC MF	601.4	Cooling RES ER2	0.0009474181	0.5698	12		3.00
	HVAC: MF -ROF	CAC - SEER 14 Replace at Fail: HVAC MF	132.2	Cooling RES	0.0009474181	0.1252	16		3.00
	HVAC: SF - ER1	CAC - SEER 15 ER1: HVAC SF	1,932.7	Cooling RES	0.0009474181	1.8310	6	$1,057	3.30
	HVAC: SF - ER2	CAC - SEER 15 ER2: HVAC SF	1,177.3	Cooling RES ER2	0.0009474181	1.1154	12		3.30
	HVAC: SF -ROF	CAC - SEER 15 Replace at Fail: HVAC SF	334.7	Cooling RES	0.0009474181	0.3171	18	$324	3.00
	HVAC: MF - ER1	CAC - SEER 15 ER1: HVAC MF	1,256.2	Cooling RES	0.0009474181	1.1902	6	$1,057	3.30
	HVAC: MF - ER2	CAC - SEER 15 ER2: HVAC MF	765.2	Cooling RES ER2	0.0009474181	0.7250	12		3.30
	HVAC: MF -ROF	CAC - SEER 15 Replace at Fail: HVAC MF	217.5	Cooling RES	0.0009474181	0.2061	18	$324	3.00
	HVAC: SF - ER1	CAC - SEER 16 ER1: HVAC SF	1,921.9	Cooling RES	0.0009474181	1.8208	6	$1,343	3.10
	HVAC: SF - ER2	CAC - SEER 16 ER2: HVAC SF	1,212.3	Cooling RES ER2	0.0009474181	1.1485	12		3.10
	HVAC: SF -ROF	CAC - SEER 16 Replace at Fail: HVAC SF	436.2	Cooling RES	0.0009474181	0.4132	18	$640.90	2.90
	HVAC: MF - ER1	CAC - SEER 16 ER1: HVAC MF	1,249.2	Cooling RES	0.0009474181	1.1835	6	$1,343	3.10
	HVAC: MF - ER2	CAC - SEER 16 ER2: HVAC MF	788.0	Cooling RES ER2	0.0009474181	0.7465	12		3.10
	HVAC: MF -ROF	CAC - SEER 16 Replace at Fail: HVAC MF	283.5	Cooling RES	0.0009474181	0.2686	18	$640.90	2.90
	HVAC: SF - ER1	CAC - SEER 17+ ER1: HVAC SF	2,040.7	Cooling RES	0.0009474181	1.9334	6	$1,911	3.10
	HVAC: SF - ER2	CAC - SEER 17+ ER2: HVAC SF	1,331.1	Cooling RES ER2	0.0009474181	1.2611	12		3.10
	HVAC: SF -ROF	CAC - SEER 17+ Replace at Fail: HVAC SF	547.4	Cooling RES	0.0009474181	0.5186	18	$1,172	2.90
	HVAC: MF - ER1	CAC - SEER 17+ ER1: HVAC MF	1,326.5	Cooling RES	0.0009474181	1.2567	6	$1,911	3.10
	HVAC: MF - ER2	CAC - SEER 17+ ER2: HVAC MF	865.2	Cooling RES ER2	0.0009474181	0.8197	12		3.10
	HVAC: MF -ROF	CAC - SEER 17+ Replace at Fail: HVAC MF	355.8	Cooling RES	0.0009474181	0.3371	18	$1,172	2.90

*Incremental cost to be adjusted based on cost testing used

RESIDENTIAL HVAC

Ductless Heat Pumps

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units (tons/measure)
	HVAC: SF - ER1	Ductless AC - ER1 SF	2,022.5	Cooling RES	0.0009474181	1.9161	6.0	$2,389.07	1.6
	HVAC: SF - ER2	Ductless AC - ER2 SF	572.3	Cooling RES ER2	0.0009474181	0.5422	12.0		
	HVAC: SF -ROF	Ductless AC - replace on fail SF	1,875.9	Cooling RES	0.0009474181	1.7773	18.0	$1,648.00	1.6
	HVAC: SF -ROF	Ductless ASHP - replace on fail SF NC	548.4	Cooling RES	0.0009474181	0.5196	18.0	$828.80	1.4
	HVAC: SF -ROF	Ductless ASHP - replace on fail SF NC	1,059.4	Heating RES	0.0000000000	0.0000	18.0		
	HVAC: SF -ROF	Ductless ASHP - replace on fail SF ROF	548.4	Cooling RES	0.0009474181	0.5196	18.0	$1,006.40	1.7
	HVAC: SF -ROF	Ductless ASHP - replace on fail SF ROF	1,059.4	Heating RES	0.0000000000	0.0000	18.0		
	HVAC: SF-ER1	Ductless ASHP Replace Electric Resistance ER1 SF	1,495.2	Cooling RES	0.0009474181	1.4166	6.0	$1,967.47	1.4
	HVAC: SF-ER1	Ductless ASHP Replace Electric Resistance ER1 SF	5,217.9	Heating RES	0.0000000000	0.0000	6.0		
	HVAC: SF-ER2	Ductless ASHP Replace Electric Resistance ER2 SF	471.3	Cooling RES ER2	0.0009474181	0.4465	12.0		
	HVAC: SF-ER2	Ductless ASHP Replace Electric Resistance ER2 SF	1,115.9	Heating RES ER2	0.0000000000	0.0000	12.0		
	HVAC: SF -ROF	Ductless ASHP Replace Electric Resistance ROF	447.1	Cooling RES	0.0009474181	0.4236	18.0	$1,121.07	1.6
	HVAC: SF -ROF	Ductless ASHP Replace Electric Resistance ROF	1,070.7	Heating RES	0.0000000000	0.0000	18.0		
	HVAC: SF -ER1	Ductless ASHP ER1 SF	1,626.0	Cooling RES	0.0009474181	1.5405	6.0	$2,246.27	1.7
	HVAC: SF -ER1	Ductless ASHP ER1 SF	2,932.9	Heating RES	0.0000000000	0.0000	6.0		
	HVAC: SF -ER2	Ductless ASHP ER2 SF	527.5	Cooling RES ER2	0.0009474181	0.4997	12.0		
	HVAC: SF -ER2	Ductless ASHP ER2 SF	1,286.4	Heating RES ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	Ductless AC - ER1 MF	1,314.6	Cooling RES	0.0009474181	1.2455	6.0	$1,601.40	1.7
	HVAC: MF - ER2	Ductless AC - ER2 MF	372.0	Cooling RES ER2	0.0009474181	0.3524	12.0		
	HVAC: MF -ROF	Ductless AC - replace on fail MF	1,219.4	Cooling RES	0.0009474181	1.1552	18.0	$1,043.73	1.6
	HVAC: MF -ROF	Ductless ASHP - replace on fail MF NC	356.5	Cooling RES	0.0009474181	0.3377	18.0	$658.00	1.4
	HVAC: MF -ROF	Ductless ASHP - replace on fail MF NC	688.6	Heating RES	0.0000000000	0.0000	18.0		
	HVAC: MF -ROF	Ductless ASHP - replace on fail MF ROF	356.5	Cooling RES	0.0009474181	0.3377	18.0	$658.00	1.4
	HVAC: MF -ROF	Ductless ASHP - replace on fail MF ROF	688.6	Heating RES	0.0000000000	0.0000	18.0		
	HVAC: MF-ER1	Ductless ASHP Replace Electric Resistance ER1 MF	971.9	Cooling RES	0.0009474181	0.9208	6.0	$1,484.00	1.4
	HVAC: MF-ER1	Ductless ASHP Replace Electric Resistance ER1 MF	3,391.6	Heating RES	0.0000000000	0.0000	6.0		
	HVAC: MF-ER2	Ductless ASHP Replace Electric Resistance ER2 MF	306.3	Cooling RES ER2	0.0009474181	0.2902	12.0		
	HVAC: MF-ER2	Ductless ASHP Replace Electric Resistance ER2 MF	725.3	Heating RES ER2	0.0000000000	0.0000	12.0		
	HVAC: MF -ROF	Ductless ASHP Replace Electric Resistance ROF MF	290.6	Cooling RES	0.0009474181	0.2754	18.0	$752.00	1.6
	HVAC: MF -ROF	Ductless ASHP Replace Electric Resistance ROF MF	696.0	Heating RES	0.0000000000	0.0000	18.0		
	HVAC: MF -ER1	Ductless ASHP ER1 MF	1,056.9	Cooling RES	0.0009474181	1.0013	6.0	$1,632.00	1.7
	HVAC: MF -ER1	Ductless ASHP ER1 MF	1,906.4	Heating RES	0.0000000000	0.0000	6.0		
	HVAC: MF -ER2	Ductless ASHP ER2 MF	342.8	Cooling RES ER2	0.0009474181	0.3248	12.0		
	HVAC: MF -ER2	Ductless ASHP ER2 MF	836.1	Heating RES ER2	0.0000000000	0.0000	12.0		

Dual Fuel Heat Pumps

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units (tons/measure)
	Income Eligible	DFHP - SEER 19 MF heat pump base	433.2	Cooling Res	0.0009474181	0.4104	18.0	$2,936.60	3.4
	Income Eligible	DFHP - SEER 19 MF heat pump base	651.4	Heating Res	0.0000000000	0.0000	18.0		
	Income Eligible	DFHP - SEER 20 MF heat pump base	639.1	Cooling Res	0.0009474181	0.6055	18.0	$3,176.60	4.4
	Income Eligible	DFHP - SEER 20 MF heat pump base	990.7	Heating Res	0.0000000000	0.0000	18.0		
	Income Eligible	DFHP - SEER 21 MF heat pump base	871.5	Cooling Res	0.0009474181	0.8257	18.0	$3,626.60	5.4
	Income Eligible	DFHP - SEER 21 MF heat pump base	1,383.7	Heating Res	0.0000000000	0.0000	18.0		

Ground Source Heat Pumps

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units (tons/measure)
	HVAC: ROF	GSHP - EER 23 - replace electric furnace / CAC - Cooling	1,811.0	Cooling Res	0.0009474181	1.7158	18.0	$4,717.00	4.4
	HVAC: ROF	GSHP - EER 23 - replace electric furnace / CAC - Heating	6,530.9	Heating RES	0.0000000000	0.0000	18.0		
	HVAC: ER1	GSHP - EER 23 - replace electric furnace / CAC ER1- Cooling	4,715.6	Cooling Res	0.0009474181	4.4676	6.0	$5,250.00	4.1
	HVAC: ER1	GSHP - EER 23 - replace electric furnace / CAC ER1 - Heating	6,530.9	Heating RES	0.0000000000	0.0000	6.0		
	HVAC: ER2	GSHP - EER 23 - replace electric furnace / CAC ER2- Cooling	1,717.0	Cooling Res ER2	0.0009474181	1.6267	12.0		
	HVAC: ER2	GSHP - EER 23 - replace electric furnace / CAC ER2 - Heating	6,530.9	Heating RES ER2	0.0000000000	0.0000	12.0		
	HVAC: ER1	GSHP EER 23 ER1 - Cooling	4,715.6	Cooling Res	0.0009474181	4.4676	6.0	$4,859.00	4.1
	HVAC: ER1	GSHP EER 23 ER1 - Heatiing	6,530.9	Heating RES	0.0000000000	0.0000	6.0		
	HVAC: ER2	GSHP EER 23 ER2 - Cooling	1,460.4	Cooling Res ER2	0.0009474181	1.3836	12.0		
	HVAC: ER2	GSHP EER 23 ER2 - Heating	6,530.9	Heating RES ER2	0.0000000000	0.0000	12.0		
	HVAC: ROF	GSHP EER 23 Replace at Fail GSHP	1,535.7	Cooling Res	0.0009474181	1.4549	18.0	$3,200.00	4.40
	HVAC: ROF	GSHP EER 23 Replace at Fail GSHP	7,008.7	Heating RES	0.0000000000	0.0000	18.0		

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Air Source Heat Pumps

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units (tons/measure)
	HVAC: SF - ER1	ASHP - SEER 15 ER Elec Resist Furnace: HVAC ER1	2,360.2	Cooling Res	0.0009474181	2.2361	6.0	$2,365.13	2.8
	HVAC: SF - ER1	ASHP - SEER 15 ER Elec Resist Furnace: HVAC ER1	12,036.5	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP - SEER 15 ER Elec Resist Furnace: HVAC ER2	312.4	Cooling Res ER2	0.0009474181	0.2959	12.0		
	HVAC: SF - ER2	ASHP - SEER 15 ER Elec Resist Furnace: HVAC ER2	12,036.5	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ER1	ASHP - SEER 15 ER with ASHP: HVAC ER1	2,349.0	Cooling Res	0.0009474181	2.2255	6.0	$2,618.54	3.1
	HVAC: SF - ER1	ASHP - SEER 15 ER with ASHP: HVAC ER1	5,147.8	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP - SEER 15 ER with ASHP: HVAC ER2	168.2	Cooling Res ER2	0.0009474181	0.1594	12.0		
	HVAC: SF - ER2	ASHP - SEER 15 ER with ASHP: HVAC ER2	523.8	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP- SEER 15 Replace at Fail Elec Resist Furnace: HVAC	301.9	Cooling Res	0.0009474181	0.2860	18.0	$787.80	3.3
	HVAC: SF - ROF	ASHP- SEER 15 Replace at Fail Elec Resist Furnace: HVAC	11,093.0	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ROF	ASHP - SEER 15 Replace at Fail with ASHP: HVAC	168.2	Cooling Res	0.0009474181	0.1594	18.0	$939.30	3.1
	HVAC: SF - ROF	ASHP - SEER 15 Replace at Fail with ASHP: HVAC	523.8	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ER1	ASHP - SEER 16 - replace electric furnace / CAC - early replacement SF ER1	2,733.5	Cooling Res	0.0009474181	2.5898	6.0	$2,896.61	3.1
	HVAC: SF - ER1	ASHP - SEER 16 - replace electric furnace / CAC - early replacement SF ER1	13,965.9	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP - SEER 16 - replace electric furnace / CAC - early replacement SF ER2	466.3	Cooling Res ER2	0.0009474181	0.4417	12.0		
	HVAC: SF - ER2	ASHP - SEER 16 - replace electric furnace / CAC - early replacement SF ER2	13,965.9	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ER1	ASHP SEER 16 replace ASHP - early replacement SF ER1	2,628.7	Cooling Res	0.0009474181	2.4905	6.0	$3,083.49	3.3
	HVAC: SF - ER1	ASHP SEER 16 replace ASHP - early replacement SF ER1	6,250.0	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP SEER 16 replace ASHP - early replacement SF ER2	307.3	Cooling Res ER2	0.0009474181	0.2911	12.0		
	HVAC: SF - ER2	ASHP SEER 16 replace ASHP - early replacement SF ER2	1,327.6	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP - SEER 16 - replace electric furnace / CAC SF	481.3	Cooling Res	0.0009474181	0.4560	18.0	$1,256.64	3.2
	HVAC: SF - ROF	ASHP - SEER 16 - replace electric furnace / CAC SF	14,670.2	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ROF	ASHP SEER 16 replace ASHP - replace on fail SF	307.3	Cooling Res	0.0009474181	0.2911	18.0	$999.90	3.3
	HVAC: SF - ROF	ASHP SEER 16 replace ASHP - replace on fail SF	1,584.0	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ER1	ASHP SEER 15 MF ER Replace ASHP: HVAC ER1	1,526.8	Cooling Res	0.0009474181	1.4466	6.0	$2,618.54	3.1
	HVAC: MF - ER1	ASHP SEER 15 MF ER Replace ASHP: HVAC ER1	3,346.1	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP SEER 15 MF ER Replace ASHP: HVAC ER2	109.3	Cooling Res ER2	0.0009474181	0.1036	12.0		
	HVAC: MF - ER2	ASHP SEER 15 MF ER Replace ASHP: HVAC ER2	340.5	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP SEER 15 MF ER Replace Elec Resist Furnace: HVAC ER1	1,534.1	Cooling Res	0.0009474181	1.4535	6.0	$2,365.13	2.8
	HVAC: MF - ER1	ASHP SEER 15 MF ER Replace Elec Resist Furnace: HVAC ER1	7,823.7	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP SEER 15 MF ER Replace Elec Resist Furnace: HVAC ER2	203.0	Cooling Res ER2	0.0009474181	0.1924	12.0		
	HVAC: MF - ER2	ASHP SEER 15 MF ER Replace Elec Resist Furnace: HVAC ER2	7,823.7	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ROF	ASHP SEER 15 MF Replace at Fail Elec Resist Furnace: HVAC	196.2	Cooling Res	0.0009474181	0.1859	18.0	$787.80	2.6
	HVAC: MF - ROF	ASHP SEER 15 MF Replace at Fail Elec Resist Furnace: HVAC	7,210.5	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ER1	ASHP SEER 16 MF ER Replace ASHP: HVAC ER1	1,708.7	Cooling Res	0.0009474181	1.6188	6.0	$3,083.49	3.3
	HVAC: MF - ER1	ASHP SEER 16 MF ER Replace ASHP: HVAC ER1	4,062.5	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP SEER 16 MF ER Replace ASHP: HVAC ER2	199.7	Cooling Res ER2	0.0009474181	0.1892	12.0		
	HVAC: MF - ER2	ASHP SEER 16 MF ER Replace ASHP: HVAC ER2	863.0	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ROF	ASHP - SEER 16 -	199.7	Cooling Res	0.0009474181	0.1892	18.0	$1,295.91	3.3
	HVAC: MF - ROF	Replace on Fail MF ASHP - SEER 16 -	1,029.6	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	Replace on Fail MF ASHP - SEER 16 - replace electric furnace / CAC MF	312.8	Cooling Res	0.0009474181	0.2964	18.0	$1,256.64	3.2
	HVAC: MF - ROF	ASHP - SEER 16 - replace electric furnace / CAC MF	9,535.6	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ER1	ASHP - SEER 16 - replace electric furnace / CAC - early replacement MF ER1	1,776.8	Cooling Res	0.0009474181	1.6834	6.0	$2,896.61	3.1
	HVAC: MF - ER1	ASHP - SEER 16 - replace electric furnace / CAC - early replacement MF ER1	9,077.8	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP - SEER 16 - replace electric furnace / CAC - early replacement MF ER2	303.1	Cooling Res ER2	0.0009474181	0.2871	12.0		
	HVAC: MF - ER2	ASHP - SEER 16 - replace electric furnace / CAC - early replacement MF ER2	9,077.8	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ROF	ASHP SEER15 MF Replace at Fail ASHP: HVAC	109.3	Cooling Res	0.0009474181	0.1036	18.0	$939.30	3.1
	HVAC: MF - ROF	ASHP SEER15 MF Replace at Fail ASHP: HVAC	340.5	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ROF	ASHP - SEER 17 - replace electric furnace / CAC SF	2,576.3	Cooling Res	0.0009474181	2.4409	18.0	$1,624.00	2.8
	HVAC: SF - ROF	ASHP - SEER 17 - replace electric furnace / CAC SF	12,836.4	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 17 - replace electric furnace / CAC MF	1,674.6	Cooling Res	0.0009474181	1.5866	18.0	$1,624.00	2.8
	HVAC: MF - ROF	ASHP - SEER 17 - replace electric furnace / CAC MF	8,343.7	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ROF	ASHP - SEER 18 - replace electric furnace / CAC SF	2,671.7	Cooling Res	0.0009474181	2.5313	18.0	$1,997.33	2.8
	HVAC: SF - ROF	ASHP - SEER 18 - replace electric furnace / CAC SF	12,836.4	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 18 - replace electric furnace / CAC MF	1,736.6	Cooling Res	0.0009474181	1.6453	18.0	$1,997.33	2.8
	HVAC: MF - ROF	ASHP - SEER 18 - replace electric furnace / CAC MF	8,343.7	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ROF	ASHP - SEER 19 - replace electric furnace / CAC SF	2,757.1	Cooling Res	0.0009474181	2.6121	18.0	$2,277.33	2.8
	HVAC: SF - ROF	ASHP - SEER 19 - replace electric furnace / CAC SF	12,836.4	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 19 - replace electric furnace / CAC MF	1,792.1	Cooling Res	0.0009474181	1.6979	18.0	$2,277.33	2.8
	HVAC: MF - ROF	ASHP - SEER 19 - replace electric furnace / CAC MF	8,343.7	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ER1	ASHP - SEER 20 - replace electric furnace / CAC - early replacement SF ER1	3,137.6	Cooling Res	0.0009474181	2.9726	6.0	$5,275.24	3.1
	HVAC: SF - ER1	ASHP - SEER 20 - replace electric furnace / CAC - early replacement SF ER1	13,965.9	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP - SEER 20 - replace electric furnace / CAC - early replacement SF ER2	870.3	Cooling Res ER2	0.0009474181	0.8246	12.0		
	HVAC: SF - ER2	ASHP - SEER 20 - replace electric furnace / CAC - early replacement SF ER2	13,965.9	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP - SEER 20 - replace electric furnace / CAC SF	898.4	Cooling Res	0.0009474181	0.8512	18.0	$3,712.00	3.2
	HVAC: SF - ROF	ASHP - SEER 20 - replace electric furnace / CAC SF	14,670.2	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 20 - replace electric furnace / CAC MF	584.0	Cooling Res	0.0009474181	0.5533	18.0	$3,596.00	3.1
	HVAC: MF - ROF	ASHP - SEER 20 - replace electric furnace / CAC MF	9,535.6	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ER1	ASHP - SEER 21 - replace electric furnace / CAC - early replacement SF ER1	3,214.6	Cooling Res	0.0009474181	3.0455	6.0	$5,275.24	0.0

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Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units (tons/measure)
	HVAC: SF - ER1	ASHP - SEER 21 - ReplaceEelectric furnace / CAC - early replacement SF	13,965.9	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ER1 ASHP - SEER 21 - Replace electric furnace / CAC - early replacement SF	947.3	Cooling Res ER2	0.0009474181	0.8975	12.0		
	HVAC: SF - ER2	ER2 ASHP - SEER 21 -Rreplace electric furnace / CAC - early replacement SF	13,965.9	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP - SEER 21 - Replace electric furnace / CAC - early replacement MF ER1	2,089.5	Cooling Res	0.0009474181	1.9796	6.0	$5,275.24	3.1
	HVAC: MF - ER1	ASHP - SEER 21 - Replace electric furnace / CAC - early replacement MF ER1	9,077.8	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP - SEER 21 - Replace electric furnace / CAC - early replacement MF ER2	615.7	Cooling Res ER2	0.0009474181	0.5834	12.0		
	HVAC: MF - ER2	ASHP - SEER 21 - Replace electric furnace / CAC - early replacement MF ER2	9,077.8	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP - SEER 21 - replace electric furnace / CAC SF	977.9	Cooling Res	0.0009474181	0.9264	18.0	$3,712.00	3.2
	HVAC: SF - ROF	ASHP - SEER 21 - replace electric furnace / CAC SF	14,670.2	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ROF	ASHP- SEER 21+ Replace at Fail Elec Resist Furnace: HVAC	635.6	Cooling Res	0.0009474181	0.6022	18.0	$3,712.00	3.2
	HVAC: SF - ROF	ASHP- SEER 21+ Replace at Fail Elec Resist Furnace: HVAC	9,535.6	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ER1	ASHP SEER 17 replace ASHP - early replacement SF ER1	2,755.2	Cooling Res	0.0009474181	2.6104	6.0	$3,701.58	3.3
	HVAC: SF - ER1	ASHP SEER 17 replace ASHP - early replacement SF ER1	6,250.0	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP SEER 17 replace ASHP - early replacement SF ER2	433.8	Cooling Res ER2	0.0009474181	0.4110	12.0		
	HVAC: SF - ER2	ASHP SEER 17 replace ASHP - early replacement SF ER2	1,327.6	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP SEER 17 replace ASHP - replace on fail SF	433.8	Cooling Res	0.0009474181	0.4110	18.0	$1,914.00	3.3
	HVAC: SF - ROF	ASHP SEER 17 replace ASHP - replace on fail SF	1,584.0	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ER1	ASHP SEER 18 replace ASHP - early replacement SF ER1	2,867.7	Cooling Res	0.0009474181	2.7169	6.0	$4,141.58	3.3
	HVAC: SF - ER1	ASHP SEER 18 replace ASHP - early replacement SF ER1	6,250.0	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP SEER 18 replace ASHP - early replacement SF ER2	546.2	Cooling Res ER2	0.0009474181	0.5175	12.0		
	HVAC: SF - ER2	ASHP SEER 18 replace ASHP - early replacement SF ER2	1,327.6	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP SEER 18 replace ASHP - replace on fail SF	546.2	Cooling Res	0.0009474181	0.5175	18.0	$2,354.00	3.3
	HVAC: SF - ROF	ASHP SEER 18 replace ASHP - replace on fail SF	1,584.0	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ROF	ASHP - SEER 18 - replace on fail SF	546.2	Cooling Res	0.0009474181	0.5175	18.0	$2,354.00	3.3
	HVAC: SF - ROF	ASHP - SEER 18 - replace on fail SF	1,584.0	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ER1	ASHP SEER 19 replace ASHP - early replacement SF ER1	2,968.3	Cooling Res	0.0009474181	2.8122	6.0	$4,471.58	3.3
	HVAC: SF - ER1	ASHP SEER 19 replace ASHP - early replacement SF ER1	6,250.0	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP SEER 19 replace ASHP - early replacement SF ER2	646.8	Cooling Res ER2	0.0009474181	0.6128	12.0		
	HVAC: SF - ER2	ASHP SEER 19 replace ASHP - early replacement SF ER2	1,327.6	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP SEER 19 replace ASHP - replace on fail SF	646.8	Cooling Res	0.0009474181	0.6128	18.0	$2,684.00	3.3
	HVAC: SF - ROF	ASHP SEER 19 replace ASHP - replace on fail SF	1,584.0	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: SF - ER1	ASHP - SEER 17 - replace electric furnace / CAC - early replacement SF ER1	2,852.4	Cooling Res	0.0009474181	2.7024	6.0	$3,824.96	3.1
	HVAC: SF - ER1	ASHP - SEER 17 - replace electric furnace / CAC - early replacement SF ER1	13,965.9	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP - SEER 17 - replace electric furnace / CAC - early replacement SF ER2	585.1	Cooling Res ER2	0.0009474181	0.5543	12.0		
	HVAC: SF - ER2	ASHP - SEER 17 - replace electric furnace / CAC - early replacement SF ER2	13,965.9	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP - SEER 17 - replace electric furnace / CAC - early replacement MF ER1	1,854.0	Cooling Res	0.0009474181	1.7565	6.0	$3,824.96	3.1
	HVAC: MF - ER1	ASHP - SEER 17 - replace electric furnace / CAC - early replacement MF ER1	9,077.8	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP - SEER 17 - replace electric furnace / CAC - early replacement MF ER2	380.3	Cooling Res ER2	0.0009474181	0.3603	12.0		
	HVAC: MF - ER2	ASHP - SEER 17 - replace electric furnace / CAC - early replacement MF ER2	9,077.8	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP SEER 17 replace ASHP - early replacement MF ER1	1,790.9	Cooling Res	0.0009474181	1.6967	6.0	$6,101.99	3.1
	HVAC: MF - ER1	ASHP SEER 17 replace ASHP - early replacement MF ER1	4,062.5	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP SEER 17 replace ASHP - early replacement MF ER2	282.0	Cooling Res ER2	0.0009474181	0.2671	12.0		
	HVAC: MF - ER2	ASHP SEER 17 replace ASHP - early replacement MF ER2	863.0	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ER1	ASHP - SEER 18 - replace electric furnace / CAC - early replacement SF ER1	2,958.0	Cooling Res	0.0009474181	2.8025	6.0	$4,279.63	2.6

RESIDENTIAL HVAC

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units (tons/measure)
	HVAC: SF - ER1	ASHP - SEER 18 - replace electric furnace / CAC - early replacement SF ER1	13,965.9	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP - SEER 18 - replace electric furnace / CAC - early replacement SF ER2	690.7	Cooling Res ER2	0.0009474181	0.6544	12.0		
	HVAC: SF - ER2	ASHP - SEER 18 - replace electric furnace / CAC - early replacement SF ER2	13,965.9	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP - SEER 18 - replace electric furnace / CAC - early replacement MF ER1	1,922.7	Cooling Res	0.0009474181	1.8216	6.0	$4,279.63	2.6
	HVAC: MF - ER1	ASHP - SEER 18 - replace electric furnace / CAC - early replacement MF ER1	9,077.8	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP - SEER 18 - replace electric furnace / CAC - early replacement MF ER2	449.0	Cooling Res ER2	0.0009474181	0.4254	12.0		
	HVAC: MF - ER2	ASHP - SEER 18 - replace electric furnace / CAC - early replacement MF ER2	9,077.8	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP SEER 18 replace ASHP - early replacement MF ER1	1,864.0	Cooling Res	0.0009474181	1.7660	6.0	$6,827.32	2.6
	HVAC: MF - ER1	ASHP SEER 18 replace ASHP - early replacement MF ER1	4,062.5	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP SEER 18 replace ASHP - early replacement MF ER2	355.0	Cooling Res ER2	0.0009474181	0.3364	12.0		
	HVAC: MF - ER2	ASHP SEER 18 replace ASHP - early replacement MF ER2	863.0	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ER1	ASHP - SEER 19 - replace electric furnace / CAC - early replacement SF ER1	3,052.5	Cooling Res	0.0009474181	2.8920	6.0	$4,620.63	3.1
	HVAC: SF - ER1	ASHP - SEER 19 - replace electric furnace / CAC - early replacement SF ER1	13,965.9	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP - SEER 19 - replace electric furnace / CAC - early replacement SF ER2	785.3	Cooling Res ER2	0.0009474181	0.7440	12.0		
	HVAC: SF - ER2	ASHP - SEER 19 - replace electric furnace / CAC - early replacement SF ER2	13,965.9	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP - SEER 19 - replace electric furnace / CAC - early replacement MF ER1	1,984.1	Cooling Res	0.0009474181	1.8798	6.0	$4,620.63	3.1
	HVAC: MF - ER1	ASHP - SEER 19 - replace electric furnace / CAC - early replacement MF ER1	9,077.8	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP - SEER 19 - replace electric furnace / CAC - early replacement MF ER2	510.4	Cooling Res ER2	0.0009474181	0.4836	12.0		
	HVAC: MF - ER2	ASHP - SEER 19 - replace electric furnace / CAC - early replacement MF ER2	9,077.8	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP SEER 19 replace ASHP - early replacement MF ER1	1,929.4	Cooling Res	0.0009474181	1.8280	6.0	$7,371.32	3.1
	HVAC: MF - ER1	ASHP SEER 19 replace ASHP - early replacement MF ER1	4,062.5	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP SEER 19 replace ASHP - early replacement MF ER2	420.5	Cooling Res ER2	0.0009474181	0.3983	12.0		
	HVAC: MF - ER2	ASHP SEER 19 replace ASHP - early replacement MF ER2	863.0	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ER1	ASHP SEER 20 replace ASHP - early replacement SF ER1	3,058.9	Cooling Res	0.0009474181	2.8980	6.0	$13,953.85	3.1
	HVAC: SF - ER1	ASHP SEER 20 replace ASHP - early replacement SF ER1	6,250.0	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP SEER 20 replace ASHP - early replacement SF ER2	737.4	Cooling Res ER2	0.0009474181	0.6986	12.0		
	HVAC: SF - ER2	ASHP SEER 20 replace ASHP - early replacement SF ER2	1,327.6	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP SEER 20 replace ASHP - replace on fail SF	737.4	Cooling Res	0.0009474181	0.6986	18.0	$9,512.00	3.1
	HVAC: SF - ROF	ASHP SEER 20 replace ASHP - replace on fail SF	1,584.0	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ER1	ASHP - SEER 20 - replace electric furnace / CAC - early replacement MF ER1	2,039.4	Cooling Res	0.0009474181	1.9322	6.0	$13,953.85	3.1
	HVAC: MF - ER1	ASHP - SEER 20 - replace electric furnace / CAC - early replacement MF ER1	9,077.8	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP - SEER 20 - replace electric furnace / CAC - early replacement MF ER2	565.7	Cooling Res ER2	0.0009474181	0.5360	12.0		
	HVAC: MF - ER2	ASHP - SEER 20 - replace electric furnace / CAC - early replacement MF ER2	9,077.8	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ER1	ASHP SEER 20 replace ASHP - early replacement MF ER1	1,988.3	Cooling Res	0.0009474181	1.8837	6.0	$14,804.70	3.1
	HVAC: MF - ER1	ASHP SEER 20 replace ASHP - early replacement MF ER1	4,062.5	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP SEER 20 replace ASHP - early replacement MF ER2	479.3	Cooling Res ER2	0.0009474181	0.4541	12.0		
	HVAC: MF - ER2	ASHP SEER 20 replace ASHP - early replacement MF ER2	863.0	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ER1	ASHP SEER 21 replace ASHP - early replacement SF ER1	3,140.8	Cooling Res	0.0009474181	2.9757	6.0	$14,804.70	3.1
	HVAC: SF - ER1	ASHP SEER 21 replace ASHP - early replacement SF ER1	6,250.0	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: SF - ER2	ASHP SEER 21 replace ASHP - early replacement SF ER2	819.3	Cooling Res ER2	0.0009474181	0.7763	12.0		
	HVAC: SF - ER2	ASHP SEER 21 replace ASHP - early replacement SF ER2	1,327.6	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: SF - ROF	ASHP SEER 21 replace ASHP - replace on fail SF	819.3	Cooling Res	0.0009474181	0.7763	18.0	$9,976.00	3.1
	HVAC: SF - ROF	ASHP SEER 21 replace ASHP - replace on fail SF	1,584.0	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 21 - replace electric furnace / CAC MF	556.2	Cooling Res	0.0009474181	0.5269	18.0	$10,092.00	3.1
	HVAC: MF - ROF	ASHP - SEER 21 - replace electric furnace / CAC MF	8,343.7	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ER1	ASHP SEER 21 replace ASHP - early replacement MF ER1	2,041.5	Cooling Res	0.0009474181	1.9342	6.0	$15,995.88	3.1
	HVAC: MF - ER1	ASHP SEER 21 replace ASHP - early replacement MF ER1	4,062.5	Heating Res	0.0000000000	0.0000	6.0		
	HVAC: MF - ER2	ASHP SEER 21 replace ASHP - early replacement MF ER2	532.6	Cooling Res ER2	0.0009474181	0.5046	12.0		
	HVAC: MF - ER2	ASHP SEER 21 replace ASHP - early replacement MF ER2	863.0	Heating Res ER2	0.0000000000	0.0000	12.0		
	HVAC: MF - ROF	ASHP - SEER 17 - replace on fail MF	282.0	Cooling Res	0.0009474181	0.2671	18.0	$1,914.00	3.3
	HVAC: MF - ROF	ASHP - SEER 17 - replace on fail MF	1,029.6	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 18 - replace on fail MF	355.0	Cooling Res	0.0009474181	0.3364	18.0	$2,354.00	3.3
	HVAC: MF - ROF	ASHP - SEER 18 - replace on fail MF	1,029.6	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 19 - replace on fail MF	420.5	Cooling Res	0.0009474181	0.3983	18.0	$2,684.00	3.3
	HVAC: MF - ROF	ASHP - SEER 19 - replace on fail MF	1,029.6	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 20 - replace on fail MF	479.3	Cooling Res	0.0009474181	0.4541	18.0	$3,828.00	3.3
	HVAC: MF - ROF	ASHP - SEER 20 - replace on fail MF	1,029.6	Heating Res	0.0000000000	0.0000	18.0		
	HVAC: MF - ROF	ASHP - SEER 21 - replace on fail MF	532.6	Cooling Res	0.0009474181	0.5046	18.0	$3,828.00	3.3
	HVAC: MF - ROF	ASHP - SEER 21 - replace on fail MF	1,029.6	Heating Res	0.0000000000	0.0000	18.0		

RESIDENTIAL HVAC

AC Tune-up

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	HVAC: SF	AC General Tune-Up (no charge or coil clean)	142.5	Cooling RES	0.0009474181	0.1350	2.0	$70.00	per measure
	HVAC: SF	AC Tune-up / refrigerant charge SF	594.4	Cooling RES	0.0009474181	0.5631	2.0	$81.00	per measure
	HVAC: SF	AC Tune-up / Indoor Coil (Evaporator) Cleaning SF	98.4	Cooling RES	0.0009474181	0.0932	2.0	$63.00	per measure
	HVAC: SF	AC Tune-up / Outdoor Coil (Condenser) Cleaning SF	196.8	Cooling RES	0.0009474181	0.1864	2.0	$31.00	per measure

HP Tune-up / refrigerant charge SF

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	HVAC: SF	General HP Tune-up (no charge or coil clean)	146.1	Cooling RES	0.0009474181	0.1384	2.0	$70.00	per measure
	HVAC: SF	General HP Tune-up (no charge or coil clean)	157.9	Heating RES	0.0000000000	0.0000	2.0		per measure
	HVAC: SF	HP Tune-up / refrigerant charge SF	609.2	Cooling RES	0.0009474181	0.5772	2.0	$81.00	per measure
	HVAC: SF	HP Tune-up / refrigerant charge SF	760.0	Heating RES	0.0000000000	0.0000	2.0		per measure
	HVAC: SF	HP Tune-up / Indoor Coil (Evaporator) Cleaning SF	100.8	Cooling RES	0.0009474181	0.0955	2.0	$63.00	per measure
	HVAC: SF	HP Tune-up / Indoor Coil (Evaporator) Cleaning SF	107.6	Heating RES	0.0000000000	0.0000	2.0		per measure
	HVAC: SF	HP Tune-up / Outdoor Coil (Condenser) Cleaning SF	201.7	Cooling RES	0.0009474181	0.1911	2.0	$31.00	per measure
	HVAC: SF	HP Tune-up / Outdoor Coil (Condenser) Cleaning SF	221.5	Heating RES	0.0000000000	0.0000	2.0		per measure

RESIDENTIAL INCOME ELIGIBLE

AC Tune-up

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	SF	AC General Tune-Up (no charge or coil clean) SF	142.5	Cooling RES	0.0009474181	0.1350	2.0	$70.00	per measure
	MF	AC General Tune-Up (no charge or coil clean) MF	92.6	Cooling RES	0.0009474181	0.0878	2.0	$70.00	per measure
	SF	AC Tune-up / refrigerant charge SF	594.4	Cooling RES	0.0009474181	0.5631	2.0	$81.00	per measure
	MF	AC Tune-up / Refrigerant charge MF	386.4	Cooling RES	0.0009474181	0.3660	2.0	$81.00	per measure
	SF	AC Tune-up / Indoor Coil (Evaporator) Cleaning SF	98.4	Cooling RES	0.0009474181	0.0932	2.0	$63.00	per measure
	MF	AC Tune-up /ndoor Coil (Evaporator) Cleaning MF	63.9	Cooling RES	0.0009474181	0.0606	2.0	$63.00	per measure
	SF	AC Tune-up /Outdoor Coil (Condenser) Cleaning SF	196.8	Cooling RES	0.0009474181	0.1864	2.0	$31.00	per measure
	MF	AC Tune-up /Outdoor Coil (Condenser) Cleaning MF	127.9	Cooling RES	0.0009474181	0.1212	2.0	$31.00	per measure

Air Sealing

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	kW	EUL	Inc. Cost	Units (sq. ft)
	MFLI	Air Sealing (Infiltration reduction) - 30% MF LI DI electric furnace base	295.7	Building Shell RES	0.0004660805	256.9	38.8	0.0181	15.0	$108.19	902
	MFLI	Air Sealing (Infiltration reduction) - 30% MF LI DI heat pump base	226.3	Building Shell RES	0.0004660805	187.5	38.8	0.0181	15.0	$108.19	902
	SFLI	Air Sealing (Infiltration reduction) - 30% SF LI DI electric furnace base	496.5	Building Shell RES	0.0004660805	427.2	69.4	0.0323	15.0	$166.44	1387
	SFLI	Air Sealing (Infiltration reduction) - 30% SF LI DI heat pump base	425.8	Building Shell RES	0.0004660805	356.5	69.4	0.0323	15.0	$166.44	1387
	SFLI	MH Adjusted Air Sealing (Infiltration reduction) - 30% SF LI DI electric furnace base	513.0	Building Shell RES	0.0004660805	446.0	67.0	0.0312	15.0	$129.60	1080

Ceiling Insulation

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	kW	EUL	Inc. Cost	Units - area of ceiling/attic (ft2)
	MFLI	Ceiling Insulation R11-R49 MF LI DI electric furnace base	924.0	Building Shell RES	0.0004660805	836.2	87.78	0.040912	25.0	$1,860.46	876
	MFLI	Ceiling Insulation R11-R49 MF LI DI heat pump base	576.0	Building Shell RES	0.0004660805	479.5	96.46	0.044958	25.0	$1,860.46	876
	MFLI	Ceiling Insulation R11-R49 MF LI DI gas heat electric cool base	124.7	Building Shell RES	0.0004660805	37.0	87.78	0.040912	25.0	$1,860.46	876
	SFLI	Ceiling Insulation R11-R49 SF LI DI electric furnace base	1,421.6	Building Shell RES	0.0004660805	1286.5	135.04	0.062941	25.0	$2,862.25	1347
	SFLI	Ceiling Insulation R11-R49 SF LI DI heat pump base	886.1	Building Shell RES	0.0004660805	737.7	148.40	0.069166	25.0	$2,862.25	1347
	SFLI	Ceiling Insulation R11-R49 SF LI DI gas heat electric cool base	191.9	Building Shell RES	0.0004660805	56.9	135.04	0.062941	25.0	$2,862.25	1347
	MFLI	Ceiling Insulation R5-R30 MF LI DI electric furnace base	1,232.2	Building Shell RES	0.0004660805	1115.1	117.05	0.054555	25.0	$836.16	719
	MFLI	Ceiling Insulation R5-R30 MF LI DI heat pump base	768.1	Building Shell RES	0.0004660805	639.5	128.63	0.059951	25.0	$836.16	719
	MFLI	Ceiling Insulation R5-R30 MF LI DI gas heat electric cool base	166.4	Building Shell RES	0.0004660805	49.3	117.05	0.054555	25.0	$836.16	719
	SFLI	Ceiling Insulation R5-R30 SF LI DI electric furnace base	1,895.6	Building Shell RES	0.0004660805	1715.5	180.08	0.083931	25.0	$1,286.39	1106
	SFLI	Ceiling Insulation R5-R30 SF LI DI heat pump base	1,181.7	Building Shell RES	0.0004660805	983.8	197.89	0.092232	25.0	$1,286.39	1106
	SFLI	Ceiling Insulation R5-R30 SF LI DI gas heat electric cool base	255.9	Building Shell RES	0.0004660805	75.8	180.08	0.083931	25.0	$1,286.39	1106
	MFLI	Ceiling Insulation R5-R38 MF LI DI electric furnace base	1,323.9	Building Shell RES	0.0004660805	1198.1	125.76	0.058615	25.0	$1,208.50	719
	MFLI	Ceiling Insulation R5-R38 MF LI DI heat pump base	825.2	Building Shell RES	0.0004660805	687.0	138.20	0.064412	25.0	$1,208.50	719
	MFLI	Ceiling Insulation R5-R38 MF LI DI gas heat electric cool base	178.7	Building Shell RES	0.0004660805	53.0	125.76	0.058615	25.0	$1,208.50	719
	SFLI	Ceiling Insulation R5-R38 SF LI DI electric furnace base	2,036.7	Building Shell RES	0.0004660805	1843.2	193.48	0.090177	25.0	$1,859.23	1106
	SFLI	Ceiling Insulation R5-R38 SF LI DI heat pump base	1,269.6	Building Shell RES	0.0004660805	1057.0	212.61	0.099096	25.0	$1,859.23	1106
	SFLI	Ceiling Insulation R5-R38 SF LI DI gas heat electric cool base	275.0	Building Shell RES	0.0004660805	81.5	193.48	0.090177	25.0	$1,859.23	1106
	MFLI	Ceiling Insulation R5-R49 MF LI DI electric furnace base	1,405.6	Building Shell RES	0.0004660805	1272.0	133.52	0.062233	25.0	$1,846.68	719
	MFLI	Ceiling Insulation R5-R49 MF LI DI heat pump base	876.2	Building Shell RES	0.0004660805	729.5	146.73	0.068388	25.0	$1,846.68	719
	MFLI	Ceiling Insulation R5-R49 MF LI DI gas heat electric cool base	189.8	Building Shell RES	0.0004660805	56.2	133.52	0.062233	25.0	$1,846.68	719
	SFLI	Ceiling Insulation R5-R49 SF LI DI electric furnace base	2,162.4	Building Shell RES	0.0004660805	1957.0	205.42	0.095743	25.0	$2,841.04	1106
	SFLI	Ceiling Insulation R5-R49 SF LI DI heat pump base	1,348.0	Building Shell RES	0.0004660805	1122.2	225.74	0.105213	25.0	$2,841.04	1106
	SFLI	Ceiling Insulation R5-R49 SF LI DI gas heat electric cool base	291.9	Building Shell RES	0.0004660805	86.5	205.42	0.095743	25.0	$2,841.04	1106
	MFLI	Ceiling Insulation R5-R60 MF LI DI electric furnace base	1,459.6	Building Shell RES	0.0004660805	1321.0	138.66	0.064627	25.0	$2,461.73	719
	MFLI	Ceiling Insulation R5-R60 MF LI DI heat pump base	909.9	Building Shell RES	0.0004660805	757.5	152.37	0.071018	25.0	$2,461.73	719
	MFLI	Ceiling Insulation R5-R60 MF LI DI gas heat electric cool base	197.1	Building Shell RES	0.0004660805	58.4	138.66	0.064627	25.0	$2,461.73	719
	SFLI	Ceiling Insulation R5-R60 SF LI DI electric furnace base	2,245.6	Building Shell RES	0.0004660805	2032.3	213.32	0.099426	25.0	$3,787.28	1106
	SFLI	Ceiling Insulation R5-R60 SF LI DI heat pump base	1,399.8	Building Shell RES	0.0004660805	1165.4	234.42	0.109259	25.0	$3,787.28	1106
	SFLI	Ceiling Insulation R5-R60 SF LI DI gas heat electric cool base	303.2	Building Shell RES	0.0004660805	89.9	213.32	0.099426	25.0	$3,787.28	1106

Floor Insulation

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	kW	EUL	Inc. Cost	Units - area of floor (ft2)
	MFLI	Floor Insulation R25 Mobile Home electric furnace/baseboard and electric cooling	2,641.1	Building Shell RES	0.0004660805	2389.3	251.9	0.1174	25.0	$734.04	1080

Dirty Filter Alarm

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	kW	EUL	Inc. Cost	Units
	MFLI	Dirty Filter Alarm_MFLI	168.5	HVAC RES	0.0004660805	106.6	61.9	0.0289	14.0	$5.00	per measure

Duct Insulation

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	ΔkWhCooling	ΔkWhHeating	Δtherms	kW	EUL	Inc. Cost*	Units
	SFLI	Duct Insulation - Electric Heating	1436.6	HVAC RES	0.0004660805	58.9	1377.7	0.00	0.6696	20.0	$138.70	
	SFLI	Mobile Home Adjusted Duct Insulation - Electric Heating	1267.6	HVAC RES	0.0004660805	52.0	1215.7		0.5908	20.0	$138.70	
	SFLI	Duct Insulation - Gas Heating	114.3	HVAC RES	0.0004660805	58.9	55.4	60.26	0.0533	20.0	$138.70	

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Duct Repair (Duct Sealing and Repair - Methodology 3)

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	ΔkWhCooling	ΔkWhHeating	kW	EUL	Inc. Cost*	Units - DuctLength (ft.)
	SFLI	Duct Repair (Sealing) - Electric Heating	183.233	HVAC RES	0.0004660805	30.2	153.1	0.0141	20.0	$299.34	37
	SFLI	Duct Repair (Sealing) - Electric Heating - MH Adjusted	218.613	HVAC RES	0.0004660805	30.2	188.4	0.0141	20.0	$299.34	37

ECM/ Blower Motor

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	Auto kWh	Continous kWh	kW	EUL	Inc. Cost	Units
	SFLI	ECM Auto Fan EUL Replacement -SF	591.9	HVAC RES	0.0004660805	265.2	4.7	322.0	0.0	0.0022	20	$97.00	per measure
	SFLI	ECM Auto Fan Early Replacement ER 1 (Full Cost) - SF	794.5	HVAC RES	0.0004660805	315.7	156.8	322.0	0.0	0.0731	6	$475.00	per measure
	SFLI	ECM Auto Fan Early Replacement ER2 (Remaining Life) - SF	591.9	HVAC RES ER2	0.0004660805	265.2	4.7	322.0	0.0	0.0022	12		per measure
	SFLI	ECM Continous Fan EUL Replacement - SF	3255.9	HVAC RES	0.0004660805	265.2	4.7	0.0	2986.0	0.0022	20	$97.00	per measure
	SFLI	ECM Continous Fan Early Replacement ER 1 (Full Cost) - SF	3458.5	HVAC RES	0.0004660805	315.7	156.8	0.0	2986.0	0.0731	6	$496.50	per measure
	SFLI	ECM Continous Fan Early Replacement ER2 (Remaining Life) - SF	3255.9	HVAC RES ER2	0.0004660805	265.2	4.7	0.0	2986.0	0.0022	12		per measure
	MFLI	ECM Auto Fan EUL Replacement - MF	591.9	HVAC RES	0.0004660805	265.2	4.7	322.0	0.0	0.0022	20	$97.00	per measure
	MFLI	ECM Auto Fan Early Replacement ER 1 (Full Cost) - MF	794.5	HVAC RES	0.0004660805	315.7	156.8	322.0	0.0	0.0731	6	$496.50	per measure
	MFLI	ECM Auto Fan Early Replacement ER2 (Remaining Life) - MF	591.9	HVAC RES ER2	0.0004660805	265.2	4.7	322.0	0.0	0.0022	12		per measure
	MFLI	ECM Continous Fan EUL Replacement - MF	3255.9	HVAC RES	0.0004660805	265.2	4.7	0.0	2986.0	0.0022	20	$97.00	per measure
	MFLI	ECM Continous Fan Early Replacement ER 1 (Full Cost) - MF	3458.5	HVAC RES	0.0004660805	315.7	156.8	0.0	2986.0	0.0731	6	$496.50	per measure
	MFLI	ECM Continous Fan Early Replacement ER2 (Remaining Life) - MF	3255.9	HVAC RES ER2	0.0004660805	265.2	4.7	0.0	2986.0	0.0022	12		per measure

Heat Pump (HP) Tune-up

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	SF	General HP tune-up (no charge or coil clean)	146.1	Cooling RES	0.0009474181	0.1384	2.0	$70.00	per measure
	SF	General HP tune-up (no charge or coil clean)	157.9	Heating RES	0.0000000000	0.0000	2.0	$0.00	per measure
	MF	General HP tune-up (no charge or coil clean)	94.9	Cooling RES	0.0009474181	0.0899	2.0	$70.00	per measure
	MF	General HP tune-up (no charge or coil clean)	102.6	Heating RES	0.0000000000	0.0000	2.0	$0.00	per measure
	SF	HP tune-up / Refrigerant charge SF	609.2	Cooling RES	0.0009474181	0.5772	2.0	$81.00	per measure
	SF	HP tune-up / Refrigerant charge SF	760.0	Heating RES	0.0000000000	0.0000	2.0	$0.00	per measure
	MF	HP tune-up / Refrigerant charge MF	396.0	Cooling RES	0.0009474181	0.3752	2.0	$81.00	per measure
	MF	HP tune-up / Refrigerant charge MF	494.0	Heating RES	0.0000000000	0.0000	2.0	$0.00	per measure
	SF	HP tune-up / Indoor Coil (Evaporator) Cleaning SF	100.8	Cooling RES	0.0009474181	0.0955	2.0	$63.00	per measure
	SF	HP tune-up / Indoor Coil (Evaporator) Cleaning SF	107.6	Heating RES	0.0000000000	0.0000	2.0	$0.00	per measure
	MF	HP tune-up / Indoor Coil (Evaporator) Cleaning MF	65.5	Cooling RES	0.0009474181	0.0621	2.0	$63.00	per measure
	MF	HP tune-up / Indoor Coil (Evaporator) Cleaning MF	69.9	Heating RES	0.0000000000	0.0000	2.0	$0.00	per measure
	SF	HP tune-up / Outdoor Coil (Condenser) Cleaning SF	201.7	Cooling RES	0.0009474181	0.1911	2.0	$31.00	per measure
	SF	HP tune-up / Outdoor Coil (Condenser) Cleaning SF	221.5	Heating RES	0.0000000000	0.0000	2.0	$0.00	per measure
	MF	HP tune-up / Outdoor Coil (Condenser) Cleaning MF	131.1	Cooling RES	0.0009474181	0.1242	2.0	$31.00	per measure
	MF	HP tune-up / Outdoor Coil (Condenser) Cleaning MF	144.0	Heating RES	0.0000000000	0.0000	2.0	$0.00	per measure

Low Flow Faucet Aerators

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	MFLI	Low Flow Bathroom Faucet Aerator MFLI	38.8	Water heating RES	0.0000887318	0.047	0.0034	10.0	$11.33	per measure
	MFLI DI	Low Flow Bathroom Faucet Aerator MFLI DI	37.9	Water heating RES	0.0000887318	0.047	0.0034	10.0	$11.33	per measure
	SFLI DI	Low Flow Bathroom Faucet Aerator SFLI DI	37.9	Water heating RES	0.0000887318	0.047	0.0034	10.0	$11.33	per measure

Low Flow Showerheads

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	MFLI	Low Flow Showerhead MFLI	205.5	Water heating RES	0.0000887318	0.109	0.0182	10.0	$7.00	per measure
	MFLI DI	Low Flow Showerhead MFLI DI	219.8	Water heating RES	0.0000887318	0.109	0.0195	10.0	$7.00	per measure
	SFLI DI	Low Flow Showerhead SFLI DI	193.6	Water heating RES	0.0000887318	1.856	0.0172	10.0	$7.00	per measure

Pipe Insulation

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	MFLI	Pipe Insulation MFLI	16.47	Water heating RES	0.0000887318	0.0015	12.0000	$7.10	per foot
	MFLI DI	Pipe Insulation MFLI DI	16.47	Water heating RES	0.0000887318	0.0015	12.0000	$7.10	per foot
	SFLI DI	Pipe Insulation SFLI DI	16.47	Water heating RES	0.0000887318	0.0015	12.0000	$7.10	per foot

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Programmable Thermostat

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	MFLI	Setback thermostat - full setback - ASHP heating/cooling MF	102.4	Cooling RES	0.0009474181	0.10	10.0	$70.00	per measure
	MFLI	Setback thermostat - full setback - ASHP heating/cooling MF	339.0	Heating RES	0.0000000000	0.00	10.0	$0.00	per measure
	SFLI	Setback thermostat - full setback - ASHP heating/cooling SF	157.6	Cooling RES	0.0009474181	0.15	10.0	$70.00	per measure
	SFLI	Setback thermostat - full setback - ASHP heating/cooling SF	521.5	Heating RES	0.0000000000	0.00	10.0	$0.00	per measure
	MFLI	Setback thermostat - full setback - elec furnace heating / central AC MF	102.4	Cooling RES	0.0009474181	0.10	10.0	$70.00	per measure
	MFLI	Setback thermostat - full setback - elec furnace heating / central AC MF	576.3	Heating RES	0.0000000000	0.00	10.0	$0.00	per measure
	SFLI	Setback thermostat - full setback - elec furnace heating / central AC SF	157.6	Cooling RES	0.0009474181	0.15	10.0	$70.00	per measure
	SFLI	Setback thermostat - full setback - elec furnace heating / central AC SF	886.6	Heating RES	0.0000000000	0.00	10.0	$0.00	per measure
	MFLI	Setback thermostat - full setback - gas heating / central AC MF	102.4	Cooling RES	0.0009474181	0.10	10.0	$70.00	per measure
	MFLI	Setback thermostat - full setback - gas heating / central AC MF	0.0	Heating RES	0.0000000000	0.00	10.0	$0.00	per measure
	SFLI	Setback thermostat for SF - full setback - gas heating / central AC	157.6	Cooling RES	0.0009474181	0.15	10.0	$70.00	per measure
	SFLI	Setback thermostat for SF - full setback - gas heating / central AC	0.0	Heating RES	0.0000000000	0.00	10.0	$0.00	per measure
	MFLI	Setback thermostat - full setback - Unknown MF	102.4	Cooling RES	0.0009474181	0.10	10.0	$70.00	per measure
	MFLI	Setback thermostat - full setback - Unknown MF	135.8	Heating RES	0.0000000000	0.00	10.0	$0.00	per measure
	SFLI	Setback thermostat for SF - full setback - Unknown	157.6	Cooling RES	0.0009474181	0.15	10.0	$70.00	per measure
	SFLI	Setback thermostat for SF - full setback - Unknown	209.0	Heating RES	0.0000000000	0.00	10.0	$0.00	per measure

Thermostatic Restrictor Shower Valve

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	SFLI DI	Shower Start 1.5 gpm electric water heater SFLI DI	41.7	Water heating RES	0.0000887318	0.109	0.0037	10.0	$50.00	per measure
	MFLI DI	Shower Start 1.5 gpm electric water heater MFLI DI	47.3	Water heating RES	0.0000887318	1.856	0.0042	10.0	$50.00	per measure

Water Heater Wrap

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	SFLI	Water Heater Wrap SFLI	100.5	Water heating RES	0.0000887318	0.0089	12.0	$58.00	per measure

Common Area Faucet Aerators

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	MFLI	Common Area Low Flow Bathroom Faucet Aerator	28.4	Water heating RES	0.0000887318	0.071	0.0025	10.0	$11.33	per measure

Common Area Low Flow Showerheads

Measure Reference No.	Program/Channel	Measure	kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	MFLI DI	Common Area Low Flow Showerhead	213.3	Water heating RES	0.0000887318	0.109	0.0189	10.0	$7.00	per measure

Lighting

** CFL baseline is Post 2020, EISA baseline is pre-2020 **

Measure Reference	Program/Channel	Measure	Gross kWh Annual Savings	End Use - RES	kW Factor - RES	End Use - BUS	kW Factor - BUS	kWh RES	kWh BUS	kW	EUL - RES	EUL - BUS**	Inc. Cost*		Units
													SF	MF	
	Lighting	LED - 10.5W Downlight E26 (EISA baseline) LI DI	23.1	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	23.1	0.0000000	0.0035	19.0	6.0	$6.00	$3.30	per measure
	Lighting	LED - 10W (Halogen baseline) LIDI	20.7	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	20.7	0.0000000	0.0031	19.0	6.0	$6.00	$3.68	per measure
	Lighting	LED - 12W (Halogen baseline) LI DI	27.9	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	27.9	0.0000000	0.0042	19.0	6.0	$6.00	$4.72	per measure
	Lighting	LED - 12W Dimmable Light Bulb (Replacing Specialty Incandescent) LI DI	42.9	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	42.9	0.0000000	0.0064	19.0	6.0	$6.00	$3.53	per measure
	Lighting	LED - 15W (Halogen baseline) LIDI	27.2	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	27.2	0.0000000	0.0041	19.0	6.0	$8.00	$6.27	per measure
	Lighting	LED - 15W Flood Light PAR30 Bulb (Halogen baseline) LI DI	32.7	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	32.7	0.0000000	0.0049	19.0	6.0	$10.00	$4.92	per measure
	Lighting	LED - 18W Flood Light PAR38 Bulb (Halogen baseline) LI DI	52.7	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	52.7	0.0000000	0.0079	19.0	6.0	$15.00	$4.92	per measure
	Lighting	LED - 20W (Halogen baseline) LIDI	36.6	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	36.6	0.0000000	0.0055	19.0	6.0	$8.00	$7.83	per measure
	Lighting	LED - 4W Candelabra (Replacing Specialty Incandescent) LI DI	23.1	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	23.1	0.0000000	0.0034	19.0	6.0	$7.00	$3.27	per measure
	Lighting	LED - 4W Candelabra (CFL baseline) LIDI	2.9	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	2.9	0.0000000	0.0004	19.0	6.0	$7.00	$3.27	per measure
	Lighting	LED - 8W Globe Light G25 Bulb (Replacing Specialty Incandescent) LI DI	23.2	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	23.2	0.0000000	0.0035	19.0	6.0	$7.00	$3.27	per measure
	Lighting	LED - 8W Globe Light G25 Bulb (Replacing CFL) LIDI	3.3	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	3.3	0.0000000	0.0005	19.0	6.0	$7.00	$3.27	per measure
	Lighting	LED - 10W (CFL baseline) LIDI	2.8	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	2.8	0.0000000	0.0004	19.0	6.0	$6.00	$3.68	per measure
	Lighting	LED - 10.5W Downlight E26 (CFL baseline) LIDI	9.0	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	9.0	0.0000000	0.0013	19.0	6.0	$6.00	$3.30	per measure
	Lighting	LED - 12W Dimmable Light Bulb (Replacing CFL) LIDI	5.5	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	5.5	0.0000000	0.0008	19.0	6.0	$6.00	$3.53	per measure
	Lighting	LED - 12W (Replacing CFL) LIDI	5.5	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	5.5	0.0000000	0.0008	19.0	6.0	$6.00	$4.72	per measure
	Lighting	LED - 15W (CFL baseline) LIDI	5.3	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	5.3	0.0000000	0.0008	19.0	6.0	$8.00	$6.27	per measure
	Lighting	LED - 15W Flood Light PAR30 Bulb (CFL baseline) LIDI	3.1	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	3.1	0.0000000	0.0005	19.0	6.0	$10.00	$4.92	per measure
	Lighting	LED - 18W Flood Light PAR30 Bulb (CFL baseline) LIDI	3.2	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	3.2	0.0000000	0.0005	19.0	6.0	$15.00	$4.92	per measure
	Lighting	LED - 20W (CFL baseline) LIDI	6.3	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	6.3	0.0000000	0.0009	19.0	6.0	$8.00	$7.83	per measure

RESIDENTIAL INCOME ELIGIBLE

Advanced Power Strips Tier 1 / Load Sensing

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	TOS/NC/DI - Home Office	Advanced Tier 1 Power Strips / TOS/NC/DI - Home Office	31.0	Miscellaneous RES	0.0001148238	0.0036	10.0	$20.00	per measure
	Kits - Home Office	Advanced Tier 1 Power Strips / Kits - Home Office	24.2	Miscellaneous RES	0.0001148238	0.0028	10.0	$20.00	per measure
	TOS/NC/DI - Home Entertainment	Advanced Tier 1 Power Strips / TOS/NC/DI - Home Entertainment	75.1	Miscellaneous RES	0.0001148238	0.0086	10.0	$20.00	per measure
	Kits - Home Entertainment	Advanced Tier 1 Power Strips / Kits - Home Entertainment	58.6	Miscellaneous RES	0.0001148238	0.0067	10.0	$20.00	per measure
	TOS/NC/DI - Unknown Location	Advanced Tier 1 Power Strips / TOS/NC/DI - Unknown Location	59.2	Miscellaneous RES	0.0001148238	0.0068	10.0	$20.00	per measure
	Kits - Unknown Location	Advanced Tier 1 Power / Kits - Unknown Location	42.1	Miscellaneous RES	0.0001148238	0.0048	10.0	$20.00	per measure
	Average	Advanced Tier 2 Power Strips / Average	162.0	Miscellaneous RES	0.0001148238	0.0186	10.0	$30.00	per measure

Class B and G are the 2 classes of power strip currently in the market, therefore the savings of class B and G were averaged for savings estimate (See efficient products deemed table)

Refrigerator

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Income Eligible	Refrigerator - early replacement ER1 (Full Cost)	564.7	Refrigeration RES	0.0001286107	0.0726	6.0	$753.00	per measure
	Income Eligible	Refrigerator - early replacement ER2 (Remaining Life)	46.7	Refrigeration RES ER2	0.0001286107	0.0060	11.0	$0.00	per measure

RESIDENTIAL HOME ENERGY REPORT

Home Energy Report

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	SF	Home Energy Report	150.0	Building Shell RES	0.0004660805	0.0699	1.0	$0.00	per report

RESIDENTIAL MULTI-FAMILY MARKET RATE

AC Tune-up

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	MF Market Rate	General Tune-Up (no charge or coil clean) / MFMR	92.6	Cooling RES	0.0009474181	0.0878	2.0	$70.00	per measure
	MF Market Rate	AC Tune-up / refrigerant charge / MFMR	386.4	Cooling RES	0.0009474181	0.3660	2.0	$81.00	per measure
	MF Market Rate	Indoor Coil (Evaporator) Cleaning / MFMR	63.9	Cooling RES	0.0009474181	0.0606	2.0	$63.00	per measure
	MF Market Rate	Outdoor Coil (Condenser) Cleaning / MFMR	127.9	Cooling RES	0.0009474181	0.1212	2.0	$31.00	per measure

Ceiling Insulation

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	kW	EUL	Inc. Cost	Units - area of ceiling/attic (ft2)
	MF Market Rate	Ceiling Insulation R11-R49 MFMR electric furnace base	924.0	Building Shell RES	0.0004660805	836.2	87.78	0.0409	25.0	$1,860.46	876
	MF Market Rate	Ceiling Insulation R11-R49 MFMR gas heat and electric cool base	466.2	Building Shell RES	0.0004660805	369.7	96.46	0.0450	25.0	$1,860.46	876
	MF Market Rate	Ceiling Insulation R5-R30 MFMR electric furnace base	1,232.2	Building Shell RES	0.0004660805	1115.1	117.05	0.0546	25.0	$836.16	719
	MF Market Rate	Ceiling Insulation R5-R30 MFMR gas heat and electric cool base	621.6	Building Shell RES	0.0004660805	493.0	128.63	0.0600	25.0	$836.16	719
	MF Market Rate	Ceiling Insulation R5-R38 MFMR electric furnace base	1,323.9	Building Shell RES	0.0004660805	1198.1	125.76	0.0586	25.0	$1,208.50	719
	MF Market Rate	Ceiling Insulation R5-R38 MFMR gas heat and electric cool base	667.9	Building Shell RES	0.0004660805	529.7	138.20	0.0644	25.0	$1,208.50	719
	MF Market Rate	Ceiling Insulation R5-R49 MFMR electric furnace base	1,405.6	Building Shell RES	0.0004660805	1272.0	133.52	0.0622	25.0	$1,846.68	719
	MF Market Rate	Ceiling Insulation R5-R49 MFMR gas heat and electric cool base	709.1	Building Shell RES	0.0004660805	562.4	146.73	0.0684	25.0	$1,846.68	719
	MF Market Rate	Ceiling Insulation R5-R60 MFMR electric furnace base	1,459.6	Building Shell RES	0.0004660805	1321.0	138.66	0.0646	25.0	$2,461.73	719
	MF Market Rate	Ceiling Insulation R5-R60 MFMR gas heat and electric cool base	736.4	Building Shell RES	0.0004660805	584.0	152.37	0.0710	25.0	$2,461.73	719

Dirty Filter Alarm

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	kW	EUL	Inc. Cost	Units
	HVAC	Dirty Filter Alarm_MFMR	79.2	HVAC RES	0.0004660805	50.1	29.1	0.0136	14.0	$5.00	per measure

ECM/ Blower Motor

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	Heating kWh	Cooling kWh	Auto kWh	Continous kWh	kW	EUL*	Inc. Cost	Units
	MF Market Rate	ECM Auto Fan Early Replacement ER1 (Full Cost) - MFMR	513.9	HVAC RES	0.0004660805	252.6	3.8	257.6	0.0	0.0018	6.0	$475.00	per measure
	MF Market Rate	ECM Auto Fan Early Replacement ER2 (Remaining Life) - MFMR	513.9	HVAC RES ER2	0.0004660805	252.6	3.8	257.6	0.0	0.0018	12.0		per measure

*EUL rounded down from 20 to 18 total years to make values divisable by 3

Lighting

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use - RES	kW Factor - RES	End Use - BUS	kW Factor - BUS	kWh RES	kWh BUS	kW	EUL - RES	EUL - BUS**	Inc. Cost*	Units
	Lighting	LED - 10W (CFL baseline)	4.1	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	4.1	0.0	0.0006	19.0	6.0	$2.03	per measure
	Lighting	LED - 10W (Halogen baseline)	22.0	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	22.0	0.0	0.0033	19.0	6.0	$2.03	per measure
	Lighting	LED - 12W Dimmable Light Bulb (Replacing CFL)	5.5	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	5.5	0.0	0.0008	19.0	6.0	$4.14	per measure
	Lighting	LED - 12W Dimmable Light Bulb (Replacing Specialty Incandescent)	42.9	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	42.9	0.0	0.0064	19.0	6.0	$4.14	per measure
	Lighting	LED - 12W (Halogen baseline)	27.9	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	27.9	0.0	0.0042	19.0	6.0	$4.72	per measure
	Lighting	LED - 12W (Replacing CFL)	5.5	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	5.5	0.0	0.0008	19.0	6.0	$4.72	per measure
	Lighting	LED - 15W (Halogen baseline)	27.2	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	27.2	0.0	0.0041	19.0	6.0	$6.27	per measure
	Lighting	LED - 15W (CFL baseline)	5.3	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	5.3	0.0	0.0008	19.0	6.0	$6.27	per measure
	Lighting	LED - 20W (Halogen baseline)	36.6	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	36.6	0.0	0.0055	19.0	6.0	$7.83	per measure
	Lighting	LED - 20W (CFL baseline)	6.3	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	6.3	0.0	0.0009	19.0	6.0	$7.83	per measure
	Lighting	LED - 15W Flood Light PAR30 Bulb (Halogen baseline)	32.7	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	32.7	0.0	0.0049	19.0	6.0	$3.05	per measure
	Lighting	LED - 15W Flood Light PAR30 Bulb (CFL baseline)	3.1	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	3.1	0.0	0.0005	19.0	6.0	$3.05	per measure
	Lighting	LED Nightlights	22.0	Lighting RES	0.0001492529	Lighting BUS	0.0001899635	22.0	0.0	0.0033	19.0	6.0	$0.35	per measure

Faucet Aerators (Kitchen)

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	MF Market Rate	Faucet Aerators (Kitchen) MFMR	115.9	Water Heating RES	0.0000887318	0.079	0.0103	10.0	$8.00	per measure

RESIDENTIAL MULTI-FAMILY MARKET RATE

Faucet Aerators (Bathroom)

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	MF Market Rate	Faucet Aerators (Bathroom) MFMR	33.5	Water Heating RES	0.0000887318	0.062	0.0030	10.0	$8.00	per measure

Low Flow Showerhead

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	EPG_electric	kW	EUL	Inc. Cost	Units
	MF Market Rate	Low Flow Showerhead MFMR	204.7	Water Heating RES	0.0000887318	0.109	0.0182	10.0	$7.00	per measure

Advanced Power Strips Tier 1 / Load Sensing

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	TOS/NC/DI - Home Office	Advanced Tier 1 Power Strips / TOS/NC/DI - Home Office	31.0	Miscellaneous RES	0.0001148238	0.0036	10.0	$20.00	per measure
	Kits - Home Office	Advanced Tier 1 Power Strips / Kits - Home Office	24.2	Miscellaneous RES	0.0001148238	0.0028	10.0	$20.00	per measure
	TOS/NC/DI - Home Entertainment	Advanced Tier 1 Power Strips / TOS/NC/DI - Home Entertainment	75.1	Miscellaneous RES	0.0001148238	0.0086	10.0	$20.00	per measure
	Kits - Home Entertainment	Advanced Tier 1 Power Strips / Kits - Home Entertainment	58.6	Miscellaneous RES	0.0001148238	0.0067	10.0	$20.00	per measure
	TOS/NC/DI - Unknown Location	Advanced Tier 1 Power Strips / TOS/NC/DI - Unknown Location	59.2	Miscellaneous RES	0.0001148238	0.0068	10.0	$20.00	per measure
	Kits - Unknown Location	Advanced Tier 1 Power / Kits - Unknown Location	42.1	Miscellaneous RES	0.0001148238	0.0048	10.0	$20.00	per measure

Advanced Power Strips Tier 2 / Advanced Control Stategies

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Efficient Products	Advanced Tier 2 Power Strips - A	237.6	Miscellaneous RES	0.0001148238	0.0273	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - B	216.0	Miscellaneous RES	0.0001148238	0.0248	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - C	194.4	Miscellaneous RES	0.0001148238	0.0223	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - D	172.8	Miscellaneous RES	0.0001148238	0.0198	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - E	151.2	Miscellaneous RES	0.0001148238	0.0174	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - F	129.6	Miscellaneous RES	0.0001148238	0.0149	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - G	108.0	Miscellaneous RES	0.0001148238	0.0124	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - H	86.4	Miscellaneous RES	0.0001148238	0.0099	10.0	$30.00	per measure
	Efficient Products	Advanced Tier 2 Power Strips - Average	162.0	Miscellaneous RES	0.0001148238	0.0186	10.0	$30.00	per measure

High Efficienty Pool Pump

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kWh_{ss}/Day	kWh_{hs}/Day	kWh_{ls}/Day	kW	EUL	Inc. Cost	Units
	MF Market Rate	Variable Speed Pool Pump	2052.8	Pool Spa RES	0.0002354459	20.9760	1.58	2.52	0.4833	10.0	$549.00	per measure

Refrigerator

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kWh_{Base}	kWh_{new}	kW	EUL	Inc. Cost	Units
	MF Market Rate	Refrigerator - early replacement ER1 (full cost) - MFMR	564.7	Refrigeration RES	0.0001286107	985.16	467.22	0.0726	17.0	$753.00	per measure
	MF Market Rate	Refrigerator - early replacement ER2 (remaining life) - MFMR	46.7	Refrigeration RES ER2	0.0001286107	N/A	467.22	0.0060	17.0	$0.00	per measure

RESIDENTIAL APPLIANCE RECYCLING

Refrigerator Recycling

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Appliance Recycling	Refrigerator recycling (pre-1990)	1027.5	Refrigeration RES	0.0001286107	0.132	8.0	$140.00	per measure
	Appliance Recycling	Refrigerator recycling (post-1990	520.0	Refrigeration RES	0.0001286107	0.067	8.0	$141.00	per measure

Freezer

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Appliance Recycling	Freezer recycling	891.2	Freezer RES	0.0001685722	0.150	8.0	$140.00	per measure

Room AC

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Appliance Recycling	Room AC recycling - Primary	302.5	Cooling RES	0.0009474181	0.2866	4.0	$64.89	per measure
	Appliance Recycling	Room AC recycling - Secondary	195.6	Cooling RES	0.0009474181	0.1853	4.0	$64.89	per measure

Dehumidifier Recycling

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW	EUL	Inc. Cost	Units
	Appliance Recycling	Dehumidifier Recycling	139	HVAC RES	0.0004660805	0.0648	5.0	$42.76	per measure

*EUL assumed to be 33% higher than Room AC EUL, based on TRM values for full equipment life (12 for dehumidifier and 9 for Room AC)

**Cost assumed based on full cost of Dehumidifier equipment ($230) and ratio of refridgerator recycling cost ($140) to full refridgerator cost ($742 + $11) . Full cost of Dehumidifier is based on an internet search.

RESIDENTIAL DEMAND RESPONSE

Demand Response

Measure Reference No.	Program/Channel	Measure	Gross kWh Annual Savings	End Use	kW Factor	kW (Annual)*	EUL	Inc. Cost	Units
	DR	Demand Response Advanced Thermostat	177.0	HVAC RES	-	-	11.0	$0.00	per thermostat

* Demand savings are calculated for demand response events, therefore no demand savings are calculated based on the energy savings for this measure.

Technical Resource Manual
Volume 1: Overview and User Guide

Ameren Missouri TRM – Volume 1: Overview and User Guide Revision Log

Revision	Date	Description
1.0	05/30/2018	Initial version filed for Commission approval.

Table of Contents

1.1 Ameren Missouri-TRM Development

1.1.1 Building upon the foundation of the Missouri Statewide TRM

In 2017, the Missouri Department of Economic Development - Division of Energy ("DE") led the development of a statewide Technical Reference Manual, funded by a US Department of Energy ("DOE") grant, facilitated through contract with Vermont Energy Investment Corporation ("VEIC"), and supported by 14 formal, cost-share partners, including Ameren Missouri, Kansas City Power & Light Company, Spire, Inc., Empire District Electric Company, Summit Natural Gas of Missouri, Inc., Missouri American Water Company, Missouri Public Utilities Alliance, Missouri Energy Initiative, Renew Missouri, Sierra Club, Natural Resources Defense Council, Department of Natural Resources, Office of Public Counsel, and Public Service Commission Staff. Although consensus could not be reached on all issues, the active support of these 14 partners led to significant agreement on many aspects of a statewide Technical Reference Manual, which has provided value for the Company's MEEIA 2019-2024 filing. The statewide Technical Reference Manual was developed for use by investor-owned utilities and as an available resource for other independent utilities, program administrators, and evaluators. Due to the regulatory and legal roles of the Public Service Commission and the Office of Public Counsel, those two partners actively monitored the development of - but did not take a position on - the actual content of the statewide Technical Reference Manual. Ameren Missouri has chosen to use the statewide Technical Reference Manual as the foundation for this Technical Resource Manual ("TRM").[1] To create a transparent and clear path from Ameren Missouri-TRM-2019-21 to the actual savings calculations for prescriptive measures, Ameren Missouri created Excel-based workbooks that detail the algorithms and associated input values with formulas intact. This will be beneficial to provide direct insight into the assumptions used and updates to those input assumptions based on future evaluation results.

1.2 Ameren Missouri-TRM Organizational Structure

1.2.1 Overall Organization

For ease of use and update, the Ameren Missouri-TRM is published in three volumes:

Volume 1: Overview and User Guide (this Volume)

Volume 2: Commercial and Industrial Measures

Volume 3: Residential Measures

Information within Volumes 2 and 3 of the Ameren Missouri-TRM is organized in a way to help facilitate its access and use. The structure within these technical documents follows a two-level format, each of which becomes a major heading in the Table of Contents. These levels are designed to define and clarify what the measure is and where it is applied.

Level 1: Measure Category

- This level of organization represents most of the major categories for which an efficient alternative exists. The following table gives examples of the categories to be found in the Ameren Missouri-TRM.

[1] References generally to the TRM Ameren Missouri is submitting with its MEEIA 2019-21 filing will be designated as the "Ameren Missouri-TRM." References to the measure TRM portion addressing measure descriptions will be referred to as the "Ameren Missouri-TRM-2019-21."

Categories in the Ameren Missouri-TRM

Commercial and Industrial Market Sector	Residential Market Sector
Agricultural	Appliances
Appliances	Consumer Electronics
Compressed Air	Hot Water
Consumer Electronics	HVAC
Food Service	Lighting
Hot Water	Miscellaneous
HVAC	Motors
Lighting	Shell
Miscellaneous	
Motors	
Refrigeration	
Shell	

Level 2: Measure and Technology

Within a particular market, end-use, and measure (e.g., LED Lighting), the Ameren Missouri-TRM is not further divided by implementation or delivery methodology. For example, the characterization of an LED installed through any residential pathway – upstream lighting, direct install, efficiency kits, hard-to-reach populations, etc. – is provided in one residential measure document, with lookup tables for the appropriate distinctions in program delivery.

Intended to help answer the question, “What technology defines the measure?”, this organizational approach seeks to capture the common information about a measure regardless of implementation or delivery mechanism. Within the measure, the organization provides those additional assumptions relevant to the program options. In addition, characterizations are also designed to be agnostic on which fuel the measure is designed to save – electricity or natural gas. By organizing the Ameren Missouri-TRM this way, measures that save on both fuels are captured in one place and defined with formulas and variables that allow visibility into the various fuel savings values. The intended end result is to create a categorization process for the Ameren Missouri-TRM that is easier to use and to maintain.

Further, information presented for each measure is standardized and may reflect either default/deemed or customer-specific values. Many of the measures may require the user to select the appropriate input value from a list of inputs for a given parameter in the savings algorithm. Where the Ameren Missouri-TRM asks the user to select the input, look-up tables of allowable values are provided. For example, a set of input parameters may depend on building type, and although a range of values may be given for each parameter, only one value is appropriate for any specific building type. If no table of alternative inputs is provided for a particular parameter, then the single deemed value will be used, unless the measure has a custom allowable input. Section 2.3 below provides further information on measure characterization content.

1.2.2 Measure Code Specification

Developing measure codes helps to uniquely identify each measure in the Ameren Missouri-TRM. Codes are designed to reflect the organization of the Ameren Missouri-TRM and the needs of the Ameren Missouri-TRM users. As Ameren Missouri works with its implementation contractors to complete final design of its MEEIA 2019-21 programs, it will create Measure Code Specifications to uniquely identify individual measures within the Ameren Missouri-TRM. It is important to define Measure Code Specifications for the implementation teams in a manner that both fits the implementation needs and allows appropriate characterization within the data tracking system.

1.2.3 Components of Ameren Missouri-TRM 2019-21 Measure Characterizations

Each measure characterization uses a standardized format that includes at least the following components:[2]

DESCRIPTION

Brief description of measure stating how it saves energy, the markets it serves, and any limitations to its applicability.

DEFINITION OF EFFICIENT EQUIPMENT

Clear definition of the criteria for the efficient equipment used to determine delta savings, including any standards or ratings (if appropriate).

DEFINITION OF BASELINE EQUIPMENT

Clear definition of the efficiency level of the baseline equipment used to determine delta savings, including any standards or ratings (if appropriate). If there is more than one definition of baseline equipment required for an individual measure – such as a measure that can be offered through “time of sale” or “early replacement” – the measure will clearly identify this and state the criteria to be used to determine the delta savings in each case.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected duration in years (or hours) of the savings. For an early replacement measure, the assumed life of the existing unit is also provided.

DEEMED MEASURE COST

For time-of-sale measures, incremental cost from baseline to efficient is provided. Installation costs should only be included if there is a difference between each efficiency level. For early replacement, the full equipment and installation cost of the efficient installation is provided in addition to the full deferred hypothetical baseline replacement cost.

LOADSHAPE

The appropriate loadshape to apply to electric savings is provided. The Ameren Missouri-TRM 2019-21 does not define loadshapes for gas-saving measures.

COINCIDENCE FACTOR

Coincidence factors represent the fraction of connected load expected to be coincident with a particular system peak period, on a diversified basis, and is based on the ratio of the system coincident peak to annual energy by end use. Coincidence factors are provided for summer peak periods. These are also referred to as "kW factors" in the deemed savings tables.

CALCULATION OF ENERGY SAVINGS

Algorithms are provided, followed by list of assumptions with their definitions.

If there are no input variables, there will be a finite number of output values. These will be identified and listed in a table. Algorithms may be included in any or all of the following:

[2] Measures that have a higher level of complexity may have additional components, but also follow the same format, flow, and function.

- **Electric Energy Savings**

  Electric energy savings characterizations are different depending on the measure.

- **Summer Coincident Peak Demand Savings**

  Summer Coincident Peak Demand characterizations are different depending on the end-use category.

- **Natural Gas Savings**

  Natural gas energy savings characterizations are different depending on the measure.

- **Water Impact Descriptions and Calculation**

  Water Impact characterizations are different depending on the measure.

DEEMED O&M COST ADJUSTMENT CALCULATION

Only required if the operation and maintenance ("O&M") cost for the efficient case is different than the baseline.

MEASURE CODE

Measure Code Specifications will be designed with implementation teams in a manner that both fits the implementation needs and allows appropriate characterization within the data tracking system.

1.2.4 Program Delivery

The measure characterizations in the Ameren Missouri-TRM are not grouped by program delivery type. As a result, the measure characterizations provided include information and assumptions to support savings calculations for the range of program delivery options commonly used for the measure. The organizational significance of this approach is that multiple baselines, incremental costs, O&M costs, measure lives, and in-service rates are included in the characterizations for measures that are delivered under two or more different program designs. Values appropriate for each given program delivery type are clearly specified in the algorithms or in look-up tables within the characterization.

Care has been taken to clearly define in the measure’s description the types of program delivery that the measure characterization is designed to support. However, there are no universally accepted definitions for a particular program type, and the description of the program type(s) may differ by measure. Nevertheless, program delivery types can be generally defined according to the following table. These are the abbreviations and definitions used in the measure descriptions in Ameren Missouri-TRM Volumes 2 and 3. When necessary, individual measure descriptions may further refine and clarify these definitions of program delivery type.

1.2.4.1 Program Delivery Types

Program	Attributes
TOS Time of Sale	**Definition:** A program in which the customer is given an incentive to purchase or install higher-efficiency equipment than if the program had not existed. This may include retail rebate (coupon) programs, upstream buy-down programs, online store programs, or contractor-based programs as examples. **Baseline** = Federal standard, code or other (explained) baseline equipment **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** LED lamp rebate
NC New Construction	**Definition:** A program that intervenes during building design to support the use of more efficient equipment and construction practices. **Baseline** = Building code, Federal standard or baseline study **Efficient Case** = The program's level of building specification **Example:** Building shell and mechanical measures
RF Retrofit	**Definition:** A program that upgrades existing equipment before the end of its useful life **Baseline** = Existing equipment or the existing condition of the building or equipment. A single baseline applies over the measure's life. **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** Air sealing and insulation
EREP Early Replacement	**Definition:** A program that replaces existing equipment before the end of its expected life. **Baseline** = Dual; it begins as the existing equipment and shifts to new baseline equipment after the expected life of the existing equipment is over **Efficient Case** = New premium efficiency equipment above federal and state codes and standard industry practice **Example:** Refrigerators, freezers
ERET Early Retirement	**Definition:** A program that retires duplicative equipment before its expected life is over. **Baseline** = The existing equipment, which is retired and not replaced **Efficient Case** = Zero because the unit is retired **Example:** Appliance recycling
DI Direct Install	**Definition:** A program where measures are installed during a site visit. **Baseline** = Existing equipment **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** Lighting and low-flow hot water measures
KITS Efficiency Kits	**Definition:** A program where measures are provided free of charge to a customer in an Efficiency Kit. **Baseline** = Existing equipment **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** Lighting and low-flow hot water measures
DR Demand Response	**Definition:** A program where customers are given an incentive to take actions in order to reduce load during specific event times. **Baseline** = Base load absent of the program. **Efficient Case** = Observed load during program event **Example:** Residential air-conditioner cycling

1.3 General Assumptions

Sources cited within the Ameren Missouri-TRM have been chosen based on two priorities: geography and age. Whenever possible, it has incorporated Missouri-specific information into each measure characterization.

When Ameren Missouri or region-specific evaluations or data were not available, best-practice research and data from other jurisdictions was used. In every case, the most recent, well-designed, and best-supported studies have been used to support the Ameren Missouri-TRM, and only if appropriate have conclusions been generalized for practical application to the Missouri programs.

General Savings Assumptions

The Ameren Missouri-TRM savings estimates are expected to serve as average, representative values, or ways to calculate savings based on program-specific information. All information is presented on a per-measure basis. In using the measure-specific information in the Ameren Missouri-TRM, it is helpful to keep the following notes in mind.

- All estimates of energy (kWh or therms) and peak (kW) savings are for first-year savings, not lifetime savings.
- Unless otherwise noted, measure life is defined to be the life of an energy consuming measure, including its equipment life and measure persistence.
- Where deemed values for savings are provided, they represent the average energy (kWh or therms) or peak (kW) savings that could be expected from the average of all measures that might be installed in Missouri in the program year.
- In general, the baselines included in the Ameren Missouri-TRM are intended to represent average conditions in Missouri. Some are based on data from the state, such as household consumption characteristics provided by the Energy Information Administration. Some are extrapolated from other areas, when Missouri data are not available.

1.3.1 Algorithms and Variables

Many of the measures in the Ameren Missouri-TRM require the user to select the appropriate input value from a list of inputs for a given parameter in the savings algorithm. Where the Ameren Missouri-TRM asks the user to select the input, look-up tables of allowable values are provided. For example, a set of input parameters may depend on building type, and while a range of values may be given for each parameter, only one value is appropriate for any specific building type. If no table of alternative inputs is provided for a particular parameter, then the single deemed value will be used, unless the measure has a custom allowable input.

1.3.1.1 Custom Value Use in Measure Implementation

This section defines the requirements for capturing custom variables that can be used in place of defaults for select assumptions within the prescriptive measures defined in the Ameren Missouri-TRM. This approach is to be used when a variable in a measure formula can be replaced by a verifiable and documented value that is not presented in the Ameren Missouri-TRM. This approach assumes that the algorithms presented in the measure are used as stated, and only allows changes to certain variable values. This approach is not a replacement algorithm for the measure. A custom variable is when customer input is provided to define the number or the value is measured at the site. Custom values can also be supplied from product data of the measure installed and historical verifiable program data. In certain cases, the custom data can be provided from a documented study or report that is applicable to the measure. Custom variables and potential sources are clearly defined in the specific measures where “Actual” or “Custom” is noted in the Ameren Missouri-TRM.

1.3.2 Net-to-Gross

In using the measure-specific information in the Ameren Missouri-TRM, it is important to note that savings outputs do not include net-to-gross (NTG) calculations.

1.3.3 Baseline Assumptions

The concept and definition of the baseline is a key element of every measure characterization and is directly related to the program delivery type. Without a clear definition of the baseline, the savings algorithms cannot be adequately specified and subsequent evaluation efforts would be hampered. As a result, each measure has a detailed description (and in many cases, specification) of the specific baseline that should be used to calculate savings. Baselines in the Ameren Missouri-TRM fall into one of the following categories, and are organized within each measure characterization by the program delivery type to which it applies:

1. Building Code: As defined by the minimum specifications required under applicable local codes or applicable federal standards.
2. Existing Equipment: As determined by the most representative (or average) example of equipment that is in the existing stock. Existing equipment baselines apply over the equipment’s remaining useful life. In addition, existing equipment applies when there is a shift in technology used, as is the case when an efficient ASHP replaces CAC/Electric Furnace technology.
3. New Equipment: As determined by the equipment that represents standard practice in the current market environment or that has been specified for individual measure use. New equipment baselines apply over the effective useful life of the measure.

1.3.3.1 Shifting Baseline Assumptions

The Ameren Missouri-TRM anticipates the effects of changes in efficiency codes and standards on certain measures. When these changes occur, a shift in the baseline is usually required. This complicates the measure savings estimation somewhat, and will be handled in future versions of the TRM by describing the choice of and reasoning behind a baseline change. In this initial version, a shifting baseline assumption may apply to early replacement measures as well as several lighting measures.

1.3.4 Summer Peak Period Definition (kW)

Summer peak coincidence factors ("CF") can be found within each measure characterization.

1.3.5 Use of O&M Costs

Some measures specify an O&M parameter that describes the incremental O&M cost savings expected over the measure's lifetime. When estimating the cost effectiveness of these measures, it is necessary to calculate the net present value ("NPV") of O&M costs over the life of the measure, which requires an appropriate discount rate. The utility's weighted average cost of capital ("WACC") is the most commonly used discount rate used in this context.

The WACC will vary over time. As a result, the Ameren Missouri-TRM does not specify the NPV of the O&M costs. Instead, the necessary cost and timeline information required to calculate the NPV is included. An example is provided below to demonstrate how to calculate the NPV of O&M costs.

EXAMPLE

Baseline Case: O&M costs equal $150 every two years.

Efficient Case: O&M costs equal $50 every five years.

Given this information, the incremental O&M costs can be determined by discounting these cash flows in the Baseline Case and the Efficient Case separately using the applicable WACC. Then the NPV of the incremental O&M costs is calculated by subtracting one NPV from the other. This value is used in each utility's cost-effectiveness screening process.

The effect of O&M costs for those measures that include baseline shifts resulting in multiple component costs and lifetimes cannot be calculated by this standard method. In only these cases, the O&M costs are presented as annual levelized equivalent cost (i.e., the annual payment that results in an equivalent NPV to the actual stream of O&M costs) and utilities should apply their own real discount rate to determine NPVs.

1.4 Glossary

Baseline Efficiency: The assumed standard efficiency of equipment, absent an efficiency program.

Building Types: Sixteen commercial and industrial ("C&I") building prototypes were modeled using DOE/EnergyPlus for the Ameren Missouri-TRM. The building types are based on the DOE Commercial Reference Buildings developed by DOE, National Renewable Energy Laboratory ("NREL"), Pacific Northwest National Laboratory (PNNL), and Lawrence Berkeley National Laboratory ("LBNL"). Detailed descriptions and variable calculations for each building prototype can be found on the Missouri Division of Energy TRM's website. Note: for C&I modeling efforts, Typical Meteorological Year ("TMY3") weather data is used as it is a designed input of energy modeling.

The following list provides a high-level definition for each C&I building type offered in the Ameren Missouri-TRM and follows DOE reference building documentation. For additional information about the prototype models and the associated inputs, please refer to https://energy.gov/eere/buildings/commercial-reference-buildings.

Building Type Name	Floor Area (ft2)	Number of Floors	CBECS #	Weighting
Large Office	498,588	12	1,251	0.5%
Medium Office	53,628	3	12,394	5.3%
Small Office	5,500	1	62,691	26.9%
Warehouse	52,045	1	70,785	30.4%
Stand-alone Retail	24,962	1	27,814	11.9%
Strip Mall	22,500	1	2,538	1.1%
Primary School	73,960	1	8,820	3.8%
Secondary School	210,887	2	7,070	3.0%
Supermarket	45,000	1	3,110	1.3%
Quick Service Restaurant	2,500	1	5,385	2.3%
Full Service Restaurant	5,500	1	12,080	5.2%
Hospital	241,351	5	747	0.3%
Outpatient Health Care	40,946	3	9,892	4.2%
Small Hotel	43,200	4	8,051	3.5%
Large Hotel	122,120	6	404	0.2%
Midrise Apartment*	33,740	4		0.0%

Note: To help determine the appropriate building type to use as a reference to a specific project, the user should take into consideration the predominant use type, size of the building/project, and the HVAC systems that serve the project. Where a project is defined by multiple uses or systems, it may be appropriate to utilize floor-area weighted averages of model outputs (e.g., EFLH) based on the distribution of those use types in the project under consideration. For example, if the user is defining EFLHs for a system or measure that impacts both retail and office spaces within a 75,000 square ft., 5-story building, then they may consider an area-weighted average EFLH from Medium Office and Stand Alone Retail.

Coincidence Factor: CFs represent the fraction of connected load expected to be coincident with a particular system peak period on a diversified basis, and is based on the ratio of the system coincident peak to annual energy by end use. CFs are provided for summer peak periods. These are also referred to as "kW factors" in the deemed savings tables.

Commercial & Industrial: The market sector that includes measures that apply to any of the building types defined in the Ameren Missouri-TRM, which includes multifamily common areas and public housing.[3]

Connected Load: The maximum wattage of the equipment under normal operating conditions.

Deemed Value: A value that has been assumed to be representative of the average condition of an input parameter.

Default Value: When a measure indicates that an input to a prescriptive saving algorithm may take on a range of values, an average value is also provided in many cases. This value is considered the default input to the algorithm, and should be used when the other alternatives listed in the measure are not applicable.

Demand Response: Measures that decrease peak demand or shift demand to off-peak periods.

End-use Category: A general term used to describe the categories of equipment that provide a service to an individual or building. See Section 2, Level 1: End-use Category Table for a list of the end use categories that are incorporated in the Ameren Missouri-TRM.

Energy Efficiency: Measures that reduce the amount of electricity or natural gas required to achieve a given end use. "Energy Efficiency" also includes measures that reduce the total BTUs of electricity and natural gas needed to meet the end use or uses

Equivalent Full Load Hours ("EFLH"): The equivalent hours that equipment would need to operate at its peak capacity in order to consume its estimated annual kWh consumption (annual kWh/connected kW).

Evaluation: (Synonym, EM&V.) In the energy efficiency arena, impact evaluation is an investigation process to determine energy or demand impacts achieved through the program activities, including but not limited to savings verification, measure research, and program research.

High Efficiency: General term for technologies and processes that require less energy, water, or other inputs to operate.

Incremental Costs: A calculated difference in equipment or technology cost between a base equipment model and the more efficient model. Incremental costs can be as little as $0, indicating that there is no expected cost difference between baseline and efficient technologies. Cost of labor or other installation related costs is not considered in incremental costs.

Lifetime: The number of years (or hours) that the new high efficiency equipment is expected to function. These are generally based on engineering lives, but sometimes are adjusted based on expectations about frequency of removal, remodeling, or demolition. Two important distinctions fall under this definition: Effective Useful Life ("EUL") and Remaining Useful Life ("RUL").

> **EUL** –Based on the manufacturer's rating of the effective useful life; how long the equipment will last. It is an estimate of the median number of years that the measures installed under a program are still in place and operable.
>
> **RUL** – Applies to retrofit or replacement measures. For example, if an existing working refrigerator is replaced with a high efficiency unit, the RUL is an assumption of how many more years the existing unit would have lasted. As a general rule, the RUL is usually assumed to be 1/3 of the EUL.

Load Factor ("LF"): The fraction of full load (wattage) for which the equipment is typically run.

Measure Cost: The incremental (for time of sale measures) or full cost (both capital and labor for retrofit

[3] Measures that apply to the multi-family and public housing building types describe how to handle tenant versus master metered buildings.

measures) of implementing the High Efficiency equipment.

Measure Description: A detailed description of the technology and the criteria it must meet to be eligible as an energy efficient measure.

Measure: An efficient technology or procedure that results in energy savings as compared to the baseline efficiency. There are three main measure types:

1) **Prescriptive Measures** - Measures or technologies offered through a standard (in contrast to custom) program for which partially or fully deemed input values are applicable:
    i. **Fully deemed measures -** Measures whose energy savings are expressed on a per unit basis in the Ameren Missouri-TRM and are not subject to change or choice by the Program Administrator.
    ii. **Partially deemed measures -** Measures whose energy savings algorithms are deemed in the Ameren Missouri-TRM, with input values that may be selected to some degree by the Program Administrator, typically based on a customer-specific input.
2) **Custom Measures –**Measures or technologies that, due to the complexity in the design and configuration of the particular measure in the energy efficiency project, may be subject to a more comprehensive custom engineering algorithm and financial analysis that more accurately characterize the energy efficiency savings within a project.
3) **Comparison group EM&V measures** – Measures that determine program savings based on the differences in electricity consumption patterns between a comparison group of the program participants, not a deemed savings value. Comparison group approaches include randomized control trials ("RCTs") and quasi-experimental methods using nonparticipants, and may involve simple differences or regression methods. Because the effects of implemented measures are reflected in the observed participant-comparison differences, separate verification is not required. These methods are generally used for planning purposes to estimate program-level savings, not facility- or project-level savings, and are therefore considered an evaluation method. <u>Note:</u> *The reference to and inclusion of Residential Peer Comparison Behavior Programs in the Ameren Missouri-TRM is an example of where comparison group EM&V values should be used to support program considerations, rather than deemed, alongside robust reference documentation for the sources of those values and the appropriate use of SEE Action[4] and UMP guidelines[5] as required for program evaluation/savings calculation*.

Measure research: An evaluation process focused on providing better/more granular data to facilitate updating measure-specific Ameren Missouri-TRM input values or algorithms.

Residential: The market sector that includes measures that apply only to detached residential buildings, duplexes, and applicable multi-family units.

Operation and Maintenance Cost Adjustments: The dollar impact resulting from differences between baseline and efficient case O&M costs.

Operating Hours ("HOURS"): The annual hours that equipment is expected to operate.

Program: The mode of delivering a particular measure or set of measures to customers. See Section 2.4.1 for a list of program descriptions that are presently operating in Missouri.

Program Research: An evaluation process that takes an alternative look into achieved program level

4 Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations; SEE Action (State and Local Energy Efficiency Action Network- EPA/DOE), 2012.

5 The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Residential Behavior Protocol, NREL/DOE, 2015.

savings across multiple measures. This may or may not be specific enough to inform future updates to the Ameren Missouri-TRM. Ex. Program billing analysis.

Savings Verification: An evaluation process that independently verifies program savings achieved through prescriptive measures.

Table 1 – Residential End-Use Category Monthly Shapes and Coincident Peak Factors

End-Use Energy Load Shapes

% Energy by Month

	Residential End-Use Load Shape									
Month	**Building Shell RES**	**Cooling RES**	**Freezer RES**	**Heating RES**	**HVAC RES**	**Lighting RES**	**Miscellaneous RES**	**Pool Spa RES**	**Refrigeration RES**	**Water Heating RES**
January	11.1297%	0.1200%	7.9579%	21.7905%	11.1297%	10.1182%	8.4893%	8.6451%	7.7053%	10.3527%
February	9.3077%	0.1100%	7.2518%	18.2135%	9.3077%	8.8441%	7.7366%	7.1145%	7.2169%	9.0720%
March	7.0042%	0.3130%	8.1080%	13.4833%	7.0042%	9.2879%	8.4863%	8.6052%	8.0272%	9.5543%
April	3.7116%	1.5047%	7.9918%	5.8486%	3.7116%	8.4645%	8.2144%	8.0702%	7.8752%	8.4799%
May	4.0888%	6.5410%	8.4083%	1.7144%	4.0888%	7.9393%	8.4847%	8.6052%	8.5646%	8.3600%
June	10.3973%	21.0823%	8.5730%	0.0510%	10.3973%	6.8508%	8.2122%	8.0702%	8.9112%	7.7065%
July	14.0100%	28.4780%	9.6095%	0.0006%	14.0100%	6.7864%	8.4883%	8.6451%	9.4239%	6.7712%
August	13.3207%	27.0766%	9.6095%	0.0009%	13.3207%	7.0565%	8.4840%	8.5653%	9.4212%	6.3688%
September	6.6759%	12.6605%	8.4277%	0.8809%	6.6759%	7.3792%	8.2136%	8.3032%	8.4971%	6.9373%
October	3.7011%	1.8472%	8.2582%	5.4962%	3.7011%	8.4539%	8.4869%	8.6052%	8.5653%	7.9644%
November	5.9593%	0.1444%	7.8465%	11.5899%	5.9593%	8.9880%	8.2122%	8.1088%	7.8717%	8.4752%
December	10.6937%	0.1222%	7.9579%	20.9301%	10.6937%	9.8312%	8.4915%	8.6619%	7.9204%	9.9577%

End-Use Energy to Coincident Peak Demand Factors

	Building Shell RES	**Cooling RES**	**Freezer RES**	**Heating RES**	**HVAC RES**	**Lighting RES**	**Miscellaneous RES**	**Pool Spa RES**	**Refrigeration RES**	**Water Heating RES**
	0.0004660805	0.0009474181	0.0001685722	0.0000000000	0.0004660805	0.0001492529	0.0001148238	0.0002354459	0.0001285253	0.0000887318

Table 2 – Commercial and Industrial End-Use Category Monthly Shapes and Coincident Peak Factors

End-Use Energy Load Shapes

% Energy by Month

	Business End-Use Load Shape												
Month	Air Comp BUS	Building Shell BUS	Cooking BUS	Cooling BUS	Ext Lighting BUS	Heating BUS	HVAC BUS	Lighting BUS	Miscellaneous BUS	Motors BUS	Process BUS	Refrigeration BUS	Water Heating BUS
January	8.5109%	10.7824%	8.6096%	0.0006%	10.6265%	21.0397%	10.7824%	9.3564%	8.5109%	8.5109%	8.5109%	8.3486%	10.8255%
February	7.7715%	9.1052%	7.8609%	0.0247%	8.2162%	17.7436%	9.1052%	7.2162%	7.7715%	7.7715%	7.7715%	7.6158%	9.1078%
March	8.6136%	7.1135%	8.1548%	0.7236%	7.0887%	13.1924%	7.1135%	7.8373%	8.6136%	8.6136%	8.6136%	8.3346%	8.5240%
April	7.9796%	4.1179%	7.2948%	2.1691%	6.8146%	5.9718%	4.1179%	7.6534%	7.9796%	7.9796%	7.9796%	8.0783%	7.2980%
May	8.5335%	4.4424%	8.6277%	6.2980%	8.1853%	2.6769%	4.4424%	9.4247%	8.5335%	8.5335%	8.5335%	8.5133%	7.9849%
June	8.1995%	10.6128%	8.3294%	21.3170%	6.7163%	0.4295%	10.6128%	7.5599%	8.1995%	8.1995%	8.1995%	8.4295%	7.2721%
July	8.4099%	14.2881%	8.5859%	29.0029%	8.6752%	0.2895%	14.2881%	9.6200%	8.4099%	8.4099%	8.4099%	8.7457%	7.4930%
August	8.4199%	13.3494%	8.5885%	27.0206%	6.9401%	0.3432%	13.3494%	7.7078%	8.4199%	8.4199%	8.4199%	8.7230%	7.5862%
September	8.2512%	5.7810%	8.3475%	10.8695%	8.2908%	0.9402%	5.7810%	8.1374%	8.2512%	8.2512%	8.2512%	8.3319%	7.5734%
October	8.5277%	3.8018%	8.6262%	1.9643%	10.0507%	5.5497%	3.8018%	9.4072%	8.5277%	8.5277%	8.5277%	8.4563%	8.2808%
November	8.2589%	6.2104%	8.3496%	0.6030%	8.7252%	11.5452%	6.2104%	7.6707%	8.2589%	8.2589%	8.2589%	8.1112%	8.6345%
December	8.5238%	10.3950%	8.6251%	0.0064%	9.6704%	20.2781%	10.3950%	8.4090%	8.5238%	8.5238%	8.5238%	8.3119%	9.4200%

End-Use Energy to Coincident Peak Demand Factors

	Air Comp BUS	Building Shell BUS	Cooking BUS	Cooling BUS	Ext Lighting BUS	Heating BUS	HVAC BUS	Lighting BUS	Miscellaneous BUS	Motors BUS	Process BUS	Refrigeration BUS	Water Heating BUS
	0.0001379439	0.0004439830	0.0001998949	0.0009106840	0.0000056160	0.0000000000	0.0004439830	0.0001899635	0.0001379439	0.0001379439	0.0001379439	0.0001357383	0.0001811545

Volume 2: Commercial and Industrial Measures

Ameren Missouri TRM – Volume 2: C&I Measures Revision Log

Revision	Date	Description
1.0	05/30/2018	Initial version filed for Commission approval.

Volume 2: Commercial and Industrial Measures

2.1 Appliances

2.1.1 Clothes Washer

DESCRIPTION

This measure relates to the installation of a commercial-grade clothes washer meeting the ENERGY STAR® minimum qualifications. Note it is assumed the domestic hot water (DHW) and dryer fuels of the installations are known.

This measure was developed to be applicable to the following program types: TOS and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The commercial-grade clothes washer must meet the ENERGY STAR® minimum qualifications (provided in the table below), as required by the program. The current specification is effective as of February 5, 2018.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is a commercial-grade clothes washer meeting the minimum federal baseline as of January 2013[1].

Efficiency Level		Top loading	Front Loading
Baseline	Federal Standard	≥1.6 MEF, ≤8.5 WF	≥2.00 MEF, ≤5.5 WF
Efficient	ENERGY STAR®	N/A	≥2.2 MEF, ≤4.0 IWF

The Modified Energy Factor (MEF) includes unit operation, water heating, and drying energy use, with the higher the value the more efficient the unit; *"The quotient of the capacity of the clothes container, divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of the remaining moisture in the wash load."*

The Water Factor (WF) indicates the total water consumption of the unit, with the lower the value the less water required; *"The quotient of the total weighted per-cycle water consumption for cold wash, divided by the capacity of the clothes washer."*[2]

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 11 years.[3]

[1] See federal standard 10 CFR 431.152.
[2] Definitions provided on the Energy Star® website.
[3] Appliance Magazine, September 2007 as referenced in ENERGY STAR® Commercial Clothes Washer Calculator.

DEEMED MEASURE COST

The incremental cost is assumed to be $200[4]:

LOADSHAPE

Loadshape – Miscellaneous BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left[\left(Capacity * \frac{1}{MEFbase} * Ncycles\right) * \left(\%CWbase + (\%DHWbase * \%Electric_{DHW}) + \left(\%Dryerbase * \%Electric_{Dryer}\right)\right)\right] - \left[\left(Capacity * \frac{1}{IMEFeff} * Ncycles\right) * \left(\%CWeff + (\%DHWeff * \%Electric_{DHW}) + \left(\%Dryereff * \%Electric_{Dryer}\right)\right)\right]$$

Where:

Capacity = Clothes washer capacity (cubic feet)

= Actual - If capacity is unknown, assume 3.1 cubic feet [5]

MEFbase = Modified Energy Factor of baseline unit

Efficiency Level	MEFbase		
	Top loading	Front Loading	Weighted Average[6]
Federal Standard	1.6	2.0	1.7

MEFeff = Modified Energy Factor of efficient unit

= Actual. If unknown, assume average values provided below.

Efficiency Level	MEFeff		
	Top loading	Front Loading	Weighted Average
ENERGY STAR®	N/A	2.2	

[4] Based on Industry Data 2007 as referenced in ENERGY STAR® Commercial Clothes Washer Calculator.
[5] Based on the average clothes washer volume of all units that pass the federal standard on the California Energy Commission (CEC) database of commercial clothes washer products (accessed on 11/26/2015).
[6] Weighted average MEF of federal standard rating for front- loading and top- loading units. Baseline weighting is based upon the relative top front loading percentage of available non-ENERGY STAR® commercial products in the CEC database (accessed 11/26/2015) and ENERGY STAR® weighting is based on eligible products as of 11/26/2015. The relative weightings are as follows, see more information in "Commercial Clothes Washer Analysis.xlsx":

Efficiency Level	Front	Top
Baseline	37%	63%
ENERGY STAR®	99%	1%

Ncycles = Number of Cycles per year

= 2190[7]

%CW = Percentage of total energy consumption for clothes washer operation (different for baseline and efficient unit – see table below)

%DHW = Percentage of total energy consumption used for water heating (different for baseline and efficient unit – see table below)

%Dryer = Percentage of total energy consumption for dryer operation (different for baseline and efficient unit – see table below)

	Percentage of Total Energy Consumption[8]		
	%CW	%DHW	%Dryer
Federal Standard	6.5%	25.9%	67.6%
ENERGY STAR	3.5%	14.1%	82.4%

$\%Electric_{DHW}$ = Percentage of DHW savings assumed to be electric

DHW fuel	$\%Electric_{DHW}$
Electric	100%
Natural Gas	0%

$\%Electric_{Dryer}$ = Percentage of dryer savings assumed to be electric

Dryer fuel	$\%Electric_{Dryer}$
Electric	100%
Natural Gas	0%

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:[9]

	ΔkWH			
Efficiency Level	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®	808.2	229.3	725.3	146.5

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy Savings as calculated above

[7] Based on DOE Technical Support Document, 2009; Chapter 8 Life-Cycle Cost and Payback Period Analysis, p 8-15.
[8] The percentage of total energy consumption that is used for the machine, heating the hot water, or by the dryer is different depending on the efficiency of the unit. Values are based on a data provided in the ENERGY STAR® Calculator for Commercial Clothes Washers.
[9] Note that the baseline savings is based on the weighted average baseline MEF (as opposed to assuming front baseline for front-efficient unit and top baseline for top- efficient unit). The reasoning is that the support of the program of more efficient units (which are predominately front loading) will result in some participants switching from planned purchase of a top loader to a front loader.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439[10]

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:

Efficiency Level	ΔkW			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR	0.1115	0.0316	0.1001	0.0202

Natural Gas Savings

$$\Delta Therms = \left[\left[\left(Capacity * \frac{1}{IMEFbase} * Ncycles\right) * \left((\%DHWbase * \%Natural\ Gas_{DHW} * R\_eff) + (\%Dryerbase * \%Gas_{Dryer}\%Gas\_Dryer)\right)\right] - \left[\left(Capacity * \frac{1}{IMEFeff} * Ncycles\right) * \left((\%DHWeff * \%Gas_{DHW}\%Natural\ Gas\_DHW * R\_eff) + (\%Dryereff * \%Gas_{Dryer}\%Gas\_Dryer)\right)\right]\right] * Therm\_convert$$

Where:

$\%Gas_{DHW}$ = Percentage of DHW savings assumed to be Natural Gas

DHW fuel	$\%Gas_{DHW}$
Electric	0%
Natural Gas	100%

R_eff = Recovery efficiency factor

= 1.26[11]

$\%Gas_{Dryer}$ = Percentage of dryer savings assumed to be Natural Gas

Dryer fuel	$\%Gas_{Dryer}$
Electric	0%
Natural Gas	100%

Therm_convert = Conversion factor from kWh to Therm

= 0.03412

Other factors as defined above.

[10] Based on Ameren Missouri 2016 Loadshape for Business Miscellaneous End-Use. Upon inspection and comparison to the residential clothes washer coincidence factor, this is a reasonable assumption until data becomes available to inform a technology specific coincidence factor. Given that business laundry schedules are likely more variable compared to residential, it follows that less overlap with the system peak hour is possible.

[11] To account for the different efficiency of electric and natural gas hot water heaters (gas water heater: recovery efficiencies ranging from 0.74 to 0.85 (0.78 used), and electric water heater with 0.98 recovery efficiency (http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Waste_Water_Heat_Recovery_Guidelines.pdf). Therefore a factor of 0.98/0.78 (1.26) is applied.

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:

Efficiency Level	ΔTherms			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR	0.0	24.9	2.8	27.7

WATER IMPACT DESCRIPTIONS AND CALCULATION

$$\Delta Water\ (gallons) = Capacity * (IWFbase - IWFeff) * Ncycles$$

Where:

WFbase = Water Factor of baseline clothes washer

Efficiency Level	WFbase		
	Top loading	Front Loading	Weighted Average[12]
Federal Standard	8.5	5.5	7.4

WFeff = Water Factor of efficient clothes washer

= Actual - If unknown assume average values provided below

Using the default assumptions provided above, the prescriptive water savings for each efficiency level are presented below:

Efficiency Level	WF			ΔWater (gallons per year)
	Top Loaders	Front Loaders	Weighted Average	Weighted Average
Federal Standard	8.5	5.5	7.4	n/a
ENERGY STAR	4.5			19,874

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[12] Weighted average MEF of federal standard rating for frontloading and top- loading units. Baseline weighting is based upon the relative top v front loading percentage of available non-ENERGY STAR® commercial product in the CEC database (accessed 11/26/2015) and ENERGY STAR® weighting is based on eligible products as of 11/26/2015. The relative weightings are as follows, see more information in "Commercial Clothes Washer Analysis.xlsx":

Efficiency Level	Front	Top
Baseline	37%	63%
ENERGY STAR®	99%	1%

2.1.2 Clothes Dryer

Description

This measure is for the installation of a residential clothes dryer, utilized in a commercial setting, meeting the ENERGY STAR® criteria. ENERGY STAR® qualified clothes dryers save energy through a combination of more efficient drying and reduced runtime of the drying cycle. More efficient drying is achieved through increased insulation, modifying operating conditions (such as air flow and/or heat input rate) improving air circulation through better drum design or booster fans, and improving efficiency of motors. Reducing the runtime of dryers through automatic termination by temperature and moisture sensors is believed to have the greatest potential for reducing energy use in clothes dryers.[13] ENERGY STAR® provides criteria for both gas and electric clothes dryers.

This measure was developed to be applicable to the following program types: TOS and NC. If applied to other program types, the measure savings should be verified.

Definition of Efficient Equipment

Clothes dryer must meet the ENERGY STAR® criteria, as required by the program.

Definition of Baseline Equipment

The baseline condition is a clothes dryer meeting the minimum federal requirements for units manufactured on or after January 1, 2015.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 14 years.[14]

Deemed Measure Cost

Dryer Size	Incremental Cost[15]
Standard	$75
Compact	$105

Loadshape

Loadshape - Miscellaneous BUS

[13] ENERGY STAR® Market & Industry Scoping Report. Residential Clothes Dryers. Table 8. November 2011. http://www.energystar.gov/ia/products/downloads/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf
[14] Based on an average estimated range of 12-16 years. ENERGY STAR® Market & Industry Scoping Report. Residential Clothes Dryers. November 2011. http://www.energystar.gov/ia/products/downloads/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf
[15] Cost based on ENERGY STAR® Savings Calculator for ENERGY STAR® Qualified Appliances. https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx

Algorithm

Calculation of Savings

Electric Energy Savings

$$\Delta kWh = \left(\frac{Load}{CEFbase} - \frac{Load}{CEFeff}\right) * Ncycles * \%Electric$$

Where:

Load = The average total weight (lbs) of clothes per drying cycle. If dryer size is unknown, assume standard.

Dryer Size	Load (lbs)[16]
Standard	8.45
Compact	3

CEFbase = Combined energy factor (CEF) (lbs/kWh) of the baseline unit is based on existing federal standards energy factor and adjusted to CEF as performed in the ENERGY STAR® analysis.[17] If product class unknown, assume electric, standard.

Product Class	CEFbase (lbs/kWh)
Vented Electric, Standard (≥ 4.4 ft^3)	3.11
Vented Electric, Compact (120V) (< 4.4 ft^3)	3.01
Vented Electric, Compact (240V) (<4.4 ft^3)	2.73
Ventless Electric, Compact (240V) (<4.4 ft^3)	2.13
Vented Gas	2.84[18]

CEFeff = CEF (lbs/kWh) of the ENERGY STAR® unit based on ENERGY STAR® requirements.[19] If product class unknown, assume electric, standard.

Product Class	CEFeff
Vented or Ventless Electric, Standard (≥ 4.4 ft^3)	3.93
Vented or Ventless Electric, Compact (120V) (< 4.4	3.80
Vented Electric, Compact (240V) (< 4.4 ft^3)	3.45
Ventless Electric, Compact (240V) (< 4.4 ft^3)	2.68
Vented Gas	3.48[20]

[16] Based on ENERGY STAR® test procedures. https://www.energystar.gov/index.cfm?c=clothesdry.pr_crit_clothes_dryers
[17] ENERGY STAR® Draft 2 Version 1.0 Clothes Dryers Data and Analysis
[18] Federal standards report CEF for gas clothes dryers in terms of lbs/kWh. To determine gas savings, this number is later converted to therms.
[19] ENERGY STAR® Clothes Dryers Key Product Criteria. https://www.energystar.gov/index.cfm?c=clothesdry.pr_crit_clothes_dryers
[20] Federal standards report CEF for gas clothes dryers in terms of lbs/kWh. To determine gas savings, this number is later converted to therms.

Ncycles = Number of dryer cycles per year. Use actual data if available. If unknown, refer to the table below.[21]

Application	Cycles per Year
Multi-family	1,074
Laundromat	1,483
On-Premise Laundromat	3,607

%Electric = The percent of overall savings coming from electricity

= 100% for electric dryers, 5% for gas dryers[22]

Using defaults provided above:

Product Class	kWh		
	Multi-family	Laundromat	On-Premise Laundromat
Vented Electric, Standard (≥ 4.4 ft^3)	608.9	840.7	2044.9
Vented Electric, Compact (120V) (< 4.4 ft^3)	222.5	307.3	747.4
Vented Electric, Compact (240V) (<4.4 ft^3)	246.3	340.1	827.2
Ventless Electric, Compact (240V) (<4.4 ft^3)	310.4	428.7	1042.6
Vented Gas	29.4	40.6	98.7

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy savings as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439[23]

Using defaults provided above:

Product Class	kW		
	Multi-family	Laundromat	On-Premise Laundromat
Vented Electric, Standard (≥ 4.4 ft^3)	0.0840	0.1160	0.2821

[21] NOPR analysis for DOE Commercial Clothes Washer standard. Annual use cycles of 1,074 and 1,483 for multifamily and laundromat applications, respectively. https://www.regulations.gov/document?D=EERE-2012-BT-STD-0020-0021. On-premise laundromat cycle average value for dryer cycles in healthcare facility, hotels, drycleaners and laundromats from tests conducted in Nicor Gas Emerging Technology Program's Commercial Dryer Modulation Retrofit Public Project Report.

[22] %Electric accounts for the fact that some of the savings on gas dryers comes from electricity (motors, controls, etc.). 5% was determined using a ratio of the electric to total savings from gas dryers given by ENERGY STAR® Draft 2 Version 1.0 Clothes Dryers Data and Analysis. Value reported in 2015 EPA EnergySTAR® appliance calculator.

[23] Based on Ameren Missouri 2016 Loadshape for Business Miscellaneous End-Use. Upon inspection and comparison to the Residential clothes washer coincidence factor, this is a reasonable assumption until data becomes available to inform a technology specific coincidence factor. Given that business laundry schedules are likely more variable compared to residential, it follows that less overlap with the system peak hour is possible.

Product Class	kW		
	Multi-family	Laundromat	On-Premise Laundromat
Vented Electric, Compact (120V) (< 4.4 ft^3)	0.0307	0.0424	0.1031
Vented Electric, Compact (240V) (<4.4 ft^3)	0.0340	0.0469	0.1141
Ventless Electric, Compact (240V) (<4.4 ft^3)	0.0428	0.0591	0.1438
Vented Gas	0.0041	0.0056	0.0136

NATURAL GAS ENERGY SAVINGS

Natural gas savings only apply to ENERGY STAR® vented gas clothes dryers.

$$\Delta Therm = \left(\frac{Load}{CEFbase} - \frac{Load}{CEFeff}\right) * Ncycles * Therm\_convert * \%Gas$$

Where:

Therm_convert = Conversion factor from kWh to Therm

= 0.03413

%Gas = Percent of overall savings coming from gas

= 0% for electric units and 84% for gas units[24]

Using defaults provided above:

ΔTherms = (8.45/2.84 – 8.45/3.48) * Ncycles * 0.03413 * 0.84

Product Class	ΔTherms		
	Multi-family	Laundromat	On-Premise Laundromat
Vented Gas	16.8	23.3	56.6

PEAK GAS SAVINGS

Savings for this measure is assumed to be evenly spread across the year. The Peak Gas Savings is therefore assumed to be:

$$\Delta PeakTherms = \frac{\Delta Therms}{365.25}$$

Where:

ΔTherms = Therm impact calculated above

365.25 = Days per year

Using defaults provided above:

[24] % Gas accounts for the fact that some of the savings on gas dryers comes from electricity (motors, controls, etc.). 84% was determined using a ratio of the gas to total savings from gas dryers given by ENERGY STAR® Draft 2 Version 1.0 Clothes Dryers Data and Analysis.

Product Class	ΔPeakTherms		
	Multi-family	Laundromat	On-Premise Laundromat
Vented Gas	0.0461	0.0637	0.1549

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.2 Compressed Air

2.2.1 Compressed Air No Loss Condensate Drain

DESCRIPTION

No-loss condensate drains remove condensate as needed without venting compressed air, resulting in less air demand and better efficiency. Replacement or upgrades of existing no-loss drains are not eligible for this measure.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is a no-loss condensate drain.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a standard condensate drain (open valve, timer, or both).

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The lifetime of a no-loss condensate drain is assumed to be 13 years.[25]

DEEMED MEASURE COST

The measure cost is $700 per drain.[26]

LOADSHAPE

Air Comp BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = CFM_{reduced} * kW_{CFM} * Hours$$

Where:

$CFM_{reduced}$ = Reduced air consumption (CFM) per drain

= 3 CFM[27]

kW_{CFM} = System power demand reduction per reduced air consumption (kw/CFM), depending on the type of compressor control, see table below[28]

[25] "Measure Life Study," Energy & Resource Solutions (prepared for the Massachusetts Joint Utilities): Table 1-1, 2005.
[26] Based on empirical project data from ComEd Comprehensive Compressed Air Study program and VEIC review of pricing data found in CAS Cost Data.xls.
[27] Reduced CFM consumption is based on a timer drain opening for 10 seconds every 300 seconds as the baseline. See "Industrial System Standard Deemed Saving Analysis.xls."
[28] Calculated based on the type of compressor control. This assumes the compressor will be between 40% and 100% capacity before and after the changes to the system demand. See "Industrial System Standard Deemed Saving Analysis.xls."

Compressor Control Type	kW_{CFM}
Reciprocating - On/off Control	0.184
Reciprocating - Load/Unload	0.136
Screw - Load/Unload	0.152
Screw - Inlet Modulation	0.055
Screw - Inlet Modulation w/ Unloading	0.055
Screw - Variable Displacement	0.153
Screw - VFD	0.178

Hours = Compressed air system pressurized hours

= Use actual hours if known, otherwise assume values in table below:

Shift	Hours
Single shift (8/5)	1976 hours 7 AM – 3 PM, weekdays, minus some holidays and scheduled down time
2-shift (16/5)	3952 hours 7AM – 11 PM, weekdays, minus some holidays and scheduled down time
3-shift (24/5)	5928 hours 24 hours per day, weekdays, minus some holidays and scheduled down time
4-shift (24/7)	8320 hours 24 hours per day, 7 days a week minus some holidays and scheduled down time

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

=

= 0.0001379439[29]

MEASURE CODE:

[29] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Compressed Air. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

2.2.2 Compressed Air Nozzle

DESCRIPTION

This measure applies to the replacement of a standard air nozzle with high-efficiency air nozzle used in a compressed air system. High-efficiency air nozzles use the Coandă effect to pull in free air and use significantly less compressed air for blowing off parts or for drying. These nozzles have the added benefits of noise reduction and improved safety in systems with greater than 30 psig.

This measure was developed to be applicable to the following program types: DI and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is a compressed air nozzle meeting program requirements.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a standArd air nozzle.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life is 15 years.[30]

DEEMED MEASURE COST

Incremental measure costs are presented in the following table.[31]

Nozzle Diameter	Measure Cost
1/8”	$42
1/4"	$57
5/16”	$87
1/2"	$121

LOADSHAPE

Air Comp BUS

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (SCFM * SCFM\%Reduced) * kW/CFM \ * \%Use \ * Hours$$

Where:

SCFM = Air flow through standard nozzle.

[30] “Focus on Energy Evaluation - Business Programs: Measure Life Study,” prepared for State of Wisconsin Public Service Commission by PA Consulting Group, August 25, 2009.
[31] Costs are from EXAIR’s website and are an average of nozzles that meet the flow requirements. Models include Atto Super, Pico Super, Nano Super, Micro Super, Mini Super, Super and Large Super nozzles. www.exair.com. Accessed March 20, 2014.

= Actual rated flow at 80 psi, if known. If unknown, use CFM by orifice diameter from table below.[32, 33]

Orifice Diameter	SCFM
1/8”	21
1/4”	58
5/16”	113
1/2"	280

SCFM%Reduced = Percent reduction in air loss per nozzle.

= Estimated at 50%[34]

kW/CFM = System power reduction per air demand (kW/CFM), depending on the type of air compressor; see table below[35]

Air Compressor Type	ΔkW/CF
Reciprocating – On/off Control	0.18
Reciprocating – Load/Unload	0.14
Screw – Load/Unload	0.15
Screw – Inlet Modulation	0.06
Screw – Inlet Modulation w/	0.06
Screw – Variable Displacement	0.15
Screw - VFD	0.18

%USE = Percent of the compressor total operating hours that the nozzle is in use

= Custom, or if unknown, assume 5%[36]

Hours = Compressed air system pressurized hours

= Use actual hours if known, otherwise assume values in table below:

32 Review of manufacturer’s information
33 Technical Reference Manual (TRM) for Ohio Senate Bill 221,”Energy Efficiency and Conservation Program” and 09-512-GE-UNC, October 15, 2009, Pgs 170-171.
34 Conservative estimate based on average values provided by the Compressed Air Challenge Training Program, Machinery’s Handbook 25th Edition, and manufacturers’ catalog.
35 Calculated based on the type of compressor control. This assumes the compressor will be between 40% and 100% capacity before and after the changes to the system demand. See “Industrial System Standard Deemed Saving Analysis.xls.”
36 Assumes 50% handheld air guns and 50% stationary air nozzles. Manual air guns tend to be used less than stationary air nozzles, and a conservative estimate of 1 second of blow-off per minute of compressor run time is assumed. Stationary air nozzles are commonly more wasteful as they are often mounted on machine tools and can be manually operated resulting in the possibility of a long term open blow situation. An assumption of 5 seconds of blow-off per minute of compressor run time is used.

Shift	Hours
Single shift (8/5)	1976 hours 7 AM – 3 PM, weekdays, minus some holidays and scheduled down time
2-shift (16/5)	3952 hours 7AM – 11 PM, weekdays, minus some holidays and scheduled down time
3-shift (24/5)	5928 hours 24 hours per day, weekdays, minus some holidays and scheduled down time
4-shift (24/7)	8320 hours 24 hours per day, 7 days a week minus some holidays and scheduled down time

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

=

= 0.0001379439[37]

NATURAL GAS SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[37] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Compressed Air. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

2.2.3 VSD Air Compressor

DESCRIPTION

This measure relates to the installation of an air compressor with a variable frequency drive, load/no load controls, or variable displacement control. A baseline modulating compressor regulates output by choking off the inlet air, which is not efficient. Efficient compressors use a variable speed drive on the motor to match output to the load. Savings are calculated using representative baseline and efficient demand numbers for compressor capacities according to the facility's load shape, and the number of hours the compressor runs at that capacity. Demand curves are as per US Department of Energy (DOE) data for a Variable Speed compressor versus a Modulating compressor. This measure applies only to an individual compressor ≤ 40 hp.

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The high efficiency equipment is a compressor ≤ 40 hp with variable speed control.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a modulating compressor with blow down ≤ 40 hp

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

10 years.[38]

DEEMED MEASURE COST[39]

$$\text{Incremental Cost (\$)} = (127 \times hp_{compressor}) + 1446$$

Where:

$hp_{compressor}$ = compressor motor nominal horsepower

LOADSHAPE

Air Comp BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = 0.9 \times hp_{compressor} \times HOURS \times (CF_b - CF_e)$$

Where:

ΔkWh = gross customer annual kWh savings for the measure

$hp_{compressor}$ = compressor motor nominal horsepower

[38] Based on data provided by vendors, reference file "VSD compressor lifetime and costs.xls."
[39] Based on data provided by vendors, reference file "VSD compressor lifetime and costs.xls."

0.9[40] = compressor motor nominal horsepower to full load kW conversion factor

HOURS = compressor total annual hours of operation. Custom input, if unknown use the following defaults based on shift structure:

Shift	Hours
Single shift (8/5)	1976 hours 7 AM – 3 PM, weekdays, minus some holidays and scheduled down time
2-shift (16/5)	3952 hours 7AM – 11 PM, weekdays, minus some holidays and scheduled down time
3-shift (24/5)	5928 hours 24 hours per day, weekdays, minus some holidays and scheduled down time
4-shift (24/7)	8320 hours 24 hours per day, 7 days a week minus some holidays and scheduled down time

CF_b = baseline compressor factor[41]

=0.890

CF_e = efficient compressor[42]

=0.705

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW \ = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439[43]

MEASURE CODE:

[40] Conversion factor based on a linear regression analysis of the relationship between air compressor motor nominal horsepower and full load kW from power measurements of 72 compressors at 50 facilities on Long Island. See "BHP Weighted Compressed Air Load Profiles v3.xls."

[41] Compressor factors were developed using DOE part load data for different compressor control types as well as load profiles from 50 facilities employing air compressors less than or equal to 40 hp. "See "BHP Weighted Compressed Air Load Profiles v3.xls" for source data and calculations.

[42] Compressor factors were developed using DOE part load data for different compressor control types as well as load profiles from 50 facilities employing air compressors less than or equal to 40 hp. "See "BHP Weighted Compressed Air Load Profiles v3.xls" for source data and calculations. The "variable speed drive" compressor factor has been adjusted up from the 0.675 presented in the analysis to 0.705 to account for the additional power draw of the VSD.

[43] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Compressed Air. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

2.3 Food Service

2.3.1 Combination Oven

Description

This measure applies to full or half-sized electric ENERGY STAR® combination ovens with a pan capacity ≥ 5 and ≤ 20 and to full or half-sized natural gas fired ENERGY STAR® combination ovens with a pan capacity ≥ 6 installed in a commercial kitchen. Combination ovens combine the function of hot air convection (convection mode), saturated and superheated steam heating (steam mode), and combination convection/steam mode for moist heating, to perform steaming, baking, roasting, re-thermalizing, and proofing of various food products. ENERGY STAR® certified combination ovens are approximately 20% more efficient than standard ovens.

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, measure savings should be verified.

Definition of Efficient Equipment

To qualify for this measure, the installed equipment must be an ENERGY STAR® certified combination oven meeting idle energy rate (kW or Btu/hr) and cooking efficiency (%) limits, as determined by fuel type, operation mode (steam or convection), and pan capacity.

ENERGY STAR® Requirements (Version 2.2, Effective October 7, 2015)

Fuel Type	Operation	Idle Rate (Btu/hr for Gas, kW for Electric)	Cooking-Energy Efficiency (%)
Natural Gas	Steam Mode Convection Mode	≤ 200P+6,511 ≤ 150P+5,425	≥ 41 ≥ 56
Electric	Steam Mode Convection Mode	≤ 0.133P+0.6400 ≤ 0.080P+0.4989	≥ 55 ≥ 76

Note: P = Pan capacity as defined in Section 1.T of the Commercial Ovens Program Requirements Version 2.2.[44]

Definition of Baseline Equipment

The baseline equipment is a new electric or natural gas combination oven that is not ENERGY STAR® certified.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years.[45]

Deemed Measure Cost

The incremental capital cost for this measure is $4,300.[46]

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[44] Pan capacity is defined as the number of steam table pans the combination oven is able to accommodate as per the ASTM F-1495-05 standard specification. https://www.energystar.gov/sites/default/files/Commercial%20Ovens%20Final%20Version%202.2%20Specification.pdf

[45] Lifetime from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator, which cites reference as "FSTC research on available models, 2009." https://www.energystar.gov/sites/default/files/asset/document/commercial_kitchen_equipment_calculator.xlsx

[46] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.

LOADSHAPE

Cooking BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation for an electric combination oven below.[47]

$$\Delta kWh = (\Delta CookingEnergy_{ConvElec} + \Delta CookingEnergy_{SteamElec} + \Delta IdleEnergy_{ConvElec} + \Delta IdleEnergy_{SteamElec}) * Days/1{,}000$$

Where:

$\Delta CookingEnergy_{ConvElec}$ = Difference in cooking energy between baseline and efficient combination oven in convection mode

= $FoodCooked_{Elec}$ * ($EFOOD_{ConvElec}$ / $ElecEFF_{ConvBase}$ - $EFOOD_{ConvElec}$ / $ElecEFF_{ConvEE}$) * %Conv

$\Delta CookingEnergy_{SteamElec}$ = Difference in cooking energy between baseline and efficient combination oven in steam mode

= $FoodCooked_{Elec}$ * ($EFOOD_{SteamElec}$ / $ElecEFF_{SteamBase}$ – $EFOOD_{SteamElec}$ / $ElecEFF_{SteamEE}$) * $\%_{Steam}$

$\Delta IdleEnergy_{ConvElec}$ = Difference in idle energy between baseline and efficient combination oven in convection mode

= (($ElecIDLE_{ConvBase}$ * ((Hours – $FoodCooked_{Elec}$ /$ElecPC_{ConvBase}$) * $\%_{Conv}$)) - ($ElecIDLE_{ConvEE}$ * ((Hours - $FoodCooked_{Elec}$ /$ElecPC_{ConvEE}$) * $\%_{Conv}$)))

$\Delta IdleEnergy_{SteamElec}$ = Difference in idle energy between baseline and efficient combination oven in steam mode

= [($ElecIDLE_{SteamBase}$ * ((Hours – $FoodCooked_{Elec}$ /$ElecPC_{SteamBase}$) * $\%_{Steam}$)) - ($ElecIDLE_{SteamEE}$ * ((Hours - $FoodCooked_{Elec}$ /$ElecPC_{SteamEE}$) * $\%_{Steam}$))]

Days = Annual days of operation

= Custom or, if unknown, use 365.25 days per year

1,000 = Wh to kWh conversion factor

Where:

$FoodCooked_{Elec}$ = Food cooked per day for electric combination oven

= Custom, or, if unknown, use 200 lbs if P <15 or 250 lbs if P ≥ 15

$EFOOD_{ConvElec}$ = ASTM energy to food for electric combination oven in convection mode

[47] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

= 73.2 Wh/lb

ElecEff = Cooking energy efficiency of electric combination oven

= Custom or if unknown, use values from table below

	Base	EE
$ElecEFF_{Conv}$	72%	76%
$ElecEFF_{Steam}$	49%	55%

$\%_{Conv}$ = Percentage of time in convection mode

= Custom or, if unknown, use 50%

$EFOOD_{SteamElec}$ = ASTM energy to food for electric combination oven in steam mode

= 30.8 Wh/lb

$\%_{steam}$ = Percentage of time in steam mode

= $1 - \%_{conv}$

$ElecIDLE_{Base}$ = Idle energy rate (W) of baseline electric combination oven

= Custom or, if unknown, use values from table below

Pan Capacity	Convection Mode ($ElecIDLE_{ConvBase}$)	Steam Mode ($ElecIDLE_{SteamBase}$)
< 15	1,320	5,260
≥ 15	2,280	8,710

Hours = Average daily hours of operation

= Custom or, if unknown, use 12 hours per day

$ElecPC_{Base}$ = Production capacity (lbs/hr) of baseline electric combination oven

= Custom or, if unknown, use values from table below

Pan Capacity	Convection Mode ($ElecPC_{ConvBase}$)	Steam Mode ($ElecPC_{SteamBase}$)
< 15	79	126
≥15	166	295

$ElecIDLE_{ConvEE}$ = Idle energy rate of ENERGY STAR electric combination oven in convection mode

= $(0.08 \cdot P + 0.4989) \cdot 1{,}000$

$ElecPC_{EE}$ = Production capacity (lbs/hr) of ENERGY STAR electric combination oven

= Custom or, if unknown, use values from table below

Pan Capacity	Convection Mode ($ElecPC_{ConvEE}$)	Steam Mode ($ElecPC_{SteamEE}$)
< 15	119	177
≥ 15	201	349

$ElecIDLE_{SteamEE}$ = Idle energy rate of ENERGY STAR electric combination oven in steam mode

= (0.133*P + 0.64)*1,000

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW \;\; = \Delta kWh \, * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001998949[48]

Other variables as defined above.

NATURAL GAS ENERGY SAVINGS

Custom calculation for a gas combination oven below:[49]

$$\Delta Therms = (\Delta CookingEnergy_{ConvGas} + \Delta CookingEnergy_{SteamGas} + \Delta IdleEnergy_{ConvGas} + \Delta IdleEnergy_{SteamGas}) * Days/100{,}000$$

Where:

$\Delta CookingEnergy_{ConvGas}$ = Difference in cooking energy between baseline and efficient combination oven in convection mode

= $FoodCooked_{Gas}$ * ($EFOOD_{ConvGas}$ / $GasEFF_{ConvBase}$ - $EFOOD_{ConvGas}$/ $GasEFF_{ConvEE}$) * %Conv

$\Delta CookingEnergy_{SteamGas}$ = Difference in cooking energy between baseline and efficient combination oven in steam mode

= $FoodCooked_{Gas}$ * ($EFOOD_{SteamGas}$ / $GasEFF_{SteamBase}$ – $EFOOD_{SteamGas}$ / $GasEFF_{SteamEE}$) * $\%_{Steam}$

$\Delta IdleEnergy_{ConvGas}$ = Difference in idle energy between baseline and efficient combination oven in convection mode

= (($GasIDLE_{ConvBase}$ * ((Hours – $FoodCooked_{Gas}$ /$GasPC_{ConvBase}$) * $\%_{Conv}$)) - ($GasIDLE_{ConvEE}$ * ((Hours - $FoodCooked_{Gas}$ /$GasPC_{ConvEE}$) * $\%_{Conv}$)))

$\Delta IdleEnergy_{SteamGas}$ = Difference in idle energy between baseline and efficient combination oven in steam mode

[48] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Electric Cooking. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."
[49] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

= [($GasIDLE_{SteamBase}$ * ((Hours – $FoodCooked_{Gas}$ /$GasPC_{SteamBase}$) * $\%_{Steam}$)) - ($GasIDLE_{SteamEE}$ * ((Hours - $FoodCooked_{Gas}$ /$GasPC_{SteamEE}$) * $\%_{Steam}$))]

100,000 = Btu to therms conversion factor

Where:

$FoodCooked_{Gas}$ = Food cooked per day for gas combination oven

= Custom, or, if unknown, use 200 lbs if P <15, 250 lbs if 15 ≤ P 30, or 400 lbs if P ≥30

$EFOOD_{ConvGas}$ = ASTM energy to food for gas combination oven in convection mode

= 250 Btu/lb

GasEff = Cooking energy efficiency of gas combination oven

= Custom or, if unknown, use values from table below

	Base	EE
$GasEFF_{Conv}$	52%	56%
$GasEFF_{Steam}$	39%	41%

$EFOOD_{SteamGas}$ = ASTM energy to food for gas combination oven in steam mode

= 105 Btu/lb

$GasIDLE_{Base}$ = Idle energy rate (Btu/hr) of baseline gas combination oven

= Custom or, if unknown, use values from table below

Pan Capacity	Convection Mode ($GasIDLE_{ConvBase}$)	Steam Mode ($GasIDLE_{SteamBase}$)
< 15	8,747	18,656
15 ≤ P 30	10,788	24,562
≥30	13,000	43,300

$GasPC_{Base}$ = Production capacity (lbs/hr) of baseline gas combination oven

= Custom or, if unknown, use values from table below

Pan Capacity	Convection Mode ($GasPC_{ConvBase}$)	Steam Mode ($GasPC_{SteamBase}$)
< 15	125	195
15 ≤ P 30	176	211
≥30	392	579

$GasIDLE_{ConvEE}$ = Idle energy rate of ENERGY STAR gas combination oven in convection mode

= 150*P + 5,425

$GasPC_{EE}$ = Production capacity (lbs/hr) of ENERGY STAR gas combination oven

= Custom or, if unknown, use values from table below

Pan Capacity	Convection Mode ($GasPC_{ConvEE)}$)	Steam Mode ($GasPC_{SteamEE)}$)
< 15	124	172
15 ≤ P 30	210	277
≥30	394	640

$GasIDLE_{SteamEE}$ = Idle energy rate of ENERGY STAR gas combination oven in steam mode

= 200*P +6,511

Other variables as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.3.2 Commercial Steam Cooker

Description

This measure applies to electric or natural gas fired ENERGY STAR® steam cookers installed in a commercial kitchen. Commercial steam cookers contain compartments where steam energy is transferred to food by direct contact. ENERGY STAR® certified steam cookers have shorter cook times, higher production rates, and reduced heat loss due to better insulation and more efficient steam delivery.

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, measure savings should be verified.

Definition of Efficient Equipment

To qualify for this measure, the installed equipment must be an ENERGY STAR® certified steam cooker meeting idle energy rate (W or Btu/hr) and cooking efficiency (%) limits, as determined by fuel type and pan capacity.

ENERGY STAR Requirements (Version 1.2, Effective August 1, 2003)

Pan Capacity	Electric Efficiency Requirements		Natural Gas Efficiency	
	Idle Energy Rate Idle Energy Rate	Cooking Efficiency	Idle Energy Rate	Cooking Efficiency
3-pan	≤ 400 W	≥ 50%	≤ 6,250 Btu/hr	≥ 38%
4-pan	≤ 530 W		≤ 8,350 Btu/hr	N/A
5-pan	≤ 670 W		≤ 10,400 Btu/hr	
6-pan and larger	≤ 800 W		≤ 12,500 Btu/hr	

Definition of Baseline Equipment

The baseline equipment is a new electric or natural gas steam cooker that is not ENERGY STAR® certified.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years.[50]

Deemed Measure Cost

Actual incremental cost for this measure should be used. If actuals are unavailable use $4,150.[51]

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[50] Lifetime from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator, which cites reference as "FSTC research on available models, 2009."
http://www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx
[51] Ameren Missouri Technical Resource Manual – Effective January 1, 2018.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation for an electric steam cooker below; otherwise use deemed value from the table that follows.[52]

$$\Delta kWh = (\Delta IdleEnergy + \Delta CookingEnergy) * Days/1{,}000$$

Where:

ΔIdleEnergy = [(1 – SteamMode) *($IdleRate_{Base}$ + SteamMode * $Production_{Base}$ * Pans *EFOOD/Eff_{Base})* (Hours – FoodCooked/($Production_{Base}$ * Pans))] – [(1 – SteamMode) *($IdleRate_{ESTAR}$ + SteamMode * $Production_{ESTAR}$ * Pans *EFOOD/Eff_{ESTAR})* (Hours – FoodCooked/($Production_{ESTAR}$ * Pans))]

ΔCookingEnergy = (FoodCooked * EFOOD/ Eff_{Base}) – (FoodCooked * EFOOD/ Eff_{ESTAR})

Where:

ΔIdleEnergy = Difference in idle energy between baseline and efficient steam cooker

ΔCookingEnergy = Difference in cooking energy between baseline and efficient steam cooker

Days = Annual days of operation

= Custom or, if unknown, use 365.25 days per year

1,000 = Wh to kWh conversion factor

SteamMode = Time (%) in constant steam mode

= Custom or, if unknown, use 40%

$IdleRate_{Base}$ = Idle energy rate (W) of baseline electric steam cooker

= 1,100 W[53]

$IdleRate_{ESTAR}$ = Idle energy rate (W) of ENERGY STAR electric steam cooker

= Custom or, if unknown, use value from table below as determined by pan capacity

Pan Capacity	$IdleRate_{ESTAR}$
3	400
4	530
5	670
6	800
10	800

$Production_{Base}$ = Production capacity (lb/hr) per pan of baseline electric steam cooker

= 23.3 lb/hr

[52] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

[53] Idle energy rate for baseline steam cookers is the average of rates provided by ENERGY STAR® for steam generator and boiler-based cookers.

$Production_{ESTAR}$ = Production capacity (lb/hr) per pan of ENERGY STAR® electric steam cooker

= Custom or, if unknown, use 16.7 lb/hr

Pans = Pan capacity of steam cooker

= Custom or, if unknown, use 6 pans

EFOOD = ASTM energy to food

= 30.8 Wh/lb

Eff_{Base} = Cooking efficiency (%) of baseline electric steam cooker[54]

= 28%

Eff_{ESTAR} = Cooking efficiency (%) of ENERGY STAR® electric steam cooker

= Custom or, if unknown, use 50%

Hours = Average daily hours of operation

= Custom or, if unknown, use 12 hours per day

FoodCooked = Food cooked per day (lbs)

= Custom or, if unknown, use 100 pounds

Savings for all pan capacities are presented in the table below.

Energy Consumption of Electric Steam Cookers			
Pan Capacity	**kWh_{Base}**	**kWh_{ESTAR}**	**Savings (kWh)**
3	18,438.9	7,637.6	10,801.3
4	23,018.6	9,784.1	13,234.5
5	27,563.8	11,953.8	15,609.9
6	32,091.7	14,100.1	17,991.6
10	50,134.5	21,384.3	28,750.1
Average	30,249.5	12,972.0	17,277.5

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001998949[55]

Other variables as defined above.

[54] Cooking efficiency for baseline steam cookers is the average of efficiencies provided by ENERGY STAR® Commercial Kitchen Equipment Savings Calculator for steam generator and boiler-based cookers.

[55] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Electric Cooking. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

NATURAL GAS ENERGY SAVINGS

Custom calculation for a natural gas steam cooker below; otherwise use deemed value from the table that follows.[56]

$$\Delta Therms = (\Delta IdleEnergy + \Delta CookingEnergy) * Days/100{,}000$$

Where:

ΔIdleEnergy = [(1 – SteamMode) *($IdleRate_{Base}$ + SteamMode * $Production_{Base}$ * Pans *EFOOD/Eff_{Base})* (Hours – FoodCooked/($Production_{Base}$ * Pans))] – [(1 – SteamMode) *($IdleRate_{ESTAR}$ + SteamMode * $Production_{ESTAR}$ * Pans *EFOOD/Eff_{ESTAR})* (Hours – FoodCooked/$Production_{ESTAR}$ * Pans)]

ΔCookingEnergy = (FoodCooked * EFOOD/ Eff_{Base}) – (FoodCooked * EFOOD/ Eff_{ESTAR})

Where:

100,000 = Btu to therms conversion factor

$IdleRate_{Base}$ = Idle energy rate (Btu/hr) of baseline gas steam cooker

= 16,500 Btu/hr[57]

$IdleRate_{ESTAR}$ = Idle energy rate (Btu/hr) of ENERGY STAR® gas steam cooker

= Custom or, if unknown, use value from table below as determined by pan capacity

Pan Capacity	$IdleRate_{ESTAR}$
3	6,250
5	10,400
6	12,500
10	12,500

$Production_{Base}$ = Production capacity (lb/hr) per pan of baseline gas steam cooker

= 23.3 lb/hr

$Production_{ESTAR}$ = Production capacity (lb/hr) per pan of ENERGY STAR® gas steam cooker

= Custom or, if unknown, use 20 lb/hr

EFOOD = ASTM energy to food

= 105 Btu/lb

Eff_{Base} = Cooking efficiency (%) of baseline gas steam cooker[58]

= 16.5%

Eff_{ESTAR} = Cooking efficiency (%) of ENERGY STAR® gas steam cooker

= Custom or if unknown, use 38%

[56] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

[57] Idle energy rate for baseline steam cookers is the average of rates provided by ENERGY STAR® for steam generator and boiler-based cookers.

[58] Cooking efficiency for baseline steam cookers is the average of efficiencies provided by ENERGY STAR® for steam generator and boiler-based cookers.

Other variables as defined above.

Savings for all pan capacities are presented in the table below.

Energy Consumption of Gas Steam Cookers			
Pan Capacity	**$Therms_{Base}$**	**$Therms_{ESTAR}$**	**Savings (Therms)**
3	1,301.5	492.8	808.7
5	1,842.1	795.7	1,046.4
6	2,107.2	947.8	1,159.4
10	3,157.4	1,344.5	1,812.9
Average	1,996.0	845.0	1,150.0

WATER IMPACT DESCRIPTIONS AND CALCULATION

Custom calculation below; otherwise use deemed value of 134,412.0 gallons per year.[59] Savings are the same for electric and gas steam cookers.

$$\Delta Water = (WaterUse_{Base} - WaterUse_{ESTAR}) * Hours * Days$$

Where:

$WaterUse_{Base}$ = Water use (gal/hr) of baseline steam cooker

= 40 gal/hr

$WaterUse_{ESTAR}$ = Water use (gal/hr) of ENERGY STAR® steam cooker[60]

= Custom or, if unknown, use 9.3 gal/hr

Other variables as defined above

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[59] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

[60] Water use for ENERGY STAR® steam cookers is the average of water use values provided by ENERGY STAR® for steam generator, boiler-based, and boiler-less cookers.

2.3.3 Fryer

DESCRIPTION

This measure applies to electric or natural gas fired ENERGY STAR® certified fryers installed in a commercial kitchen. ENERGY STAR® fryers offer shorter cook times and higher production rates through advanced burner and heat exchanger designs. Fry pot insulation reduces standby losses, resulting in lower idle energy rates. Standard-sized ENERGY STAR® fryers are up to 30% more efficient, and large-vat ENERGY STAR® fryers are up to 35% more efficient, than standard fryers.

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be an ENERGY STAR® certified fryer meeting idle energy rate (W or Btu/hr) and cooking efficiency (%) limits, as determined by both fuel type and fryer capacity (standard versus large vat).

ENERGY STAR® Requirements (Version 2.0, Effective April 22, 2011)

Fryer Capacity	Electric Efficiency Requirements		Natural Gas Efficiency Requirements	
	Idle Energy Rate	Cooking Efficiency Consumption	Idle Energy Rate	Cooking Efficiency Consumption
Standard Open Deep-Fat Fryer	≤ 1,000 W	≥ 80%	≤ 9,000 Btu/hr	≥ 50%
Large Vat Open Deep-Fat Fryer	≤ 1,100 W		≤ 12,000 Btu/hr	

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a new electric or natural gas fryer that is not ENERGY STAR® certified.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years.[61]

DEEMED MEASURE COST

The incremental capital cost for this measure is $210 for standard electric, $0 for large vat electric, $0 for standard gas, and $1,120 for large vat gas fryers.[62]

[61] Lifetime from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator, which cites reference as "FSTC research on available models, 2009." https://www.energystar.gov/sites/default/files/asset/document/commercial_kitchen_equipment_calculator.xlsx.

[62] Measure costs from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator, which cites reference as "EPA research using AutoQuotes, 2012."

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CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation for an electric fryer below; otherwise use deemed value of 952.3 kWh for standard fryers and 2,537.9 kWh for large vat fryers.[63]

$$\Delta kWh = (\Delta IdleEnergy + \Delta CookingEnergy) * Days / 1{,}000$$

Where:

ΔIdleEnergy = $(ElecIdle_{Base} * (Hours - FoodCooked/ElecPC_{Base})) - (ElecIdle_{ESTAR} * (Hours - FoodCooked/ElecPC_{ESTAR}))$

ΔCookingEnergy = $(FoodCooked * EFOOD_{Elec} / ElecEff_{Base}) - (FoodCooked * EFOOD_{Elec} / ElecEff_{ESTAR})$

Where:

ΔIdleEnergy = Difference in idle energy between baseline and efficient fryer

ΔCookingEnergy = Difference in cooking energy between baseline and efficient fryer

Days = Annual days of operation

= Custom or, if unknown, use 365.25 days per year

1,000 = Wh to kWh conversion factor

$ElecIdle_{Base}$ = Idle energy rate of baseline electric fryer

= 1,050 W for standard fryers and 1,350 W for large vat fryers

$ElecIdle_{ESTAR}$ = Idle energy rate of ENERGY STAR® electric fryer

= Custom or, if unknown, use 1,000 W for standard fryers and 1,100 for large vat fryers

Hours = Average daily hours of operation

= Custom or, if unknown, use 16 hours per day for a standard fryer and 12 hours per day for a large vat fryer

FoodCooked = Food cooked per day

= Custom or, if unknown, use 150 pounds

$ElecPC_{Base}$ = Production capacity of baseline electric fryer

= 65 lb/hr for standard fryers and 100 lb/hr for large vat fryers

$ElecPC_{ESTAR}$ = Production capacity of ENERGY STAR® electric fryer

= Custom or, if unknown, use 70 lb/hr for standard fryers and 110 lb/hr for large vat fryers

$EFOOD_{Elec}$ = ASTM energy to food

[63] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

= 167 Wh/lb

$ElecEff_{Base}$ = Cooking efficiency of baseline electric fryer

= 75% for standard fryers and 70% for large vat fryers

$ElecEff_{ESTAR}$ = Cooking efficiency of ENERGY STAR® electric fryer

= Custom or, if unknown, use 80% for both standard and large vat fryers

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW \quad = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001998949[64]

Other variables as defined above.

NATURAL GAS ENERGY SAVINGS

Custom calculation for a natural gas fryer below; otherwise use deemed value of 507.9 therms/yr for standard fryers and 415.1 therms/yr for large vat fryers.[65]

$$\Delta Therms = (\Delta IdleEnergy + \Delta CookingEnergy) * Days/100{,}000$$

Where:

ΔIdleEnergy = $(GasIdle_{Base} * (Hours - FoodCooked/GasPC_{Base})) - (GasIdle_{ESTAR} * (Hours - FoodCooked/GasPC_{ESTAR}))$

ΔCookingEnergy = $(FoodCooked * EFOOD_{Gas} / GasEff_{Base}) - (FoodCooked * EFOOD_{Gas}/GasEff_{ESTAR})$

Where:

100,000 = Btu to therms conversion factor

$GasIdle_{Base}$ = Idle energy rate of baseline gas fryer

= 14,000 Btu/hr for standard fryers and 16,000 Btu/hr for large vat fryers

$GasIdle_{ESTAR}$ = Idle energy rate of ENERGY STAR® gas fryer

= Custom or, if unknown, use 9,000 Btu/hr for standard fryers and 12,000 Btu/hr for large vat fryers

$GasPc_{Base}$ = Production capacity of baseline gas fryer

= 60 lb/hr for standard fryers and 100 lb/hr for large vat fryers

$GasPc_{ESTAR}$ = Production capacity of ENERGY STAR® gas fryer

= Custom or, if unknown, use 65 lb/hr for standard fryers and 110 lb/hr for large vat fryers

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[64] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Electric Cooking. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

[65] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

$EFOOD_{Gas}$ = ASTM energy to food

= 570 Btu/lb

$GasEff_{Base}$ = Cooking efficiency of baseline gas fryer

= 35% for both standard and large vat fryers

$GasEff_{ESTAR}$ = Cooking efficiency of ENERGY STAR® gas fryer

= Custom or, if unknown, use 50% for both standard and large vat fryers

Other variables as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.3.4 Convection Oven

Description

This measure applies to either full or half-sized electric ENERGY STAR® convection ovens and to half-sized natural gas fired ENERGY STAR® convection ovens installed in a commercial kitchen. Convection ovens are general purpose ovens that use fans to circulate hot, dry air over the food surface. ENERGY STAR® certified convection ovens are approximately 20% more efficient than standard ovens.

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, measure savings should be verified.

Definition of Efficient Equipment

To qualify for this measure, the installed equipment must be an ENERGY STAR® certified convection oven meeting idle energy rate (kW or Btu/hr) and cooking efficiency (%) limits, as determined by both fuel type and oven capacity (full size versus half size).

ENERGY STAR® Requirements (Version 2.2, Effective October 7, 2015)

Oven Capacity	Electric Efficiency Requirements		Natural Gas Efficiency Requirements	
	Idle Energy Rate	Cooking Efficiency	Idle Energy Rate	Cooking Efficiency
Full Size	≤ 1.60 kW	≥ 71%	≤ 12,000 Btu/hr	≥ 46%
Half Size	≤ 1.00 kW		N/A	N/A

Definition of Baseline Equipment

The baseline equipment is a new electric or natural gas convection oven that is not ENERGY STAR® certified.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years.[66]

Deemed Measure Cost

The incremental capital cost for this measure is $0.[67]

[66] Lifetime from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator, which cites reference as "FSTC research on available models, 2009." https://www.energystar.gov/sites/default/files/asset/document/commercial_kitchen_equipment_calculator.xlsx.
[67]Measure cost from ENERGY STAR® which cites reference as "EPA research on available models using AutoQuotes, 2013."

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CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation for an electric convection oven below; otherwise use 1,938.5 kWh for full-size ovens and 192.1 kWh for half-size ovens.[68]

$$\Delta kWh = (\Delta IdleEnergy + \Delta CookingEnergy) * Days/1{,}000$$

Where:

ΔIdleEnergy = ($ElecIdle_{Base}$* (Hours - FoodCooked/$ElecPC_{Base}$)) - ($ElecIdle_{ESTAR}$ * (Hours -FoodCooked/$ElecPC_{ESTAR}$))

ΔCookingEnergy = (FoodCooked * $EFOOD_{Elec}$/ $ElecEff_{Base}$) - (FoodCooked * $EFOOD_{Elec}$/ $ElecEff_{ESTAR}$)

Where:

ΔIdleEnergy = Difference in idle energy between baseline and efficient convection oven

ΔCookingEnergy = Difference in cooking energy between baseline and efficient convection oven

Days = Annual days of operation

= Custom or, if unknown, use 365.25 days per year

1,000 = Wh to kWh conversion factor

$ElecIdle_{Base}$ = Idle energy rate of baseline electric convection oven

= 2,000 W for full-size ovens and 1,030 W for half-size ovens

$ElecIdle_{ESTAR}$ = Idle energy rate of ENERGY STAR® electric convection oven

= Custom or, if unknown, use 1,600 W for full-size ovens and 1,000 W for half-size ovens

Hours = Average daily hours of operation

= Custom or, if unknown, use 12 hours per day

FoodCooked = Food cooked per day

= Custom or, if unknown, use 100 pounds

$ElecPC_{Base}$ = Production capacity of baseline electric convection oven

= 90 lb/hr for full-size ovens and 45 lb/hr for half-size ovens

$ElecPC_{ESTAR}$ = Production capacity of ENERGY STAR® electric convection oven

= Custom or, if unknown, use 90 lb/hr for full-size ovens and 50 lb/hr for half-size ovens

$EFOOD_{Elec}$ = ASTM energy to food for electric convection oven

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[68] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

= 73.2 Wh/lb

$ElecEff_{Base}$ = Cooking efficiency of baseline electric convection oven

= 65% for full-size ovens and 68% for half-size ovens

$ElecEff_{ESTAR}$ = Cooking efficiency of ENERGY STAR® electric convection oven

= Custom or, if unknown, use 71% for both full-size and half-size ovens

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW \quad = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001998949[69]

Other variables as defined above.

NATURAL GAS ENERGY SAVINGS

Custom calculation for a natural gas convection oven below, otherwise use deemed value of 129.4 therms/yr.[70]

$$\Delta Therms = (\Delta IdleEnergy + \Delta CookingEnergy) * Days/100{,}000$$

Where:

ΔIdleEnergy = ($GasIdle_{Base}$* (Hours - FoodCooked/$GasPC_{Base}$)) - ($GasIdle_{ESTAR}$ * (Hours -FoodCooked/$GasPC_{ESTAR}$))

ΔCookingEnergy = (FoodCooked * $EFOOD_{Gas}$/ $GasEff_{Base}$) - (FoodCooked * $EFOOD_{Gas}$/ $GasEff_{ESTAR}$)

Where:

100,000 = Btu to therms conversion factor

$GasIdle_{Base}$ = Idle energy rate of baseline gas convection oven

= 15,100 Btu/hr

$GasIdle_{ESTAR}$ = Idle energy rate of ENERGY STAR® gas convection oven

= Custom or, if unknown, use 12,000 Btu/hr

$GasPC_{Base}$ = Production capacity of baseline gas convection oven

= 83 lb/hr

$GasPC_{ESTAR}$ = Production capacity of ENERGY STAR® gas convection oven

= Custom or, if unknown, use 86 lb/hr

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[69] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Electric Cooking. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

[70] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

$EFOOD_{Gas}$ = ASTM energy to food for gas convection oven

= 250 Btu/lb

$GasEff_{Base}$ = Cooking efficiency of baseline gas convection oven

= 44%

$GasEff_{ESTAR}$ = Cooking efficiency of ENERGY STAR® gas convection oven

= Custom or, if unknown, use 46%

Other variables as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.3.5 Griddle

Description

This measure applies to electric or natural gas fired ENERGY STAR® certified griddles installed in a commercial kitchen. ENERGY STAR® commercial griddles achieve approximately 10% higher efficiency than standard griddles with strategies such as highly conductive or reflective plate materials and improved thermostatic controls.

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, measure savings should be verified.

Definition of Efficient Equipment

To qualify for this measure the installed equipment must be a new ENERGY STAR® electric or natural gas fired griddle meeting idle energy rate limits as determined by fuel type.

ENERGY STAR® Requirements (Version 1.2, Effective May 8, 2009 for natural gas and January 1, 2011 for electric griddles)

Electric Efficiency Requirements		Natural Gas Efficiency Requirements	
Idle Energy Rate	Cooking Efficiency Consumption	Idle Energy Rate	Cooking Efficiency Consumption
≤ 320 W/ft^2 ≤ 1.00 kW	Reported	≤ 2,650 Btu/hr/ft^2 N/A	Reported

Definition of Baseline Equipment

The baseline equipment is a new electric or natural gas fired griddle that is not ENERGY STAR® certified.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years.[71]

Deemed Measure Cost

The incremental capital cost for this measure is $0 for an electric griddle and $360 for a gas griddle.[72]

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Calculation of Savings

Electric Energy Savings

Custom calculation for an electric griddle below; otherwise use deemed value of 1,910.4 kWh.[73]

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[71] Lifetime from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator, which cites reference as "FSTC research on available models, 2009." http://www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx

[72] Measure costs from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator, which cites reference as "EPA research on available models using AutoQuotes, 2012." http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG.

[73] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

$$\Delta kWh = (\Delta IdleEnergy + \Delta CookingEnergy) * Days/1{,}000$$

Where:

ΔIdleEnergy	= [($ElecIdle_{Base}$* Width * Depth) * (Hours – FoodCooked/$ElecPC_{Base}$)] – [($ElecIdle_{ESTAR}$ * Width * Depth) * (Hours – FoodCooked/$ElecPC_{ESTAR}$))
ΔCookingEnergy	= (FoodCooked * $EFOOD_{Elec}$/ $ElecEff_{Base}$) – (FoodCooked * $EFOOD_{Elec}$/ $ElecEff_{ESTAR}$)

Where:

ΔIdleEnergy	= Difference in idle energy between baseline and efficient griddle
ΔCookingEnergy	= Difference in cooking energy between baseline and efficient griddle
Days	= Annual days of operation
	= Custom or, if unknown, use 365.25 days per year
1,000	= Wh to kWh conversion factor
$ElecIdle_{Base}$	= Idle energy rate of baseline electric griddle
	= 400 W/ft^2
$ElecRate_{ESTAR}$	= Idle energy rate of ENERGY STAR® electric griddle
	= Custom or, if unknown, use 320 W/ft^2
Width	= Griddle width
	= Custom or, if unknown, use 3 feet
Depth	= Griddle depth
	= Custom or, if unknown, use 2 feet
Hours	= Average daily hours of operation
	= Custom or, if unknown, use 12 hours per day
FoodCooked	= Food cooked per day
	= Custom or, if unknown, use 100 pounds
$ElecPC_{Base}$	= Production capacity of baseline electric griddle
	= 35 lb/hr
$ElecPC_{ESTAR}$	= Production capacity of ENERGY STAR® electric griddle
	= Custom or, if unknown, use 40 lb/hr
$EFOOD_{Elec}$	= ASTM energy to food
	= 139 Wh/lb
$ElecEff_{Base}$	= Cooking efficiency of baseline electric griddle
	= 65%
$ElecEff_{ESTAR}$	= Cooking efficiency of ENERGY STAR® electric griddle
	= Custom or, if unknown, use 70%

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001998949[74]

Other variables as defined above.

NATURAL GAS ENERGY SAVINGS

Custom calculation for a natural gas griddle below; otherwise use deemed value of 131.4 therms.[75]

$$\Delta Therms = (\Delta IdleEnergy + \Delta CookingEnergy) * Days/100{,}000$$

Where:

$\Delta IdleEnergy$ = [$GasIdle_{Base}$* (Width * Depth) * (Hours – FoodCooked/$GasPC_{Base}$)] – [$GasIdle_{ESTAR}$ * (Width * Depth) * (Hours – FoodCooked/$GasPC_{ESTAR}$))

$\Delta CookingEnergy$ = (FoodCooked * $EFOOD_{Gas}$/ $GasEff_{Base}$) – (FoodCooked * $EFOOD_{Gas}$/ $GasEff_{ESTAR}$)

Where:

100,000 = Btu to therms conversion factor

$GasIdle_{Base}$ = Idle energy rate of baseline gas griddle

= 3,500 Btu/hr/ft^2

$GasIdle_{ESTAR}$ = Idle energy rate of ENERGY STAR® gas griddle

= Custom or, if unknown, use 2,650 Btu/hr/ft^2

$GasPC_{Base}$ = Production capacity of baseline gas griddle

= 25 lb/hr

$GasPC_{ESTAR}$ = Production capacity of ENERGY STAR® gas griddle

= Custom or, if unknown, use 45 lb/hr

$EFOOD_{Gas}$ = ASTM energy to food

= 475 Btu/lb

$GasEff_{Base}$ = Cooking efficiency of baseline gas griddle

= 32%

$GasEff_{ESTAR}$ = Cooking efficiency of ENERGY STAR® gas griddle

= Custom or, if unknown, use 38%

Other variables as defined above.

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[74] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Electric Cooking. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

[75] Algorithms and assumptions derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

Water Impact Descriptions and Calculation

N/A

Deemed O&M Cost Adjustment Calculation

N/A

Measure Code:

2.3.6 Kitchen Demand Ventilation Controls

DESCRIPTION

This measure related to the installation of commercial kitchen demand ventilation controls that vary the kitchen ventilation exhaust and make-up airflow based on cooking load and/or time of day.

This measure was developed to be applicable to the following program types: TOS and RF. For TOS applications. ASHRAE 90.1 and local codes should be applied to situations where hood exhaust rates exceed 5,000 cfm. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the installed equipment must be a control system that varies the exhaust rate of kitchen ventilation (exhaust and makeup air fans) based on the energy and effluent output from the cooking appliances (i.e., the more heat and smoke/vapors generated, the more ventilation needed). This involves installing a new temperature sensor in the hood exhaust collar and/or an optic sensor on the end of the hood that sense cooking conditions which allows the system to automatically vary the rate of exhaust to what is needed by adjusting the fan speed accordingly.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is kitchen ventilation system that has constant speed, continuously operating ventilation motor(s).

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[76]

DEEMED MEASURE COST

The capital cost for this measure is proportional to the rated horsepower of the exhaust motor(s), based on installation classification:

Measure Cost $= HP_{exhaust} * Cost_{HP}$

Where:

$HP_{exhaust}$ = total rated horsepower of the exhaust motor(s)

$Cost_{HP}$ = cost per horsepower as listed in the table below

Measure Category	Incremental Cost[77] , $/HP
Retrofit	$1,988
Time of Sale	$994

[76] Pacific Gas & Electric Company Work Paper PGECOFST116 Demand Ventilation Controls Revision # 1, June 1, 2009.
[77] Pacific Gas & Electric Company Work Paper PGECOFST116 Demand Ventilation Controls Revision # 1, June 1, 2009.

LOADSHAPE

Cooking BUS **Algorithm**

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Fan energy savings:

$$\Delta kWh = HP_{exhaust} * (0.76\ kW/HP^{78}) * Hours * Days$$

Where:

Hours = Average daily hours of operation. If unknown, assume 12 hours.

Days = Annual days of operation. If unknown assume 365.25 days.

Other variables as defined above.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001998949[79]

NATURAL GAS ENERGY SAVINGS

For applications where 100% make-up air is tempered, annual gas savings attributed to heating can be estimated as:

$$\Delta Therms = CFM * HP_{exhaust} * Hours/24 * Q * /(Eff_{heat} * 100{,}000)$$

Where:

CFM = average airflow reduction for the system, per rated horsepower of exhaust motor(s).

= custom input, or 448 cfm/HP[80] if unknown.

Q = Annual heating energy required (tabulated values represenent continuous operation) to heat kitchen make-up air, Btu/cfm.[81]

[78] Normalized demand savings per rated HP of exhaust motor. Pacific Gas & Electric Company Work Paper PGECOFST116 Demand Ventilation Controls Revision # 1, June 1, 2009.

[79] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Electric Cooking. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

[80] Based on data presented in Pacific Gas & Electric Company Work Paper PGECOFST116 Demand Ventilation Controls Revision # 1, June 1, 2009. See workbook KDVC.xlsx for derivation.

[81] Assuming a base temperature of 65. It is assumed that kitchens often separate dedicated 100% outdoor air make up units and kitchen staff prefer to have outside air heated to 65 degrees. See workbook KDVC.xlsx for derivation.

Zone	Q, Btu/cfm
St Louis	125,363

Eff_{heat} = Heating efficiency of unit supplying make-up air.

= actual if known, otherwise assume 80%[82]

100,000 = conversion from Btu to Therm

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[82] IECC code minimum thermal efficiency requirements for a warm air duct furnace.

2.3.7 Hot Food Holding Cabinet

Description

This measure applies to electric ENERGY STAR® certified hot food holding cabinets (HFHCs) installed in a commercial kitchen. ENERGY STAR® HFHCs achieve approximately 70% higher efficiency than standard models by incorporating better insulation which reduces heat loss, offers better temperature uniformity within the cabinet from top to bottom, and keeps the external cabinet cooler. In addition, many certified HFHCs may include additional energy saving devices such as magnetic door gaskets, auto-door closures, or dutch doors.

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, the measure savings should be verified.

Definition of Efficient Equipment

To qualify for this measure, the installed equipment must be a new ENERGY STAR® electric HFHC meeting idle energy rate limits as determined by product interior volume.

ENERGY STAR® Requirements (Version 2.0, Effective October 1, 2011)

Interior Volume (ft^3)	Idle Energy Consumption Rate (W)
0 < V < 13	≤ 21.5 V
13 ≤ V < 28	≤ 2.0 V + 254.0
28 ≤ V	≤ 3.8 V + 203.5

Definition of Baseline Equipment

The baseline equipment is a new electric HFHC that is not ENERGY STAR® certified.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years.[83]

Deemed Measure Cost

Actual incremental costs should be used if available. If actual costs are unknown, assume $1,783.[84]

Loadshape

Cooking BUS

[83] Lifetime from ENERGY STAR® Commercial Kitchen Equipment Calculator, which cites reference as "FSTC research on available models, 2009."
[84] Ameren Missouri Technical Resource Manual – Effective January 1, 2018.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation below.[85]

$$\Delta kWh = (IdleRate_{Base} - IdleRate_{EE}) * Hours * Days/1{,}000$$

$IdleRate_{Base}$ = Idle energy rate (W) of baseline HFHC

= 40 * V

Where:

V = Interior volume (ft^3) of new HFHC

= Custom

$IdleRate_{ESTAR}$ = Idle energy rate (W) of ENERGY STAR® HFHC

= See table below for idle energy rates based on interior volume

Interior Volume (ft^3)	Idle Energy Consumption Rate (W)
0 < V < 13	21.5 * V
13 ≤ V < 28	(2.0 * V) + 254.0
28 ≤ V	(3.8 * V) + 203.5

Hours = Average daily hours of operation

= Custom or, if unknown, use 15 hours per day

Days = Annual days of operation

= Custom or, if unknown, use 365.25 days per year

1,000 = Wh to kWh conversion factor

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001998949[86]

Other variables as defined above.

[85] Algorithms and assumptions derived from Commercial Kitchen Equipment Calculator.

[86] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Electric Cooking. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.3.8 Pre-Rinse Spray Valve

DESCRIPTION

Pre-rinse valves use a spray of water to remove food waste from dishes prior to cleaning in a dishwasher. More efficient spray valves use less water, thereby reducing water consumption, water heating cost, and waste water (sewer) charges. Pre-rinse spray valves include a nozzle, squeeze lever, and dish guard bumper. The primary impacts of this measure are water savings. Reduced hot water consumption saves either natural gas or electricity, depending on the type of energy the hot water heater uses.

This measure was developed to be applicable to the following program types: TOS, RF, and DI. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the new or replacement pre-rinse spray nozzle must use less than 1.6 gallons per minute.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment will vary based on the delivery method and is defined below:

Time of Sale	Retrofit, Direct Install
The baseline equipment is assumed to be 1.6 gallons per minute. The Energy Policy Act of 2005 sets the maximum flow rate for pre-rinse spray valves at 1.6 gallons per minute at 60 pounds per square inch of water pressure when tested in accordance with ASTM F2324-03. This performance standard went into effect January 1, 2006.	Actual existing flow rates should be used when possible. If unknown, baseline can be assumed to be 2.23 gallons per minute.[87] If existing pre-rinse spray valve flow rate is unknown, then existing pre-rinse spray valve must have been installed prior to 2006. The Energy Policy Act of 2005 sets the maximum flow rate for pre-rinse spray valves at 1.6 gallons per minute at 60 pounds per square inch of water pressure when tested in accordance with ASTM F2324-03. This performance standard went into effect January 1, 2006. However, field data shows that not all nozzles in use have been replaced with the newer flow rate nozzle. Products predating this standard can use up to five gallons per minute.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 5 years[88]

DEEMED MEASURE COST

When available, the actual cost of the measure should be used. If unknown, a default value of $92.90[89] may be assumed.

[87] Verification measurements taken at 195 installations showed average pre flowrates of 2.23 gallons per minute. IMPACT AND PROCESS EVALUATION FINAL REPORT for CALIFORNIA URBAN WATER CONSERVATION COUNCIL 2004-5 PRE-RINSE SPRAY VALVE INSTALLATION PROGRAM (PHASE 2) (PG&E Program # 1198-04; SoCalGas Program 1200-04) ("CUWCC Report," Feb 2007).
[88] Consistent with Ameren Missouri MEEIA 2016-18 and KCPL TRM assumptions.
[89] Average of costs recognized by Ameren Missouri ($85.8) and KCPL ($100).

LOADSHAPE

Cooking BUS**Algorithm**

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS (NOTE WATER SAVINGS MUST FIRST BE CALCULATED)

$$\Delta kWH = \Delta Gallons * 8.33 * 1 * (Tout - Tin) * (1/EFF\_Elec) / 3{,}413$$

Where:

ΔGallons = amount of water saved as calculated below in Water Impact Calculation

8.33 = specific mass in pounds of one gallon of water (lbm/gal)

1 = Specific heat of water: 1 Btu/lbm/°F

Tout = Water Heater Outlet Water Temperature

= Custom, otherwise assume Tin + 70°F temperature rise from Tin[90]

Tin = Inlet Water Temperature

= Custom, otherwise assume 57.9F[91]

EFF_Elec = Efficiency of electric water heater supplying hot water to pre-rinse spray valve

=Custom, otherwise assume 97%[92]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001998949[93]

NATURAL GAS ENERGY SAVINGS

ΔTherms = ΔGallons * 8.33 * 1 * (Tout - Tin) * (1/EFF_Gas) /100,000

Where (new variables only):

EFF_Gas = Efficiency of gas water heater supplying hot water to pre-rinse spray valve

= Custom, otherwise assume 80%[94]

[90]If unknown, assume a 70 degree temperature rise from Tin per Food Service Technology Center calculator assumptions to account for variations in mixing and water heater efficiencies.

[91] Using 40" deep soil temp as a proxy at Powell Gardens SCAN site. Average by month of available data from 3/28/02–10/11/14: 12 month average is 57.898. http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=2061.

[92]This efficiency value is based on IECC 2012/2015 performance requirement for electric resistant water heaters rounded without the slight adjustment allowing for reduction based on size of storage tank.

[93] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Electric Cooking. See reference “Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf.”

[94] IECC 2012/2015, Table C404.2, Minimum Performance of Water-Heating Equipment.

WATER IMPACT CALCULATION

$$\Delta Gallons = (FLObase - FLOeff) * 60 * HOURSday * DAYSyear$$

Where:

FLObase = Base case flow in gallons per minute (Gal/min). Use actual when appropriate if available, otherwise assume:

Time of Sale	Retrofit, Direct Install
1.6 gal/min[95]	2.23 gal/min[96]

FLOeff = Efficient case flow in gallons per minute (Gal/min). Use actual flow rate of installed equipment if known, otherwise assume:

Time of Sale	Retrofit, Direct Install
1.06 gal/min[97]	1.06 gal/min[98]

60 = Minutes per hour

HOURSday = Hours per day that the pre-rinse spray valve is used at the site, custom, otherwise:[99]

Application	Hours/day
Small, quick- service restaurants	1
Medium-sized casual dining restaurants	1.5
Large institutional establishments with cafeteria	3

DAYSyear = Days per year pre-rinse spray valve is used at the site, custom, otherwise 312 days/yr based on assumed 6 days/wk x 52 wk/yr = 312 day/yr.

MEASURE CODE:

[95]The baseline equipment is assumed to be 1.6 gallons per minute. The Energy Policy Act (EPAct) of 2005 sets the maximum flow rate for pre-rinse spray valves at 1.6 gallons per minute at 60 pounds per square inch of water pressure when tested in accordance with ASTM F2324-03. This performance standard went into effect January 1, 2006. www1.eere.energy.gov/femp/pdfs/spec_prerinsesprayvavles.pdf.

[96] Verification measurements taken at 195 installations showed average pre flowrates of 2.23 gallons per minute. IMPACT AND PROCESS EVALUATION FINAL REPORT for CALIFORNIA URBAN WATER CONSERVATION COUNCIL 2004-5 PRE-RINSE SPRAY VALVE INSTALLATION PROGRAM (PHASE 2) (PG&E Program # 1198-04; SoCalGas Program 1200-04) ("CUWCC Report," Feb 2007).

[97]1.6 gallons per minute used to be the high efficiency flow, but more efficient spray valves are available ranging down to 0.64 gallons per minute per Federal Energy Management Program which references the Food Services Technology Center web site with the added note that even more efficient models may be available since publishing the data. The average of the nozzles listed on the FSTC website is 1.06.

[98]1.6 gallons per minute used to be the high efficiency flow, but more efficient spray valves are available ranging down to 0.64 gallons per minute per Federal Energy Management Program which references the Food Services Technology Center web site with the added note that even more efficient models may be available since publishing the data. The average of the nozzles listed on the FSTC website is 1.06.

[99] Hours primarily based on PG& E savings estimates, algorithms, sources (2005), Food Service Pre-Rinse Spray Valves.

2.4 Hot Water

2.4.1 Low Flow Faucet Aerator

DESCRIPTION

This measure relates to the direct installation of a low flow faucet aerator in a commercial building. Expected applications include small business, office, restaurant, or motel. For multifamily or senior housing, the residential low flow faucet aerator should be used.

This measure was developed to be applicable to the following program type: DI.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the installed equipment must be an energy efficient faucet aerator, for bathrooms rated at 1.5 gallons per minute (GPM) or less, or for kitchens rated at 2.2 GPM or less. Savings are calculated on an average savings per faucet fixture basis.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is assumed to be a standard bathroom faucet aerator rated at 2.25 GPM or more, or a standard kitchen faucet aerator rated at 2.75 GPM or more.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 9 years.[100]

DEEMED MEASURE COST

The incremental cost for this measure is $8[101] or program actual

LOADSHAPE

Water Heating BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Note these savings are *per* faucet retrofitted.[102]

$$\Delta kWh = \%ElectricDHW * ((GPM\_base - GPM\_low)/GPM\_base) * Usage * EPG\_electric * ISR$$

Where:

[100] Table C-6, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. "http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure_life_GDS%5B1%5D.pdf."

[101] Direct-install price per faucet assumes cost of aerator and install time. (2011, Market research average of $3 and assess and install time of $5 (20min @ $15/hr).

[102] This algorithm calculates the amount of energy saved per aerator by determining the fraction of water consumption savings for the upgraded fixture. Due to the distribution of water consumption by fixture type, as well as the different number of fixtures in a building, several variables must be incorporated.

%ElectricDHW = proportion of water heating supplied by electric resistance heating

DHW fuel	%Electric_DHW
Electric	100%
Fossil Fuel	0%
Unknown	43%[103]

GPM_base = Average flow rate, in gallons per minute, of the baseline faucet "as-used"

= 1.2[104] or custom based on metering studies[105]

GPM_low = Average flow rate, in gallons per minute, of the low-flow faucet aerator "as-used"

= 0.94[106] or custom based on metering studies[107]

Usage = Estimated usage of mixed water (mixture of hot water from water heater line and cold-water line) per faucet (gallons per year)

= If data is available to provide a reasonable custom estimate it should be used, if not use the following defaults (or substitute custom information in to the calculation):

Building Type	Gallons hot water per unit per day[108] (A)	Unit	Estimated % hot water from Faucets[109] (B)	Multiplier[110] (C)	Unit	Days per year (D)	Annual gallons mixed water per faucet (A*B*C*D)
Small Office	1	person	100%	10	employees per faucet	250	2,500
Large Office	1	person	100%	45	employees per faucet	250	11,250
Fast Food Rest	0.7	meal/day	50%	75	meals per faucet	365	9,581
Sit-Down Rest	2.4	meal/day	50%	36	meals per faucet	365	15,768

[103] Default assumption for unknown fuel is based on EIA Commercial Building Energy Consumption Survey (CBECS) 2012 for Midwest North Central Region (see 'HC8.9 Water Heating in Midwest Region.xls'). If utilities have specific evaluation results providing a more appropriate assumption for buildings in a particular market or geographical area, then they should be used.

[104] Representative baseline flow rate for kitchen and bathroom faucet aerators from sources 1, 2, 3, and 4. This accounts for all throttling and differences from rated flow rates. The most comprehensive available studies did not disaggregate kitchen use from bathroom use, but instead looked at total flow and length of use for all faucets. This makes it difficult to reliably separate kitchen water use from bathroom water use.

[105] Measurement should be based on actual average flow consumed over a period of time rather than a onetime spot measurement for maximum flow. Studies have shown maximum flow rates do not correspond well to average flow rate due to occupant behavior which does not always use maximum flow.

[106] Average retrofit flow rate for kitchen and bathroom faucet aerators from sources 1, 2, 3, and 4. This accounts for all throttling and differences from rated flow rates. Assumes all kitchen aerators at 2.2 gpm or less and all bathroom aerators at 1.5 gpm or less. The most comprehensive available studies did not disaggregate kitchen use from bathroom use, but instead looked at total flow and length of use for all faucets. This makes it difficult to reliably separate kitchen water use from bathroom water use. It is possible that programs installing low-flow aerators lower than the 2.2 gpm for kitchens and 1.5 gpm for bathrooms will see a lower overall average retrofit flow rate.

[107] Measurement should be based on actual average flow consumed over a period of time rather than a onetime spot measurement for maximum flow. Studies have shown maximum flow rates do not correspond well to average flow rate due to occupant behavior which does not always use maximum flow.

[108] Table 2-45 Chapter 49, Service Water Heating, 2007 ASHRAE Handbook, HVAC Applications.

[109] Estimated based on data provided in Appendix E, "Waste Not, Want Not: The Potential for Urban Water Conservation in California," http://www.pacinst.org/reports/urban_usage/appendix_e.pdf.

[110] Based on review of the Illinois plumbing code (Employees and students per faucet). Retail, grocery, warehouse and health are estimates. Meals per faucet estimated as 4 bathroom and 3 kitchen faucets and average meals per day of 250 (based on California study above) – 250/7 = 36. Fast food assumption estimated.

Building Type	Gallons hot water per unit per day[108] (A)	Unit	Estimated % hot water from Faucets [109] (B)	Multiplier [110] (C)	Unit	Days per year (D)	Annual gallons mixed water per faucet (A*B*C*D)
Retail	2	employee	100%	5	employees per faucet	365	3,650
Grocery	2	employee	100%	5	employees per faucet	365	3,650
Warehouse	2	employee	100%	5	employees per faucet	250	2,500
Elementary School	0.6	person	50%	50	students per faucet	200	3,000
Jr High/High School	1.8	person	50%	50	students per faucet	200	9,000
Health	90	patient	25%	2	Patients per faucet	365	16,425
Motel	20	room	25%	1	faucet per room	365	1,825
Hotel	14	room	25%	1	faucet per room	365	1,278
Other	1	employee	100%	20	employees per faucet	250	5,000

EPG_electric = Energy per gallon of mixed water used by faucet (electric water heater)

= (8.33 * 1.0 * (WaterTemp - SupplyTemp)) / (RE_electric * 3412)

= (8.33 * 1.0 * (90 – 57.9)) / (0.98 * 3412)

= 0.0800 kWh/gal

8.33 = Specific weight of water (lbs/gallon)

1.0 = Heat Capacity of water (btu/lb-F)

WaterTemp = Assumed temperature of mixed water

= 90F [111]

SupplyTemp = Assumed temperature of water entering building

= 57.9F [112]

RE_electric = Recovery efficiency of electric water heater

= 98% [113]

3412 = Converts Btu to kWh (Btu/kWh)

ISR = In service rate of faucet aerators

=Assumed to be 1.0

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh * CF

[111]Temperature cited from SBW Consulting, Evaluation for the Bonneville Power Authority, 1994, http://www.bpa.gov/energy/n/reports/evaluation/residential/faucet_aerator.cfm. This is a variable that would benefit from further evaluation.

[112] Using 40" deep soil temp as a proxy at Powell Gardens SCAN site. Average by month of available data from 3/28/02–10/11/14: 12 month average is 57.898. http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=2061

[113] Electric water heater have recovery efficiency of 98%: http://www.ahrinet.org/ARI/util/showdoc.aspx?doc=576

Where:

ΔkWh = calculated value above on a per faucet basis

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001811545FOSSIL FUEL IMPACT DESCRIPTIONS AND CALCULATION

ΔTherms = %FossilDHW * ((GPM_base - GPM_low)/GPM_base) * Usage * EPG_gas * ISR

Where:

%FossilDHW = proportion of water heating supplied by fossil fuel heating

DHW fuel	%Fossil_DHW
Electric	0%
Fossil Fuel	100%
Unknown	57%[114]

EPG_gas = Energy per gallon of mixed water used by faucet (gas water heater)

= (8.33 * 1.0 * (WaterTemp - SupplyTemp)) / (RE_gas * 100,000)

= 0.00772 Therm/gal

Where:

RE_gas = Recovery efficiency of gas water heater

` = 67%[115]

100,000 = Converts Btus to Therms (Btu/Therm)

Other variables as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

Δgallons = ((GPM_base - GPM_low)/GPM_base) * Usage * ISR

Variables as defined above

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

SOURCES USED FOR GPM ASSUMPTIONS

Source ID	Reference
1	2000, Mayer, Peter, William DeOreo, and David Lewis. Seattle Home Water Conservation Study. December 2000.

[114] Default assumption for unknown fuel is based on EIA Commercial Building Energy Consumption Survey (CBECS) 2012 for Midwest North Central Region (see 'HC8.9 Water Heating in Midwest Region.xls'). If utilities have specific evaluation results providing a more appropriate assumption for buildings in a particular market or geographical area, then they should be used.

[115] Review of AHRI Directory suggests range of recovery efficiency ratings for new Gas DHW units of 70-87%. Average of existing units is estimated at 75%. Commercial properties are more similar to MF homes than SF homes. MF hot water is often provided by a larger commercial boiler. This suggests that the average recovery efficiency is somewhere between a typical central boiler efficiency of .59 and the .75 for single family home. An average is used for this analysis by default.

2	2003, Mayer, Peter, William DeOreo. Residential Indoor Water Conservation Study. Aquacraft, Inc. Water Engineering and Management. Prepared for East Bay Municipal Utility District and the US EPA. July 2003.
3	2011, DeOreo, William. Analysis of Water Use in New Single Family Homes. By Aquacraft. For Salt Lake City Corporation and US EPA. July 20, 2011.
4	2008, Schultdt, Marc, and Debra Tachibana. Energy related Water Fixture Measurements: Securing the Baseline for Northwest Single Family Homes. 2008 ACEEE Summer Study on Energy Efficiency in Buildings.

MEASURE CODE:

2.4.2 Circulator Pump

DESCRIPTION

Demand control recirculation pumps seek to reduce inefficiency by combining control via temperature and demand inputs, whereby the controller will not activate the recirculation pump unless both (a) the recirculation loop return water has dropped below a prescribed temperature (e.g. 100°F) and (b) a CDHW demand is sensed as water flow through the CDHW system.

This measure was developed to be applicable to the following program types: TOS, RF, and NC. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

Re-circulating pump shall cycle on based on (a) the recirculation loop return water dropping below a prescribed temperature (e.g. 100°F) and (b) a CDHW demand is sensed as water flow through the CDHW system.

DEFINITION OF BASELINE EQUIPMENT

The base case for this measure category is an existing, un-controlled recirculation pump on a gas-fired Central Domestic Hot Water System.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The effective useful life is 15 years.[116]

DEEMED MEASURE COST

The assumed measure cost is $1,200 per pump.[117]

LOADSHAPE

Miscellaneous BUS

Algorithm

CALCULATION OF ENERGY SAVINGS

Savings shown are per pump.

ELECTRIC ENERGY SAVINGS

Deemed at 651 kWh.[118]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

[116] Benningfield Group. (2009). *PY 2009 Monitoring Report: Demand Control for Multifamily Central Domestic Hot Water.* Folsom, CA: Prepared for Southern California Gas Company, October 30, 2009.
[117] Gas Technology Institute. (2014). *1003: Demand-based domestic hot water recirculation Public project report.* Des Plaines, IL: Prepared for Nicor Gas, January 7, 2014.
[118] Based on results from the Nicor Gas Emerging Technology Program study, this value is the average kWh saved per pump. Note this value does not reflect savings from electric units but electrical savings from gas-fired units.

ΔkWh = calculated value above on a per faucet basis

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

NATURAL GAS SAVINGS

ΔTherms = 55.9 * number of dwelling units[119]

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[119] Based on results from the Nicor Gas Emerging Technology Program study, this value is the average therms saved per dwelling unit.

2.4.3 Heat Pump Water Heater

DESCRIPTION

This measure applies to the installation of a heat pump water heater (HPWH) in place of a standard electric water heater in a commercial building. Savings are presented dependent on the heating system installed in the building due to the impact of the heat pump water heater on the heating and cooling loads.

This measure was developed to be applicable to the following program types: TOS and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be a heat pump water heater meeting program efficiency requirements.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is assumed to be a new, electric storage water heater meeting federal minimum efficiency standards.[120]

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 13 years.[121]

DEEMED MEASURE COST

Actual costs should be used where available. Incremental capital costs are presented in the table below for heat pump water heaters with energy factors (EF) of 2.0 and 2.4 and rated volumes of 40 gallons and 50 gallons, respectively.[122]

EF	Rated Volume (gal)	Incremental Cost
2.0	40	$1,340.30
2.4	50	$1,187.58

For larger heat pump water heaters, incremental capital costs are presented in the table below based on heating capacity.[123]

Heating Capacity (MBtu/hr)	Incremental Cost
10-50	$4,000.00
>50-100	$7,000.00
>100-300	$10,000.00
>300-500	$14,000.00

[120] Federal standards for ≤55 gallon and ≤12 kW storage water heaters are from 10 CFR §430.32(d). Federal standards for >120 gallon and>12 kW storage water heaters are from 10 CFR §431.110. Since the federal standard effectively requires a heat pump water heater for residential electric storage water heaters >55 gallons and ≤120 gallons, this measure excludes those units.
[121] 2010 Residential Heating Products Final Rule Technical Support Document, U.S. DOE, Table 8.7.2.
[122] Cost information is based upon data from "2010-2012 WA017 Ex Ante Measure Cost Study Draft Report," Itron, February 28, 2014. See "NR HW Heater_WA017_MCS Results Matrix - Volume I_August2016.xls" for more information.
[123] Costs for larger heat pump water heaters are from 2017 Michigan Energy Measures Database.xlsx and are based on heat pump water heaters with a COP ≥3.0.

Heating Capacity (MBtu/hr)	Incremental Cost
>500	$18,000.00

LOADSHAPE

Water Heating BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{(1/EF_{BASE} - 1/EF_{EE}) * HotWaterUse_{Gallon} * \gamma Water * (T_{Out} - T_{In}) * 1.0}{3{,}412}\right) + kWh\_cool - kWh\_heat$$

Where:

EF_{BASE} = Efficiency of baseline water heater according to federal standards, expressed as Energy Factor (EF) or Thermal Efficiency (E_t)

= See table below

Equipment Type	Size Category	Federal Standard Minimum Efficiency
HPWH ≤12 kW	≤55 gallon	EF: 0.96 – (0.0003 * rated volume in gallons)
HPWH >12kW	>120 gallon	E_t: 98%[124]

EF_{EE} = EF of heat pump water heater

= Actual

$HotWaterUse_{Gallon}$ = Estimated annual hot water consumption (gallons)

= Actual if possible to provide reasonable custom estimate. If not, two methodologies are provided to develop an estimate:

1. Consumption per water heater capacity

= Consumption/cap * Capacity

Where:

Consumption/cap = Estimate of consumption per gallon of tank capacity, dependent on building type:[125]

[124] Efficiency of baseline water heaters >120 gallons based on search of electric storage water heaters >120 gallons available on AHRI directory.

[125] Based on Cadmus analysis. Annual hot water usage in gallons based on CBECS (2003) consumption data for West North Central (removed outliers of 1,000 kBtu/hr or less) to calculate hot water usage. Annual hot water gallons per tank size gallons based on the tank sizing methodology found in ASHRAE 2011 HVAC Applications. Chapter 50 Service Water Heating. Demand assumptions (gallons per day) for each building type based on ASHRAE Chapter 50 and "Technology Data Characterizing Water Heating in Commercial Buildings: Application to End Use Forecasting," Lawrence Berkeley National Library, December 1995. VEIC considers these values to be relatively conservative estimates that may benefit from future evaluation.

Building Type	Consumption/cap
Grocery, Convenience Store, and Restaurant	803
Lodging, Hospital, and Multifamily	630
Health Clinic, Church, Warehouse	433
Education, Office, and Retail	594
Industrial	558
Agriculture	558
Average Non Residential	558

Capacity = Capacity of hot water heater in gallons

= Actual

2. Consumption by facility size[126]

Building Type	Gallons hot water per unit per day	Unit	Units/1000 ft^2	Days per year	Gallons/1000 ft^2 floor area
Small Office	1	person	2.3	250	575
Large Office	1	person	2.3	250	575
Fast Food Rest	0.7	meal/day	784.6	365	200,458
Sit-Down Rest	2.4	meal/day	340	365	297,840
Retail	2	employee	1	365	730
Grocery	2	employee	1.1	365	803
Warehouse	2	employee	0.5	250	250
Elementary School	0.6	person	9.5	200	1,140
Jr High/High School	1.8	person	9.5	200	3,420
Health	90	patient	3.8	365	124,830
Motel	20	room	5	365	36,500
Hotel	14	room	2.2	365	11,242
Other	1	employee	0.7	250	175

γWater = Specific weight of water

= 8.33 pounds per gallon

T_{OUT} = Tank temperature

= Actual, if unknown assume 125°F[127]

[126] Technology Data Characterizing Water Heating in Commercial Buildings: Application to End Use Forecasting," Lawrence Berkeley National Library, December 1995.

[127] Ideally, the actual set point of the water heater should be used. If not available, 125 degrees is provided as an estimate of unmixed output temperature. While plumbing code generally limits temperatures at the end use, it typically does not limit the water heater system, which can be anywhere in the range 120 -201 degrees. For applications such as laundry and dishwashing, health and safety regulations may require water to be initially heated to higher temperatures. Since temperature set points can vary widely, market, program, or site-specific data should be used whenever possible.

T_{IN} = Incoming water temperature from well or municipal system

= 57.898°F[128]

1.0 = Heat capacity of water (1 Btu/lb*°F)

3,412 = Conversion factor from Btu to kWh

kWh_cool = Cooling savings from conversion of heat in building to water heat[129]

$$= \left[\frac{\left(\left(1 - \frac{1}{EF_{EE}}\right) * HotWaterUse_{Gallon} * \gamma Water * (T_{OUT} - T_{IN}) * 1.0\right) * LF * 53\% * LM}{COP_{COOL} * 3412} * \%Cool\right]$$

Where:

LF = Location Factor

= 1.0 for HPWH installation in a conditioned space

= 0.5 for HPWH installation in an unknown location[130]

= 0.0 for installation in an unconditioned space

53% = Portion of reduced waste heat that results in cooling savings[131]

COP_{COOL} = COP of central air conditioner

= Actual

LM = Latent multiplier to account for latent cooling demand:[132]

Weather Basis (City based upon)	LM
St Louis, MO	3.0

%Cool = Percentage of buildings with central cooling

Home	%Cool
Cooling	100%
No Cooling	0%

[128] Using 40" deep soil temp as a proxy at Powell Gardens SCAN site. Average by month of available data from 3/28/02–10/11/14: 12 month average is 57.898. http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=2061

[129] This algorithm calculates the heat removed from the air by subtracting the heat pump water heater electric consumption from the total water heating energy delivered. This is then adjusted to account for location of the heat pump unit and the coincidence of the waste heat with cooling requirements, the efficiency of the central cooling, and latent cooling demands.

[130] Professional judgment.

[131] Based on 193 days where CDD 65>0, divided by 365.25. CDD days determined from TMY data with a base temp of 65°F.

[132] The Latent Multiplier is used to convert the sensible cooling savings calculated to a value representing sensible and latent cooling loads. The values are derived from the methodology outlined in Infiltration Factor Calculation Methodology by Bruce Harley, Senior Manager, Applied Building Science, CLEAResult 11/18/2015 and is based upon an 8760 analysis of sensible and total heat loads using hourly climate data.

kWh_heat = Heating cost from conversion of heat in building to water heat (dependent on heating fuel)

$$= \left(\frac{\left(\left(1 - \frac{1}{\mathrm{EF_{EE}}}\right) * HotWaterUse_{Gallon} * \gamma\mathrm{Water} * (\mathrm{T_{OUT}} - \mathrm{T_{IN}}) * 1.0\right) * \mathrm{LF} * 43\%}{\mathrm{COP_{HEAT}} * 3412} \right) * \%\mathrm{ElectricHeat}$$

Where:

43% = Portion of reduced waste heat that results in increased heating load[133]

COP_{HEAT} = Actual. *Note: electric resistance heating and heat pumps will have an efficiency greater than or equal to 100%*

%ElectricHeat = Percentage of buildings with electric heat

Heating fuel	%ElectricHeat
Electric	100%
Natural Gas	0%

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWh * CF$$

Where:

kWh = Electric energy savings, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001811545[134]

NATURAL GAS SAVINGS

$$\Delta Therms = - \left(\frac{\left(\left(1 - \frac{1}{\mathrm{EF_{EE}}}\right) * HotWaterUse_{Gallon} * \gamma\mathrm{Water} * (\mathrm{T_{OUT}} - \mathrm{T_{IN}}) * 1.0\right) * \mathrm{LF} * 53\%}{\eta\mathrm{Heat} * 100{,}000} \right) * \%\mathrm{GasHeat}$$

Where:

ΔTherms = Heating cost from conversion of heat in building to water heat for buildings with natural gas heat[135]

100,000 = Conversion factor from Btu to therms

ηHeat = Efficiency of heating system

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133 Based on 157 days where HDD 60>0, divided by 365.25. HDD days determined from TMY data with a base temp of 60°F.

134 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Water Heating. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

135 This is the additional energy consumption required to replace the heat removed from the building during the heating season by the heat pump water heater. The variable kWh_heating (electric resistance) is that additional heating energy for a building with electric resistance heat (COP 1.0). This formula converts the additional heating kWh for an electric resistance building to the MMBtu required in a natural gas heated building, applying the relative efficiencies.

= Actual

%GasHeat = Percentage of buildings with gas heat

Heating Fuel	%GasHeat
Electric	0%
Gas	100%

Other factors as defined above

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.5 HVAC

Table: Effective Full Load Heating and Cooling Hours, by building type.

	Whiteman AFB (Avg)		Lincoln, NE (NW)		Fort Madison, IA (NE)		Kaiser (SW)		Cape Girardeau (SE)		St Louis		Kansas City	
Building Type	Heating EFLH	Cooling EFLH	Heating EFLH	Cooling EFLH	Heating EFLH	Cooling EFLH	Heating EFLH	Cooling EFLH	Heating EFLH	Cooling EFLH	Heating EFLH	Cooling EFLH	Heating EFLH	Cooling EFLH
Large Office	1039	1846	1141	1756	1088	1539	997	1918	861	1784	988	1869	1056	1792
Medium Office	649	1350	740	1245	728	1146	567	1412	528	1323	645	1386	708	1325
Small Office	946	1114	1030	1041	1029	975	926	1165	769	1082	893	1159	989	1097
Warehouse	991	415	1201	380	1227	357	1189	457	851	391	1059	433	1207	400
Stand-alone Retail	1012	1000	1125	903	1139	808	968	1076	891	965	994	986	1036	946
Strip Mall	1030	970	1124	884	1148	794	984	1044	905	944	1001	956	1039	916
Primary School	806	1019	892	958	898	852	798	1155	666	1016	785	1195	840	971
Secondary School	719	812	803	724	867	677	754	911	603	800	712	873	779	779
Supermarket	1279	875	1367	800	1405	672	1330	902	1120	837	1248	846	1344	820
Quick Service Restaurant	1233	1013	1414	916	1513	819	1316	1127	1025	973	1262	1035	1387	970
Full Service Restaurant	1367	1119	1499	1014	1655	952	1442	1234	1156	1114	1380	1124	1473	1059
Hospital	3388	3318	3205	3055	3467	2733	3891	3448	2913	3312	3170	3413	3372	3215
Outpatient Health Care	3203	3113	3261	2834	3150	2627	3128	3217	3001	3109	3013	3265	3164	2994
Small Hotel - Building	602	2247	697	2097	760	1914	620	2386	436	2304	575	2277	669	2207
Large Hotel - Building	1656	2148	1472	2016	1980	1916	1943	2369	1202	2186	1551	2363	1692	2155
Midrise Apartment - Building	1462	1132	1599	1028	1710	901	1590	1214	1208	1085	1433	1171	1580	1090
C&I Average[136]	1067	1018	1196	937	1217	865	1118	1085	910	996	1060	1053	1164	986

[136] See Volume 1 for details on modeling calculations and assumptions.

2.5.1 Small Commercial Learning Thermostats

DESCRIPTION

This measure characterizes the energy savings from the installation of a new programmable thermostat for reduced cooling and heating energy consumption through temperature set-back during unoccupied or reduced demand times as well as automatic adjustments based on occupancy patterns and various independent variables such as weather. This measure is limited to small businesses as defined by programs,[137] as they have smaller HVAC systems that are similar to residential HVAC systems and may be controlled by a simple manual adjustment thermostat. Mid- to large-sized businesses will typically have a building automation system or some other form of automated HVAC controls. This measure is only appropriate for single zone heating systems. Custom calculations are required for savings for learning thermostats installed in multi-zone systems.

This measure was developed to be applicable to the following program types: RF, DI, and TOS.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The criteria for this measure are established by replacement of a manual-only temperature control with one that has the capability to adjust temperature set-points according to various independent variables without manual intervention.

DEFINITION OF BASELINE EQUIPMENT

For new thermostats the baseline is a non-programmable thermostat requiring manual intervention to change the temperature set-point.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life of a learning thermostat is assumed to be 10 years[138] based upon equipment life only.[139]

DEEMED MEASURE COST

Actual material and labor costs should be used if the implementation method allows. If unknown, the capital cost for this measure is assumed to be $224.[140]

LOADSHAPE

Cooling BUS

Heating BUS

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[137] The square footage of the small office prototype building modeled in is 7,500 sf.

[138] Table 1, HVAC Controls, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007.

[139] Future evaluation is strongly encouraged to inform the persistence of savings to further refine measure life assumption. As this characterization depends heavily upon a large scale but only 2-year study of the energy impacts of programmable thermostats, the longer-term impacts should be assessed.

[140] 2012 Ameren Missouri Technical Resource Manual – Effective January 1, 2018.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{1}{eff} * EFLH_{COOL} * \frac{Btuh_{COOL}}{1000} * ESF_{COOL}$$

Where:

eff	= Efficiency of HVAC unit
	= Actual; If not available, assume 10 SEER
$EFLH_{COOL}$	= Effective Full Load Cooling Hours
	= Actual; If not available, refer to section 2.7 HVAC
$Btuh_{COOL}$	= Cooling System Capacity
	= Actual
ESF_{COOL}	= Cooling energy savings factor
	= Assume 0.139[141]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWh * CF$$

Where:

kWh	= Electric energy savings, as calculated above
CF	= Summer peak coincidence demand (kW) to annual energy (kWh) factor
	= 0.0009106840

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = \frac{Sqft * Savings\ Factor * PF}{100 * AFUE(exist)}$$

Where:

Sqft	= Square footage of building controlled by thermostat
AFUE (exist)	= Efficiency rating of existing heating equipment (AFUE), in decimal form.
100	= Converts kBtu to therms, 1 therm = 100 kBtu
Savings Factor	= 9.940 kBtu/sf-yr[142]

[141] Cadmus (Aarish, C., M. Perussi, A. Rietz, and D. Korn). *Evaluation of the 2013–2014 Programmable and Smart Thermostat Program.* Prepared for Northern Indiana Public Service Company and Vectren Corporation. 2015.
[142] Heating Savings Factors for the programmable thermostat are calculated as the savings in annual building load divided by the square footage of the prototype building (5,500 sf) and converted to kBtu.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.5.2 Small Commercial Programmable Thermostats

DESCRIPTION

This measure characterizes the energy savings from the installation of a new programmable thermostat for reduced heating and cooling energy consumption through temperature set-back during unoccupied or reduced demand times. This measure is limited to small businesses as defined by programs,[143] as they have smaller HVAC systems that are similar to residential HVAC systems and may be controlled by a simple manual adjustment thermostat. Mid- to large-sized businesses will typically have a building automation system or some other form of automated HVAC controls. This measure is only appropriate for single zone heating systems. Custom calculations are required for savings for programmable thermostats installed in multi-zone systems.

This measure was developed to be applicable to the following program types: RF and DI.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The criteria for this measure are established by replacement of a manual-only temperature control with one that has the capability to adjust temperature set-points according to a schedule without manual intervention.

DEFINITION OF BASELINE EQUIPMENT

For new thermostats the baseline is a non-programmable thermostat requiring manual intervention to change the temperature set-point.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life of a programmable thermostat is assumed to be 8 years[144] based upon equipment life only.[145]

DEEMED MEASURE COST

Actual material and labor costs should be used if the implementation method allows. If unknown, the capital cost for this measure is assumed to be $181.[146]

LOADSHAPE

Cooling BUS

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[143] The square footage of the small office prototype building modeled in is 7,500 sf.

[144] Table 1, HVAC Controls, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007.

[145] Future evaluation is strongly encouraged to inform the persistence of savings to further refine measure life assumption. As this characterization depends heavily upon a large scale but only 2-year study of the energy impacts of programmable thermostats, the longer-term impacts should be assessed.

[146] Based upon Nicor, Illinois Rider 30 Business EER Program Database, Paid Rebates with Programmable Thermostat Installation Costs, Program to Date as of January 11, 2013. If Missouri average costs are available, they should be used.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{Sqft * Savings\ Factor * PF}{EER(exist)}$$

Where:

Sqft = Square footage of building controlled by thermostat

EER(exist) = Efficiency rating of existing cooling equipment EER (btu hr/W)

Savings Factor = 0.578 kWh/sf-yr[147]

PF = Persistence Factor to account for thermostat being placed on hold, reset or bypassed.

= Actual if provided in program evaluation, else assume 50% [148]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWh * CF$$

Where:

kWh = Electric energy savings, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0009106840

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = \frac{Sqft * Savings\ Factor * PF}{100 * AFUE(exist)}$$

Where:

Sqft = Square footage of building controlled by thermostat

AFUE (exist) = Efficiency rating of existing heating equipment (AFUE), in decimal form.

100 = Converts kBtu to therms, 1 therm = 100 kBtu

[147] Cooling savings factors for the programmable thermostat are calculated as the savings in annual building load divided by the square footage of the small office prototype building (5,500 sf).

[148] This factor is based on consideration of the findings from a number of evaluations, including Sachs et al, *"Field Evaluation of Programmable Thermostats,"* US DOE Building Technologies Program, December 2012, p35; "low proportion of households that ended up using thermostat-enabled energy saving settings" http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/field_eval_thermostats.pdf%20, and Meier et al., *"Usability of residential thermostats: Preliminary investigations,"* Lawrence Berkeley National Laboratory, March 2011, p1; "The majority of occupants operated thermostats manually, rather than relying on their programmable features and almost 90% of respondents reported that they rarely or never adjusted the thermostat to set a weekend or weekday program. Photographs of thermostats were collected in one on-line survey, which revealed that about 20% of the thermostats displayed the wrong time and that about 50% of the respondents set their programmable thermostats on "long term hold" (or its equivalent)." http://eec.ucdavis.edu/files/Usability_of_residential_thermostats.pdf.

Savings Factor = 9.940 kBtu/sf-yr[149]

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[149] Heating Savings Factors for the programmable thermostat are calculated as the savings in annual building load divided by the square footage of the prototype building (5,500 sf) and converted to kBtu.

2.5.3 Demand Controlled Ventilation

DESCRIPTION

Demand control ventilation (DCV) automatically adjusts building ventilation rates based on occupancy. DCV is part of a building's ventilation system control strategy. It may include hardware, software, and controls as an integral part of a building's ventilation design. Active control of the ventilation system provides the opportunity to reduce heating and cooling energy use.

The primary component is a control sensor to communicate either directly with the economizer or with a central computer. The component is most typically a carbon dioxide (CO_2) sensor, occupancy sensor, or turnstile counter. This measure is modeled to assume night time set backs are in operation and minimum outside air is being used when the building is unoccupied.

This measure was developed to be applicable to the following program type: RF. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment condition is defined by new CO_2 sensors installed on return air systems where no other sensors were previously installed. Additionally, commissioned control logic and installed hardware must be capable of reducing ventilation rates based on sensor input. For heating savings, this measure does not apply to any system with terminal reheat (constant volume or variable air volume). For terminal reheat system a custom savings calculation should be used.

DEFINITION OF BASELINE EQUIPMENT

The base case for this measure is a space with no demand control capability. The current code minimum for outside air (OA) is 17 CFM per occupant (ASHRAE 62.1) which is the value assumed in this measure.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The deemed measure life is 10 years.[150]

DEEMED MEASURE COST

As a retrofit measure, the actual cost of installation should be used for screening. Costs should include the hardware and labor costs to install the sensors. Additional purchase and installation costs for any other component of the DCV system that was not previously existing should also be included.

LOADSHAPE

Cooling BUS

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

For facilities heated by natural gas, cooling savings are:

$$\Delta kWh = SQFT_{cond}/1000 * SF_{cooling}$$

[150] Based on CO_2 sensor estimated life, determined through conversations with contractors to have a minimum lifetime of 10 years. It is recommended that they are part of a normal preventive maintenance program, as calibration is an important part of extending useful life. Although they are not subject to mechanical failure, they can fall out of tolerance over time.

For facilities heated by heat pumps, heating and cooling savings are:

$$\Delta kWh = SQFT_{cond}/1000 * SF_{cooling} + SQFT_{cond}/1000 * SF_{Heat\ HP}$$

For facilities heated by electric resistance heating and cooling savings are:

$$\Delta kWh = SQFT_{cond}/1000 * SF_{cooling} + SQFT_{cond}/1000 * SF_{Heat\ ER}$$

Where:

$SQFT_{cond}$ = Square footage of conditioned space commissioned with DCV

$SF_{cooling}$ = Cooling Savings Factor, including cooling and fan energy savings

$SF_{Heat\ HP}$ = Heating Savings factor for facilities heated by Heat Pump (HP)

$SF_{Heat\ ER}$ = Heating Savings factor for facilities heated by Electric Resistance (ER)

All Savings Factors are based on building type and weather zone, as listed in the following tables:[151]

Building Type	$SF_{cooling}$ (kWh/1000 SqFt)						
	North East (Fort Madison, IA)	North West (Lincoln, NE)	South East (Cape Girardeau, MO)	South West (Kaiser, MO)	St Louis, MO	Kansas City, MO	Average/Unknown (Knob Noster, MO)
Office - Low-rise	475	533	535	634	649	555	579
Office - Mid-rise	448	502	504	597	611	523	545
Office - High-rise	468	525	527	624	639	547	570
Religious Building	567	635	639	756	774	662	690
Restaurant	561	629	632	748	765	655	683
Retail - Department Store	654	734	737	873	893	764	797
Retail - Strip Mall	399	447	449	532	544	466	486
Convenience Store	631	708	711	842	862	737	769
Elementary School	353	395	397	470	481	412	430
High School	340	382	384	454	465	398	415
College/University	442	495	498	589	603	516	538
Healthcare Clinic	384	431	433	513	525	449	468
lodging	605	679	682	808	827	707	738
Manufacturing	500	560	563	666	682	584	609
Special Assembly Auditorium	476	534	536	635	650	556	580

Building Type	$SF_{Heat\ HP}$ (kWh/1000 SqFt)						
	North East (Fort Madison, IA)	North West (Lincoln, NE)	South East (Cape Girardeau, MO)	South West (Kaiser, MO)	St Louis, MO	Kansas City, MO	Average/Unknown (Knob Noster, MO)
Office - Low-rise	171	191	145	151	156	176	159
Office - Mid-rise	114	128	97	100	104	117	106
Office - High-rise	154	172	130	135	140	158	143
Religious Building	1,118	1,248	945	983	1,018	1,149	1,036
Restaurant	799	892	675	702	727	821	740

[151] Energy savings factors were calculated using weather data and methodology consistent with ASHRAE standards. Savings are calculated on an annual basis for each given weather zone in Missouri. Original energy savings for DCV were developed for Illinois utilizing standards, inputs and approaches as set forth by ASHRAE 62.1and 90.1. These savings factors were then translated into Missouri-specific values using adjustment factors based on differences in heating and cooling degree hours. See DCV savings factors v1.xlsx for derivation.

Building Type	SF Heat HP (kWh/1000 SqFt)						
	North East (Fort Madison, IA)	North West (Lincoln, NE)	South East (Cape Girardeau, MO)	South West (Kaiser, MO)	St Louis, MO	Kansas City, MO	Average/Unknown (Knob Noster, MO)
Retail - Department Store	277	310	234	244	252	285	257
Retail - Strip Mall	184	205	155	161	167	189	170
Convenience Store	134	150	114	118	122	138	125
Elementary School	475	531	402	418	433	488	440
High School	465	519	393	409	423	478	431
College/University	923	1,031	780	812	840	949	856
Healthcare Clinic	331	370	280	291	301	340	307
lodging	157	175	132	138	143	161	145
Manufacturing	122	136	103	107	111	125	113
Special Assembly Auditorium	1,335	1,490	1,128	1,173	1,215	1,371	1,236

Building Type	SF Heat ER (kWh/1000 SqFt)						
	North East (Fort Madison, IA)	North West (Lincoln, NE)	South East (Cape Girardeau, MO)	South West (Kaiser, MO)	St Louis, MO	Kansas City, MO	Average/Unknown (Knob Noster, MO)
Office - Low-rise	514	574	434	452	468	528	476
Office - Mid-rise	343	383	290	301	312	352	318
Office - High-rise	461	515	390	406	420	474	428
Religious Building	3,354	3,744	2,835	2,948	3,053	3,446	3,108
Restaurant	2,396	2,675	2,025	2,106	2,181	2,462	2,220
Retail - Department Store	832	929	703	731	757	855	771
Retail - Strip Mall	551	615	465	484	501	566	510
Convenience Store	403	450	341	354	367	414	374
Elementary School	1,426	1,592	1,205	1,253	1,298	1,465	1,321
High School	1,395	1,557	1,179	1,226	1,270	1,433	1,292
College/University	2,770	3,093	2,341	2,435	2,521	2,846	2,567
Healthcare Clinic	993	1,109	839	873	904	1,020	920
lodging	470	525	397	413	428	483	436
Manufacturing	365	408	309	321	332	375	338
Special Assembly Auditorium	4,004	4,470	3,384	3,519	3,644	4,114	3,709

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWhcooling * CF$$

Where:

kWhcooling = Electric energy savings, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0009106840

NATURAL GAS SAVINGS

$$\Delta Therms = SQFT_{cond}/1000 * SF_{Heat\ Gas}$$

Where:

$SF_{Heat\ Gas}$ = Savings factor for facilities heated by natural gas, as listed in the following table:

Building Type	$SF_{Heat\ Gas}$ (Therm/1000 sq ft)						
	North East (Fort Madison, IA)	North West (Lincoln, NE)	South East (Cape Girardeau, MO)	South West (Kaiser, MO)	St Louis, MO	Kansas City, MO	Average/Unknown (Knob Noster, MO)
Office - Low-rise	22	24	19	19	20	23	20
Office - Mid-rise	15	16	12	13	13	15	14
Office - High-rise	20	22	17	17	18	20	18
Religious Building	143	160	121	126	130	147	133
Restaurant	102	114	86	90	93	105	95
Retail - Department Store	35	40	30	31	32	36	33
Retail - Strip Mall	23	26	20	21	21	24	22
Convenience Store	17	19	15	15	16	18	16
Elementary School	61	68	51	53	55	62	56
High School	60	66	50	52	54	61	55
College/University	118	132	100	104	108	121	109
Healthcare Clinic	42	47	36	37	39	44	39
lodging	20	22	17	18	18	21	19
Manufacturing	16	17	13	14	14	16	14
Special Assembly Auditorium	171	191	144	150	155	175	158

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.5.4 Advanced Roof Top Unit (RTU) Controls

DESCRIPTION

A traditional packaged HVAC rooftop unit uses a zone thermostat to control the operation of the compressor or the gas furnace, depending on whether the zone thermostat is calling for cooling or heating. Under a conventional control scheme, the compressor or furnace is cycled on or off to maintain the zone thermostat set point with the supply fan operating continuously (when the building is occupied) to provide sufficient ventilation air and provide comfort heating and cooling for the space. The supply-fan speed is typically not capable of modulation, so it supplies constant air volume under all modes of operations.

Modulating the supply fan in conjunction with demand-controlled ventilation (DCV) can reduce both heating/cooling energy and fan energy requirements. This measure describes the energy savings realized by retrofitting traditional RTUs with advanced controllers that enable integrated air-side economization, supply-fan speed control (by installing a variable speed drive), and demand-controlled ventilation.

This measure is applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

A traditional RTU retrofitted and commissioned with advanced controls that allow for modulation of supply fan speed in conjunction with demand-controlled ventilation (DCV).

DEFINITION OF BASELINE EQUIPMENT

Packaged heating and cooling equipment with constant speed supply fans providing ventilation at the design rate at all times when the fan is operating and when the building is occupied.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life for HVAC application is 15 years.[152]

DEEMED MEASURE COST

As a retrofit measure, actual costs should be specified when available. Default measure costs are listed below based on RTU supply fan horsepower rating:[153]

Supply Fan[154] Size (hp)	Controller	Installation Labor	Total Retrofit Cost
1	$2,200	$750	$2,950
2	$2,600	$750	$3,350
3	$3,500	$750	$4,250
5	$4,000	$750	$4,750
7.5	$4,142	$750	$4,892

[152] Consistent with other HVAC variable speed drive lifetimes.
[153] Advanced Rooftop Control (ARC) Retrofit: Field-Test Results, PNNL-22656. U.S. Department of Energy, July 2013.
[154] Interpolation may be used to estimate controller cost for motor sizes not listed.

LOADSHAPE

HVAC BUS **Algorithm**

CALCULATION OF SAVINGS

Although advanced RTUs controls can enable operating strategies that result in heating and cooling savings, field testing has shown variable results (in some instances increased heating/cooling energy consumption has been observed). Field testing has suggested that upwards of 90% of total energy savings can be attributed to reduced fan energy requirements, and therefore the following savings estimates are limited to those relating to fan energy consumption.

ELECTRIC ENERGY SAVINGS

$\Delta kWh = P_{sf} * SF * Hours_{fan}$

Where:

P_{sf} = Nominal horsepower of supply fan motor

SF = Fan energy savings factor[155] (kWh/hour/horsepower)

= 0.558

$Hours_{fan}$ = Annual operating hours for fan motor based on building type.

Default hours are provided for HVAC applications which vary by building type.[156] When available, actual hours should be used, especially in instances where RTU operation is seasonal.

Building Type	Total Fan Run Hours
Large Office	6753
Medium Office	6968
Small Office	6626
Warehouse	6263
Stand-alone Retail	6679
Strip Mall	6687
Primary School	5906
Secondary School	6702
Supermarket	6900
Quick Service Restaurant	7679
Full Service Restaurant	7664
Hospital	8760
Outpatient Health Care	8760
Small Hotel - Building	8760
Large Hotel - Building	8760
Midrise Apartment - Building	8728
Nonresidential Average	6773

[155] Based on average field testing results outlined in Advanced Rooftop Control (ARC) Retrofit: Field-Test Results, PNNL-22656. U.S. Department of Energy, July 2013. Savings factors were consistent across the capacity range. See "RTU Control Savings.xlsx" for additional details.

[156] Hours per year are estimated using the modeling results and represent the total number of hours the fans are operating for heating, cooling and ventilation for each building type.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = As calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0004439830

NATURAL GAS ENERGY SAVINGS

If fossil fuel impacts are expected, a custom analysis should be used to support them.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.5.5 Electric Chiller

DESCRIPTION

This measure involves the installation of a new electric chiller meeting the efficiency standards presented below. This measure could relate to the replacement of an existing unit at the end of its useful life, or the installation of a new system in an existing building (i.e. time of sale). Only single-chiller applications should be assessed with this methodology. The characterization is not suited for multiple chillers projects or chillers equipped with variable speed drives (VSDs), for which a custom analysis should be used to establish savings.

This measure was developed to be applicable to the following program types: TOS and NC. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to exceed the efficiency requirements defined by the program.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to meet the efficiency requirements set forth by local jurisdictions. In most cases, this will be some version of International Energy Conservation Code (IECC). Depending on the version, this will correspond to the requirements defined within Table 503.2.3(7) in the case of IECC 2009 or Table 403.2.3(7) in the case of either IECC 2012 or the IECC 2015.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 20 years.[157]

DEEMED MEASURE COST

The incremental capital cost for this measure is $106.23 per ton.[158]

Water cooled, electrically operated, positive displacement (rotary screw and scroll) ($/ton)				
Capacity (tons)	**> .72 kW/ton**	**.72 and > .68 kW/ton**	**.68 and >.64 kW/ton**	**.64 kW/ton and less**
< 50	$76	$126	n/a	n/a
>= 50 and <100	$38	$63	n/a	n/a
>= 100 and <150	$25	$42	n/a	n/a
>= 150 and <200	$0	$61	$122	$183
>= 200	$0	$31	$61	$92

Water cooled, electrically operated, positive displacement (reciprocating) ($/ton)			
Capacity (tons)	**> .60 kW/ton**	**.60 and > .58 kW/ton**	**.58 kw/ton and less**

[157] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values," California Public Utilities Commission, December 16, 2008.
[158] Ameren Missouri Technical Resource Manual Effective January 1, 2018.

Water cooled, electrically operated, positive displacement (reciprocating) ($/ton)			
< 100	$73	$110	$183
>= 100 and <150	$49	$73	$122
>= 150 and <200	$37	$55	$92
>= 200 and <300	$61	$91	$152
>= 300	$30	$46	$76

LOADSHAPE

Cooling BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = TONS * ((IPLVbase) - (IPLVee)) * EFLH$$

Where:

TONS = Chiller nominal cooling capacity in tons (note: 1 ton = 12,000 Btu/hr)

= Actual installed

$IPLV_{base}$ =Efficiency of baseline equipment expressed as Integrated Part Load Value(kW/ton). Chiller units are dependent on chiller type. See 'Chiller Units, Convertion Values' and 'Baseline Efficiency Values by Chiller Type' and Capacity in the Reference Tables section.

$IPLV_{ee}$[159] = Efficiency of high efficiency equipment expressed as Integrated Part Load Value (kW/ton)[160]

= Actual installed

EFLH = Equivalent Full Load Hours for cooling are provided in section 2.7 HVAC

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWH * CF$$

Where:

ΔkWH = Annual electricity savings, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor for Cooling

= 0.0009106840

NATURAL GAS ENERGY SAVINGS

N/A

[159] Integrated Part Load Value is a seasonal average efficiency rating calculated in accordance with ARI Standard 550/590. It may be calculated using any measure of efficiency (EER, kW/ton, COP), but for consistency, it is expressed in terms of IPLV here.

[160] Can determine IPLV from standard testing or looking at engineering specs for design conditions. Standard data is available from AHRnetI.org. http://www.ahrinet.org/.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

REFERENCE TABLES

Chillers Ratings- Chillers are rated with different units depending on equipment type as shown below

Equipment Type	Unit
Air cooled, electrically operated	EER
Water cooled, electrically operated, positive displacement (reciprocating)	kW/ton
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	kW/ton

In order to convert chiller equipment ratings to IPLV the following relationships are provided

kW/ton = 12 / EER

kW/ton = 12 / (COP x 3.412)

COP = EER / 3.412

COP = 12 / (kW/ton) / 3.412

EER = 12 / kW/ton

EER = COP x 3.412

<u>Baseline Efficiency Values by Chiller Type and Capacity:</u>

Note: Efficiency requirements depend on the path (Path A or Path B) that the building owner has chosen to meet compliance requirements. For air cooled and absorption chillers, Path A should be assumed. For water cooled chillers, the building owner should be consulted and the relevant path used for calculations. When unknown, Path A should be used.

<u>2009 IECC Baseline Efficiency Values by Chiller Type and Capacity</u>

TABLE 503.2.3(7)
WATER CHILLING PACKAGES, EFFICIENCY REQUIREMENTS[a]

EQUIPMENT TYPE	SIZE CATEGORY	UNITS	BEFORE 1/1/2010		AS OF 1/1/2010[c]				TEST PROCEDURE[b]
					PATH A		PATH B		
			FULL LOAD	IPLV	FULL LOAD	IPLV	FULL LOAD	IPLV	
Air-cooled chillers	< 150 tons	EER	≥ 9.562	≥ 10.416	≥ 9.562	≥ 12.500	NA[d]	NA[d]	AHRI 550/590
	≥ 150 tons	EER			≥ 9.562	≥ 12.750	NA[d]	NA[d]	
Air cooled without condenser, electrical operated	All capacities	EER	≥ 10.586	≥ 11.782	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements				
Water cooled, electrically operated, reciprocating	All capacities	kW/ton	≤ 0.837	≤ 0.696	Reciprocating units must comply with water cooled positive displacement efficiency requirements				
Water cooled, electrically operated, positive displacement	< 75 tons	kW/ton	≤ 0.790	≤ 0.676	≤ 0.780	≤ 0.630	≤ 0.800	≤ 0.600	
	≥ 75 tons and < 150 tons	kW/ton			≤ 0.775	≤ 0.615	≤ 0.790	≤ 0.586	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.717	≤ 0.627	≤ 0.680	≤ 0.580	≤ 0.718	≤ 0.540	
	≥ 300 tons	kW/ton	≤ 0.639	≤ 0.571	≤ 0.620	≤ 0.540	≤ 0.639	≤ 0.490	
Water cooled, electrically operated, centrifugal	< 150 tons	kW/ton	≤ 0.703	≤ 0.669	≤ 0.634	≤ 0.596	≤ 0.639	≤ 0.450	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.634	≤ 0.596					
	≥ 300 tons and < 600 tons	kW/ton	≤ 0.576	≤ 0.549	≤ 0.576	≤ 0.549	≤ 0.600	≤ 0.400	
	≥ 600 tons	kW/ton	≤ 0.576	≤ 0.549	≤ 0.570	≤ 0.539	≤ 0.590	≤ 0.400	
Air cooled, absorption single effect	All capacities	COP	≥ 0.600	NR[e]	≥ 0.600	NR[e]	NA[d]	NA[d]	AHRI 560
Water-cooled, absorption single effect	All capacities	COP	≥ 0.700	NR[e]	≥ 0.700	NR[e]	NA[d]	NA[d]	
Absorption double effect, indirect-fired	All capacities	COP	≥ 1.000	≥ 1.050	≥ 1.000	≥ 1.050	NA[d]	NA[d]	
Absorption double effect, direct fired	All capacities	COP	≥ 1.000	≥ 1.000	≥ 1.000	≥ 1.000	NA[d]	NA[d]	

For SI: 1 ton = 907 kg, 1 British thermal unit per hour = 0.2931 W

a. The chiller equipment requirements do not apply for chillers used in low-temperature applications where the design leaving fluid temperature is < 40°F.

b. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

c. Compliance with this standard can be obtained by meeting the minimum requirements of Path A or B. However, both the full load and IPLV must be met to fulfill the requirements of Path A or B.

d. NA means that this requirement is not applicable and cannot be used for compliance.

2012 IECC Baseline Efficiency Values by Chiller Type and Capacity

TABLE C403.2.3(7)
MINIMUM EFFICIENCY REQUIREMENTS:
WATER CHILLING PACKAGES[a]

EQUIPMENT TYPE	SIZE CATEGORY	UNITS	BEFORE 1/1/2010 FULL LOAD	BEFORE 1/1/2010 IPLV	AS OF 1/1/2010[b] PATH A FULL LOAD	AS OF 1/1/2010[b] PATH A IPLV	AS OF 1/1/2010[b] PATH B FULL LOAD	AS OF 1/1/2010[b] PATH B IPLV	TEST PROCEDURE[c]
Air-cooled chillers	< 150 tons	EER	≥ 9.562	≥ 10.416	≥ 9.562	≥ 12.500	NA	NA	AHRI 550/590
	≥ 150 tons	EER			≥ 9.562	≥ 12.750	NA	NA	
Air cooled without condenser, electrical operated	All capacities	EER	≥ 10.586	≥ 11.782	Air-cooled chillers without condensers shall be rated with matching condensers and comply with the air-cooled chiller efficiency requirements				
Water cooled, electrically operated, reciprocating	All capacities	kW/ton	≤ 0.837	≤ 0.696	Reciprocating units shall comply with water cooled positive displacement efficiency requirements				
Water cooled, electrically operated, positive displacement	< 75 tons	kW/ton	≤ 0.790	≤ 0.676	≤ 0.780	≤ 0.630	≤ 0.800	≤ 0.600	
	≥ 75 tons and < 150 tons	kW/ton			≤ 0.775	≤ 0.615	≤ 0.790	≤ 0.586	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.717	≤ 0.627	≤ 0.680	≤ 0.580	≤ 0.718	≤ 0.540	
	≥ 300 tons	kW/ton	≤ 0.639	≤ 0.571	≤ 0.620	≤ 0.540	≤ 0.639	≤ 0.490	
Water cooled, electrically operated, centrifugal	< 150 tons	kW/ton	≤ 0.703	≤ 0.669	≤ 0.634	≤ 0.596	≤ 0.639	≤ 0.450	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.634	≤ 0.596					
	≥ 300 tons and < 600 tons	kW/ton	≤ 0.576	≤ 0.549	≤ 0.576	≤ 0.549	≤ 0.600	≤ 0.400	
	≥ 600 tons	kW/ton	≤ 0.576	≤ 0.549	≤ 0.570	≤ 0.539	≤ 0.590	≤ 0.400	
Air cooled, absorption single effect	All capacities	COP	≥ 0.600	NR	≥ 0.600	NR	NA	NA	AHRI 560
Water cooled, absorption single effect	All capacities	COP	≥ 0.700	NR	≥ 0.700	NR	NA	NA	
Absorption double effect, indirect fired	All capacities	COP	≥ 1.000	≥ 1.050	≥ 1.000	≥ 1.050	NA	NA	
Absorption double effect, direct fired	All capacities	COP	≥ 1.000	≥ 1.000	≥ 1.000	≥ 1.000	NA	NA	

For SI: 1 ton = 3517 W, 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.
NA = Not applicable, not to be used for compliance; NR = No requirement.

a. The centrifugal chiller equipment requirements, after adjustment in accordance with Section C403.2.3.1 or Section C403.2.3.2, do not apply to chillers used in low-temperature applications where the design leaving fluid temperature is less than 36°F. The requirements do not apply to positive displacement chillers with leaving fluid temperatures less than or equal to 32°F. The requirements do not apply to absorption chillers with design leaving fluid temperatures less than 40°F.

b. Compliance with this standard can be obtained by meeting the minimum requirements of Path A or B. However, both the full load and IPLV shall be met to fulfill the requirements of Path A or B.

c. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

2015 IECC Baseline Efficiency Values by Chiller Type and Capacity

TABLE C403.2.3(7)
WATER CHILLING PACKAGES – EFFICIENCY REQUIREMENTS[a, b, d]

EQUIPMENT TYPE	SIZE CATEGORY	UNITS	BEFORE 1/1/2015 Path A	BEFORE 1/1/2015 Path B	AS OF 1/1/2015 Path A	AS OF 1/1/2015 Path B	TEST PROCEDURE[c]
Air-cooled chillers	< 150 Tons	EER (Btu/W)	≥ 9.562 FL ≥ 12.500 IPLV	NA[c]	≥ 10.100 FL ≥ 13.700 IPLV	≥ 9.700 FL ≥ 15,800 IPLV	AHRI 550/ 590
	≥ 150 Tons		≥ 9.562 FL ≥ 12.500 IPLV	NA[c]	≥ 10.100 FL ≥ 14.000 IPLV	≥ 9.700 FL ≥ 16.100 IPLV	
Air cooled without condenser, electrically operated	All capacities	EER (Btu/W)	Air-cooled chillers without condenser shall be rated with matching condensers and complying with air-cooled chiller efficiency requirements.				
Water cooled, electrically operated positive displacement	< 75 Tons	kW/ton	≤ 0.780 FL ≤ 0.630 IPLV	≤ 0.800 FL ≤ 0.600 IPLV	≤ 0.750 FL ≤ 0.600 IPLV	≤ 0.780 FL ≤ 0.500 IPLV	
	≥ 75 tons and < 150 tons		≤ 0.775 FL ≤ 0.615 IPLV	≤ 0.790 FL ≤ 0.586 IPLV	≤ 0.720 FL ≤ 0.560 IPLV	≤ 0.750 FL ≤ 0.490 IPLV	
	≥ 150 tons and < 300 tons		≤ 0.680 FL ≤ 0.580 IPLV	≤ 0.718 FL ≤ 0.540 IPLV	≤ 0.660 FL ≤ 0.540 IPLV	≤ 0.680 FL ≤ 0.440 IPLV	
	≥ 300 tons and < 600 tons		≤ 0.620 FL ≤ 0.540 IPLV	≤ 0.639 FL ≤ 0.490 IPLV	≤ 0.610 FL ≤ 0.520 IPLV	≤ 0.625 FL ≤ 0.410 IPLV	
	≥ 600 tons		≤ 0.620 FL ≤ 0.540 IPLV	≤ 0.639 FL ≤ 0.490 IPLV	≤ 0.560 FL ≤ 0.500 IPLV	≤ 0.585 FL ≤ 0.380 IPLV	
Water cooled, electrically operated centrifugal	< 150 Tons	kW/ton	≤ 0.634 FL ≤ 0.596 IPLV	≤ 0.639 FL ≤ 0.450 IPLV	≤ 0.610 FL ≤ 0.550 IPLV	≤ 0.695 FL ≤ 0.440 IPLV	
	≥ 150 tons and < 300 tons		≤ 0.634 FL ≤ 0.596 IPLV	≤ 0.639 FL ≤ 0.450 IPLV	≤ 0.610 FL ≤ 0.550 IPLV	≤ 0.635 FL ≤ 0.400 IPLV	
	≥ 300 tons and < 400 tons		≤ 0.576 FL ≤ 0.549 IPLV	≤ 0.600 FL ≤ 0.400 IPLV	≤ 0.560 FL ≤ 0.520 IPLV	≤ 0.595 FL ≤ 0.390 IPLV	
	≥ 400 tons and < 600 tons		≤ 0.576 FL ≤ 0.549 IPLV	≤ 0.600 FL ≤ 0.400 IPLV	≤ 0.560 FL ≤ 0.500 IPLV	≤ 0.585 FL ≤ 0.380 IPLV	
	≥ 600 Tons		≤ 0.570 FL ≤ 0.539 IPLV	≤ 0.590 FL ≤ 0.400 IPLV	≤ 0.560 FL ≤ 0.500 IPLV	≤ 0.585 FL ≤ 0.380 IPLV	
Air cooled, absorption, single effect	All capacities	COP	≥ 0.600 FL	NA[c]	≥ 0.600 FL	NA[c]	AHRI 560
Water cooled absorption, single effect	All capacities	COP	≥ 0.700 FL	NA[c]	≥ 0.700 FL	NA[c]	
Absorption, double effect, indirect fired	All capacities	COP	≥ 1.000 FL ≥ 1.050 IPLV	NA[c]	≥ 1.000 FL ≥ 1.050 IPLV	NA[c]	
Absorption double effect direct fired	All capacities	COP	≥ 1.000 FL ≥ 1.000 IPLV	NA[c]	≥ 1.000 FL ≥ 1.050 IPLV	NA[c]	

a. The requirements for centrifugal chiller shall be adjusted for nonstandard rating conditions in accordance with Section C403.2.3.1 and are only applicable for the range of conditions listed in Section C403.2.3.1. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

b. Both the full-load and IPLV requirements shall be met or exceeded to comply with this standard. Where there is a Path B, compliance can be with either Path A or Path B for any application.

c. NA means the requirements are not applicable for Path B and only Path A can be used for compliance.

d. FL represents the full-load performance requirements and IPLV the part-load performance requirements.

MEASURE CODE:

2.5.6 Heat Pump Systems

DESCRIPTION

This measure applies to the installation of high-efficiency air-cooled, water source, ground water source, and ground source heat pump systems. This measure could apply to replacing an existing unit at the end of its useful life, or installation of a new unit in a new or existing building.

This measure was developed to be applicable to the following program types: TOS and NC. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a high-efficiency air-cooled, water source, ground water source, or ground source heat pump system that exceeds the energy efficiency requirements specified by the building code applicable to local jurisdiction. This may be a version of the 2009, 2012 or 2015 International Energy Conservation Code (IECC) or ASHRAE 90.1 standard.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be a standard-efficiency air- cooled, water source, ground water source, or ground source heat pump system that meets the energy efficiency requirements of local building code. The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[161]

DEEMED MEASURE COST

For analysis purposes, the incremental capital cost for this measure is assumed as $100 per ton for air-cooled units.[162] The incremental cost for all other equipment types should be determined on a site-specific basis.

LOADSHAPE

Cooling BUSHeating BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

For units with cooling capacities less than 65 kBtu/hr:

$$\Delta kWh = \text{Annual kWh Savings}_{cool} + \text{Annual kWh Savings}_{heat}$$

$$\text{Annual kWh Savings}_{cool} = (kBtu/hr_{cool}) * [(1/SEERbase) - (1/SEERee)] * EFLH_{cool}$$

$$\text{Annual kWh Savings}_{heat} = (kBtu/hr_{heat}) * [(1/HSPFbase) - (1/HSPFee)] * EFLH_{heat}$$

For units with cooling capacities equal to or greater than 65 kBtu/hr:

[161] Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007.
[162] Based on a review of TRM incremental cost assumptions from Vermont, Wisconsin, and California.

ΔkWh = Annual kWh Savings$_{cool}$ + Annual kWh Savings$_{heat}$

Annual kWh Savings$_{cool}$ = (kBtu/hr$_{cool}$) * [(1/EERbase) – (1/EERee)] * EFLH$_{cool}$

Annual kWh Savings$_{heat}$ = (kBtu/hr$_{heat}$)/3.412 * [(1/COPbase) – (1/COPee)] * EFLH$_{heat}$

Where:

kBtu/hr$_{cool}$ = Capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/hr).

= Actual installed

SEERbase =Seasonal Energy Efficiency Ratio of the baseline equipment

= SEER from tables below, if applicable code is based onIECC, or custom input as necessary.

SEERee = Seasonal Energy Efficiency Ratio of the energy efficient equipment.

= Actual installed

EFLH$_{cool}$ = Equivalent Full Load Hours for cooling are provided in section 2.7 HVAC End Use.

HSPFbase = Heating Seasonal Performance Factor of the baseline equipment

= HSPF from tables below, if applicable code is based on IECC, or custom input as necessary.

HSPFee = Heating Seasonal Performance Factor of the energy efficient equipment.

= Actual installed. If rating is COP, HSPF = COP * 3.413

EFLH$_{heat}$ = Heating mode equivalent full load hours are provided in section 2.7 HVAC End Use.

EERbase = Energy Efficiency Ratio of the baseline equipment

= EER from tables below, based on the applicable IECC. For air-cooled units < 65 kBtu/hr, assume the following conversion from SEER to EER for calculation of peak savings:[163]

$$EER = (-0.02 * SEER^2) + (1.12 * SEER)$$

EERee = Energy Efficiency Ratio of the energy efficient equipment. For air-cooled units < 65 kBtu/hr, if the actual EERee is unknown, assume the conversion from SEER to EER as provided above.

= Actual installed

kBtu/hr$_{heat}$ = Capacity of the heating equipment in kBtu per hour.

= Actual installed

3.412 = Btu per Wh.

COPbase = Coefficient of performance of the baseline equipment

[163] Based on Wassmer, M. (2003). A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. Masters Thesis, University of Colorado at Boulder. Note this is appropriate for single speed units only.

= COP from tables below, based on the applicable IECC. If rating is HSPF, COP = HSPF / 3.413

COPee = Coefficient of performance of the energy efficient equipment.

= Actual installed

Minimum Efficiency Requirements: 2009 IECC

TABLE 503.2.3(2)
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[b]	TEST PROCEDURE[a]
Air cooled, (Cooling mode)	< 65,000 *Btu/h*[d]	Split system	13.0 SEER	*AHRI210/240*
		Single package	13.0 SEER	
	≥ 65,000 *Btu/h* and < 135,000 *Btu/h*	Split system and single package	10.1 EERc (before Jan 1, 2010) 11.0 EERc (as of Jan 1, 2010)	
	≥ 135,000 *Btu/h* and < 240,000 *Btu/h*	Split system and single package	9.3 EERc (before Jan 1, 2010) 10.6 EERc (as of Jan 1, 2010)	AHRI *340/360*
	≥ 240,000 *Btu/h*	Split system and single package	9.0 EERc 9.2 IPLYc (before Jan 1, 2010) 9.5 EERc 9.2 IPLYc (as of Jan 1, 2010)	
Through-the-Wall (Air cooled, cooling mode)	< 30,000 *Btu/h*[d]	Split system	10.9 SEER (before Jan 23, 2010) 12.0 SEER (as of Jan 23,2010)	*AHRI210/240*
		Single package	10.6 SEER (before Jan 23, 2010) 12.0 SEER (as of Jan 23,2010)	
Water Source (Cooling mode)	< 17,000 *Btu/h*	86°F entering water	11.2 EER	AHRI/ASHRAE 13256-1
	≥ 17,000 *Btu/h* and < 135,000 *Btu/h*	86°F entering water	12.0 EER	AHRIASHRAE 13256-1
Groundwater Source (Cooling mode)	< 135,000 *Btu/h*	59°F entering water	16.2 EER	AHRI/ASHRAE 13256-1
Ground source (Cooling mode)	< 135,000 *Btu/h*	77°F entering water	13.4 EER	AHRI/ASHRAE 13256-1
Air cooled (Heating mode)	< 65,000 *Btu/h*[d] (Cooling capacity)	Split system	7.7 HSPF	*AHRI210/240*
		Single package	7.7 HSPF	
	≥ 65,000 *Btu/h* and < 135,000 *Btu/h* (Cooling capacity)	47°F *db/43°F* wb Outdoor air	3.2 COP (before Jan 1, 2010) 3.3 COP (as of Jan 1, 2010)	
	≥ 135,000 *Btu/h* (Cooling capacity)	47°F *db/43°F* wb Outdoor air	3.1 COP (before Jan 1, 2010) 3.2 COP (as of Jan 1, 2010)	AHRI *340/360*

TABLE 503.2.3(2)-continued
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[b]	TEST PROCEDURE[a]
Through-the-wall (Air cooled, heating mode)	< 30,000 Btu/h	Split System	7.1 HSPE (before Jan 23, 2010) 7.4 HSPF (as of Jan 23,2010)	AHRI210/240
		Single package	7.0 HSPF (before Jan 23, 2010) 7.4 HSPF (as of Jan 23,2010)	
Water source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	68°F entering water	4.2 COP	AHRI/ASHRAE 13256-1
Groundwater source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	50°F entering water	3.6 COP	AHRI/ASHRAE 13256-1
Ground source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	32°F entering water	3.1 COP	AHRI/ASHRAE 13256-1

For SI: °C = [(OF) - 32]/1.8, 1 British thermal unit per hour = 0.2931 W

db = dry-bulb temperature, of; wb = wet-bulb temperature, oF.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation.

c. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

d. Single-phase air-cooled heat pumps < 65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA), SEER and HSPF values are those set by NAECA.

Minimum Efficiency Requirements: 2012 IECC

TABLE C403.2.3(2)
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (cooling mode)	< 65,000 Btu/h[b]	All	Split System	13.0 SEER	AHRI 210/240
			Single Packaged	13.0 SEER	
Through-the-wall, air cooled	≤ 30,000 Btu/h[b]	All	Split System	13.0 SEER	
			Single Packaged	13.0 SEER	
Single-duct high-velocity air cooled	< 65,000 Btu/h[b]	All	Split System	10.0 SEER	
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	AHRI 340/360
		All other	Split System and Single Package	10.8 EER 11.0 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.6 EER 10.7 IEER	
		All other	Split System and Single Package	10.4 EER 10.5 IEER	
	≥ 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER 9.6 IEER	
		All other	Split System and Single Package	9.3 EER 9.4 IEER	
Water source (cooling mode)	< 17,000 Btu/h	All	86°F entering water	11.2 EER	ISO 13256-1
	≥ 17,000 Btu/h and < 65,000 Btu/h	All	86°F entering water	12.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	86°F entering water	12.0 EER	
Ground water source (cooling mode)	< 135,000 Btu/h	All	59°F entering water	16.2 EER	
		All	77°F entering water	13.4 EER	
Water-source water to water (cooling mode)	< 135,000 Btu/h	All	86°F entering water	10.6 EER	ISO 13256-2
			59°F entering water	16.3 EER	
Ground water source Brine to water (cooling mode)	< 135,000 Btu/h	All	77°F entering fluid	12.1 EER	
Air cooled (heating mode)	< 65,000 Btu/h[b]	—	Split System	7.7 HSPF	AHRI 210/240
		—	Single Package	7.7 HSPF	
Through-the-wall, (air cooled, heating mode)	≤ 30,000 Btu/h[b] (cooling capacity)	—	Split System	7.4 HSPF	
		—	Single Package	7.4 HSPF	
Small-duct high velocity (air cooled, heating mode)	< 65,000 Btu/h[b]	—	Split System	6.8 HSPF	

(continued)

TABLE C403.2.3(2)—continued
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb Outdoor Air	3.3 COP	AHRI 340/360
			17°F db/15°F wb Outdoor Air	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb Outdoor Air	3.2 COP	
			17°F db/15°F wb Outdoor Air	2.05 COP	
Water source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	68°F entering water	4.2 COP	ISO 13256-1
Ground water source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	50°F entering water	3.6 COP	
Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	32°F entering fluid	3.1 COP	
Water-source water to water (heating mode)	< 135,000 Btu/h (cooling capacity)	—	68°F entering water	3.7 COP	ISO 13256-2
		—	50°F entering water	3.1 COP	
Ground source brine to water (heating mode)	< 135,000 Btu/h (cooling capacity)	—	32°F entering fluid	2.5 COP	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

a. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.

b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

Minimum Efficiency Requirements: 2015 IECC

TABLE C403.2.3(2)
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 1/1/2016	As of 1/1/2016	
Air cooled (cooling mode)	< 65,000 Btu/h[b]	All	Split System	13.0 SEER[c]	14.0 SEER[c]	AHRI 210/240
			Single Package	13.0 SEER[c]	14.0 SEER[c]	
Through-the-wall, air cooled	≤ 30,000 Btu/h[b]	All	Split System	12.0 SEER	12.0 SEER	
			Single Package	12.0 SEER	12.0 SEER	
Single-duct high-velocity air cooled	< 65,000 Btu/h[b]	All	Split System	11.0 SEER	11.0 SEER	
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 12.0 IEER	AHRI 340/360
		All other	Split System and Single Package	10.8 EER 11.0 IEER	10.8 EER 11.8 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.6 EER 10.7 IEER	10.6 EER 11.6 IEER	
		All other	Split System and Single Package	10.4 EER 10.5 IEER	10.4 EER 11.4 IEER	
	≥ 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER 9.6 IEER	9.5 EER 10.6 IEER	
		All other	Split System and Single Package	9.3 EER 9.4 IEER	9.3 EER 9.4 IEER	
Water to Air: Water Loop (cooling mode)	< 17,000 Btu/h	All	86°F entering water	12.2 EER	12.2 EER	ISO 13256-1
	≥ 17,000 Btu/h and < 65,000 Btu/h	All	86°F entering water	13.0 EER	13.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	86°F entering water	13.0 EER	13.0 EER	
Water to Air: Ground Water (cooling mode)	< 135,000 Btu/h	All	59°F entering water	18.0 EER	18.0 EER	ISO 13256-1
Brine to Air: Ground Loop (cooling mode)	< 135,000 Btu/h	All	77°F entering water	14.1 EER	14.1 EER	ISO 13256-1
Water to Water: WaterLoop (cooling mode)	< 135,000 Btu/h	All	86°F entering water	10.6 EER	10.6 EER	ISO 13256-2
Water to Water: Ground Water (cooling mode)	< 135,000 Btu/h	All	59°F entering water	16.3 EER	16.3 EER	
Brine to Water: Ground Loop (cooling mode)	< 135,000 Btu/h	All	77°F entering fluid	12.1 EER	12.1 EER	

(continued)

TABLE C403.2.3(2)—continued
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 1/1/2016	As of 1/1/2016	
Air cooled (heating mode)	< 65,000 Btu/h[b]	—	Split System	7.7 HSPF[c]	8.2 HSPF[c]	AHRI 210/240
		—	Single Package	7.7 HSPF[c]	8.0 HSPF[c]	
Through-the-wall, (air cooled, heating mode)	≤ 30,000 Btu/h[b] (cooling capacity)	—	Split System	7.4 HSPF	7.4 HSPF	
		—	Single Package	7.4 HSPF	7.4 HSPF	
Small-duct high velocity (air cooled, heating mode)	< 65,000 Btu/h[b]	—	Split System	6.8 HSPF	6.8 HSPF	
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb outdoor air	3.3 COP	3.3 COP	AHRI 340/360
			17°F db/15°F wb outdoor air	2.25 COP	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb outdoor air	3.2 COP	3.2 COP	
			17°F db/15°F wb outdoor air	2.05 COP	2.05 COP	
Water to Air: Water Loop (heating mode)	< 135,000 Btu/h (cooling capacity)	—	68°F entering water	4.3 COP	4.3 COP	ISO 13256-1
Water to Air: Ground Water (heating mode)	< 135,000 Btu/h (cooling capacity)	—	50°F entering water	3.7 COP	3.7 COP	
Brine to Air: Ground Loop (heating mode)	< 135,000 Btu/h (cooling capacity)	—	32°F entering fluid	3.2 COP	3.2 COP	
Water to Water: Water Loop (heating mode)	< 135,000 Btu/h (cooling capacity)	—	68°F entering water	3.7 COP	3.7 COP	ISO 13256-2
Water to Water: Ground Water (heating mode)	< 135,000 Btu/h (cooling capacity)	—	50°F entering water	3.1 COP	3.1 COP	
Brine to Water: Ground Loop (heating mode)	< 135,000 Btu/h (cooling capacity)	—	32°F entering fluid	2.5 COP	2.5 COP	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.

b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

c. Minimum efficiency as of January 1, 2015.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWH_{Cool} * CF$$

Where:

ΔkWH = Annual cooling electricity savings, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0009106840

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.5.7 Packaged Terminal Air Conditioner (PTAC) and Packaged Terminal Heat Pump (PTHP)

DESCRIPTION

A PTAC is a packaged terminal air conditioner that cools and provides heat through an electric resistance heater (heat strip). A PTHP is a packaged terminal heat pump. A PTHP uses its compressor year-round to heat or cool. In warm weather, it efficiently captures heat from inside a space and pumps it outside for cooling. In cool weather, it captures heat from outdoor air and pumps it into a space, adding heat from electric heat strips as necessary to provide heat.

This measure characterizes:

a) Time of Sale: the purchase and installation of a new efficient PTAC or PTHP.

b) Early Replacement: the early removal of an existing PTAC or PTHP from service, prior to its natural end of life, and replacement with a new efficient PTAC or PTHP unit. Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life. The measure is only valid for non-fuel switching installations – for example replacing a cooling only PTAC with a PTHP can currently not use the TRM.

This measure was developed to be applicable to the following program types: TOS, NC, and EREP.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be PTACs or PTHPs that exceed baseline efficiencies.

DEFINITION OF BASELINE EQUIPMENT

TOS: the baseline conditions is provided in the Federal Baseline reference table provided below.

EREP: the baseline is the existing PTAC or PTHP for the assumed remaining useful life of the unit and the new baseline as defined above for the remainder of the measure life.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[164]

Remaining life of existing equipment is assumed to be 5 years.[165]

DEEMED MEASURE COST

TOS: The incremental capital cost for this equipment is estimated to be $84/ton.[166]

EREP: The measure cost is the full cost of removing the existing unit and installing a new one. The actual program cost should be used. If unknown assume $1,047 per ton.[167]

[164] Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007
[165] Standard assumption of one third of effective useful life.
[166] DEER 2008. This assumes that baseline shifts between IECC versions carries the same incremental costs. Values should be verified during evaluation
[167] Based on DCEO – IL PHA Efficient Living Program data.

The assumed deferred cost (after 5 years) of replacing existing equipment with new baseline unit is assumed to be $1,039 per ton.[168] This cost should be discounted to present value using the utilities' discount rate.

LOADSHAPE

Cooling BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Electric savings for PTACs and PTHPs should be calculated using the following algorithms

ENERGY SAVINGS

TOS:

PTAC ΔkWh[169] = Annual kWh $Savings_{cool}$

PTHP ΔkWh = Annual kWh $Savings_{cool}$ + Annual kWh $Savings_{heat}$

Annual kWh $Savings_{cool}$ = $(kBtu/hr_{cool})$ * [(1/EERbase) – (1/EERee)] * $EFLH_{cool}$

Annual kWh $Savings_{heat}$ = $(kBtu/hr_{heat})$/3.412 * [(1/COPbase) – (1/COPee)] * $EFLH_{heat}$

EREP:

ΔkWh for remaining life of existing unit (1st 5years) = Annual kWh $Savings_{cool}$ + Annual kWh $Savings_{heat}$

Annual kWh $Savings_{cool}$ = $(kBtu/hr_{cool})$ * [(1/EERexist) – (1/EERee)] * $EFLH_{cool}$

Annual kWh $Savings_{heat}$ = $(kBtu/hr_{heat})$/3.412 * [(1/COPexist) – (1/COPee)] * $EFLH_{heat}$

ΔkWh for remaining measure life (next 10 years) = Annual kWh $Savings_{cool}$ + Annual kWh $Savings_{heat}$

Annual kWh $Savings_{cool}$ = $(kBtu/hr_{cool})$ * [(1/EERbase) – (1/EERee)] * $EFLH_{cool}$

Annual kWh $Savings_{heat}$ = $(kBtu/hr_{heat})$/3.412 * [(1/COPbase) – (1/COPee)] * $EFLH_{heat}$

Where:

$kBtu/hr_{cool}$ = Capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/hr).

= Actual installed

$EFLH_{cool}$ = Equivalent Full Load Hours for cooling are provided in section 2.7 HVAC End Use:

$EFLH_{heat}$= Equivalent Full Load Hours for heating are provided in section 2.7 HVAC End Use

EERexist = Energy Efficiency Ratio of the existing equipment

[168] Based on subtracting TOS incremental cost from the DCEO data and incorporating inflation rate of 1.91%.
[169] There are no heating efficiency improvements for PTACs since although some do provide heating, it is always through electric resistance and therefore the COPbase and COPee would be 1.0.

= Actual. If unknown assume 8.1 EER[170]

EERbase = Energy Efficiency Ratio of the baseline equipment.

= See the table below for requirements where local code is based on IECC. Content is based on tables 503.3.3(3) (IECC 2009) and C403.2.3(3) (IECC 2012, 2015): Minimum Efficiency Reguirements: Electrically operated packaged terminal air conditioners, packaged terminal heat pumps. An alternate, custom input may be necessary for jurisdictions recognizing alternative code.

Equipment Type	IECC 2009 Minimum Efficiency	IECC 2012 Minimum Efficiency	IECC 2015 Minimum Efficiency
PTAC (Cooling mode) New Construction	12.5 - (0.213 . Cap/1000) EER	13.8 – (0.300 x Cap/1000) EER	14.0 – (0.300 x Cap/1000) EER
PTAC (Cooling mode) Replacements	10.9 - (0.213 . Cap/1000) EER	10.9 – (0.213 x Cap/1000) EER	10.9 – (0.213 x Cap/1000) EER
PTHP (Cooling mode) New Construction	12.3 - (0.213 . Cap/1000) EER	14.0 – (0.300 x Cap/1000) EER	14.0 – (0.300 x Cap/1000) EER
PTHP (Cooling mode) Replacements	10.8 - (0.213 . Cap/1000) EER	10.8 – (0.213 x Cap/1000) EER	10.8 – (0.213 x Cap/1000) EER
PTHP (Heating mode) New Construction	3.2 - (0.026 . Cap/1000) COP	3.2 – (0.026 x Cap/1000) COP	3.2 – (0.026 x Cap/1000) COP
PTHP (Heating mode) Replacements	2.9 - (0.026 . Cap/1000) COP	2.9 – (0.026 x Cap/1000) COP	2.9 – (0.026 x Cap/1000) COP

“Cap” = The rated cooling capacity of the project in Btu/hr. If the units capacity is less than 7000 Btu/hr, use 7,000 Btu/hr in the calculation. If the unit’s capacity is greater than 15,000 Btu/hr, use 15,000 Btu/hr in the calculations.

Replacement unit shall be factory labeled as follows: “MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS,” Replacement efficiencies apply only to units with existing sleeves less than 16 inches (406mm) in height and less than 42 inches (1067 mm) in width.

EERee = Energy Efficiency Ratio of the energy efficient equipment. For air-cooled units < 65 kBtu/hr, if the actual EERee is unknown, assume the following conversion from SEER to EER for calculation of peak savings:[171] $EER = (-0.02 * SEER^2) + (1.12 * SEER)$

= Actual installed

$kBtu/hr_{heat}$ = Capacity of the heating equipment in kBtu per hour.

= Actual installed

3.412 = Btu per Wh.

COPexist = Coefficient of performance of the existing equipment

[170] Estimated using the IECC building energy code up until year 2003 (p107; https://law.resource.org/pub/us/code/ibr/icc.iecc.2000.pdf) and assuming a 1 ton unit; EER = 10 – (0.16 * 12,000/1,000) = 8.1.
[171] Based on Wassmer, M. (2003). A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. Masters Thesis, University of Colorado at Boulder. Note this is appropriate for single speed units only.

= Actual. If unknown assume 1.0 COP for PTAC units and 2.6 COP[172] for PTHPs.

COPbase = Coefficient of performance of the baseline equipment; see table above for values.

COPee = Coefficient of performance of the energy efficient equipment.

= Actual installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

TOS:

$$\Delta kW = \Delta kWH_{cool} * CF$$

EREP:

ΔkW for remaining life of existing unit (1st 5years)

$$\Delta kW = \Delta kWH_{cool(1st\ 5\ years)} * CF$$

ΔkW for remaining measure life (next 10 years)

$$\Delta kW = \Delta kWH_{cool(next\ 10\ years)} * CF$$

Where:

ΔkWH_{cool} = Annual cooling electricity savings, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor for Cooling

= 0.0009106840

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[172]Estimated using the IECC building energy code up until year 2003 (p107; https://law.resource.org/pub/us/code/ibr/icc.iecc.2000.pdf) and assuming a 1 ton unit; COP = 2.9 – (0.026 * 12,000/1,000) = 2.6.

2.5.8 Single-Package and Split System Unitary Air Conditioner

DESCRIPTION

This measure promotes the installation of high-efficiency unitary air-, water-, and evaporatively cooled air conditioning equipment, both single-package and split systems. Air conditioning (AC) systems are a major consumer of electricity and systems that exceed baseline efficiencies can save considerable amounts of energy. This measure could apply to the replacement of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building.

This measure was developed to be applicable to the following program types: TOS and NC. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a high-efficiency air-, water-, or evaporatively cooled air conditioner that exceeds the energy efficiency requirements specified by the building code applicable to local jurisdiction. This may be a version of the 2009, 2012 or 2015 IECC or ASHRAE 90.1 standard.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be a standard-efficiency air-, water, or evaporatively cooled air conditioner that meets the energy efficiency requirements of local building code. The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[173]

DEEMED MEASURE COST

The incremental capital cost for this measure is assumed to be $100 per ton.[174]

LOADSHAPE

Cooling BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

For units with cooling capacities less than 65 kBtu/hr:

$$\Delta kWH = (kBtu/hr) * [(1/SEERbase) – (1/SEERee)] * EFLH$$

For units with cooling capacities equal to or greater than 65 kBtu/hr:

$$\Delta kWH = (kBtu/hr) * [(1/EERbase) – (1/EERee)] * EFLH$$

Where:

[173] Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007.

[174] Based on a review of TRM incremental cost assumptions from Vermont, Wisconsin, and California. This assumes that baseline shift from between IECC versions carries the same incremental costs. Values should be verified during evaluation.

kBtu/hr = Capacity of the cooling equipment actually installed in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/hr)

SEERbase = Seasonal Energy Efficiency Ratio of the baseline equipment

= SEER values from tables below, if applicable code is based on IECC, or custom input as necessary.

SEERee = Seasonal Energy Efficiency Ratio of the energy efficient equipment (actually installed)

EERbase = Energy Efficiency Ratio of the baseline equipment

= EER values from tables below, if applicable code is based on IECC, or custom input as necessary. (For air-cooled units < 65 kBtu/hr, assume the following conversion from SEER to EER for calculation of peak savings:[175] EER = (-0.02 * $SEER^2$) + (1.12 * SEER))

EERee = Energy Efficiency Ratio of the energy efficient equipment. For air-cooled units < 65 kBtu/hr, if the actual EERee is unknown, assume the conversion from SEER to EER for calculation of peak savings as above).

= Actual installed

EFLH = Equivalent Full Load Hours for cooling are provided in section 2.7 HVAC End Use

[175] Based on Wassmer, M. (2003). A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. Masters Thesis, University of Colorado at Boulder. Note this is appropriate for single speed units only.

<u>2009 IECC Minimum Efficiency Requirements</u>

TABLE 503.2.3(1)
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[b]	TEST PROCEDURE[a]
Air conditioners, Air cooled	< 65,000 Btu/h[d]	Split system	13.0 SEER	AHRI210/240
		Single package	13.0 SEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	10.3 EERc (before Jan 1, 2010) 11.2 EERc (as of Jan 1, 2010)	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	9.7 EERc (before Jan 1, 2010) 11.0 EERc (as of Jan 1, 2010)	AHRI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split system and single package	9.5 EERc 9.7 IPLYc (before Jan 1, 2010) 10.0 EERc 9.7 IPLyg (as of Jan 1, 2010)	
	≥ 760,000 Btu/h	Split system and single package	9.2 EERc 9.4 IPLYc (before Jan 1, 2010) 9.7 EERc 9.4 IPLYc (as of Jan 1, 2010)	
Through-the-wall, Air cooled	< 30,000 Btu/h[d]	Split system	10.9 SEER (before Jan 23, 2010) 12.0 SEER (as of Jan 23,2010)	AHRI210/240
		Single package	10.6 SEER (before Jan 23, 2010) 12.0 SEER (as of Jan 23,2010)	
Air conditioners, Water and evaporatively cooled	< 65,000 Btu/h	Split system and single package	12.1 EER	AHRI210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	11.5 EERc	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	11.0 EERc	AHRI 340/360
	≥ 240,000 Btu/h	Split system and single package	11.5 EERc	

For SI: 1 British thermal unit per hour = 0.2931 W

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. IPLVs are only applicable to equipment with capacity modulation.

c. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

d. Single-phase air-cooled air conditioners < 65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA); SEER values are those set by NAECA.

2012 IECC Minimum Efficiency Requirements

TABLE C403.2.3(1)
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 6/1/2011	As of 6/1/2011	
Air conditioners, air cooled	< 65,000 Btu/h[b]	All	Split System	13.0 SEER	13.0 SEER	AHRI 210/240
			Single Package	13.0 SEER	13.0 SEER	
Through-the-wall (air cooled)	≤ 30,000 Btu/h[b]	All	Split system	12.0 SEER	12.0 SEER	
			Single Package	12.0 SEER	12.0 SEER	
Small-duct high-velocity (air cooled)	< 65,000 Btu/h[b]	All	Split System	10.0 SEER	10.0 SEER	
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 11.4 IEER	11.2 EER 11.4 IEER	AHRI 340/360
		All other	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 11.2 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 11.2 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	10.8 EER 11.0 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 10.1 IEER	10.0 EER 10.1 IEER	
		All other	Split System and Single Package	9.8 EER 9.9 IEER	9.8 EER 9.9 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 9.8 IEER	9.7 EER 9.8 IEER	
		All other	Split System and Single Package	9.5 EER 9.6 IEER	9.5 EER 9.6 IEER	
Air conditioners, water cooled	< 65,000 Btu/h[b]	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER	12.1 EER 12.3 IEER	AHRI 340/360
		All other	Split System and Single Package	11.3 EER 11.5 IEER	11.9 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	12.5 EER 12.7 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	12.3 EER 12.5 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 IEER	12.4 EER 12.6 IEER	
		All other	Split System and Single Package	10.8 EER 10.9 IEER	12.2 EER 12.4 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 IEER	12.0 EER 12.4 IEER	
		All other	Split System and Single Package	10.8 EER 10.9 IEER	12.0 EER 12.2 IEER	

(continued)

TABLE C403.2.3(1)—continued
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 6/1/2011	As of 6/1/2011	
Air conditioners, evaporatively cooled	< 65,000 Btu/h[b]	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER	12.1 EER 12.3 IEER	AHRI 340/360
		All other	Split System and Single Package	11.3 EER 11.5 IEER	11.9 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	12.0 EER 12.2 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	11.8 EER 12.0 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 IEER	11.9 EER 12.1 IEER	
		All other	Split System and Single Package	10.8 EER 10.9 IEER	12.2 EER 11.9 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 11.1 IEER	11.7 EER 11.9 IEER	
		All other	Split System and Single Package	10.8 EER 10.9 IEER	11.5 EER 11.7 IEER	
Condensing units, air cooled	≥ 135,000 Btu/h			10.1 EER 11.4 IEER	10.5 EER 14.0 IEER	AHRI 365
Condensing units, water cooled	≥ 135,000 Btu/h			13.1 EER 13.6 IEER	13.5 EER 14.0 IEER	
Condensing units, evaporatively cooled	≥ 135,000 Btu/h			13.1 EER 13.6 IEER	13.5 EER 14.0 IEER	

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.

b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

2015 IECC Minimum Efficiency Requirements

TABLE C403.2.3(1)
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY Before 1/1/2016	MINIMUM EFFICIENCY As of 1/1/2016	TEST PROCEDURE[a]
Air conditioners, air cooled	< 65,000 Btu/h[b]	All	Split System	13.0 SEER	13.0 SEER	AHRI 210/240
			Single Package	13.0 SEER	14.0 SEER[c]	
Through-the-wall (air cooled)	≤ 30,000 Btu/h[b]	All	Split system	12.0 SEER	12.0 SEER	
			Single Package	12.0 SEER	12.0 SEER	
Small-duct high-velocity (air cooled)	< 65,000 Btu/h[b]	All	Split System	11.0 SEER	11.0 SEER	
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 11.4 IEER	11.2 EER 12.8 IEER	AHRI 340/360
		All other	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 12.6 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 12.4 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	10.8 EER 12.2 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 10.1 IEER	10.0 EER 11.6 IEER	
		All other	Split System and Single Package	9.8 EER 9.9 IEER	9.8 EER 11.4 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 9.8 IEER	9.7 EER 11.2 IEER	
		All other	Split System and Single Package	9.5 EER 9.6 IEER	9.5 EER 11.0 IEER	
Air conditioners, water cooled	< 65,000 Btu/h[b]	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 13.9 IEER	AHRI 340/360
		All other	Split System and Single Package	11.9 EER 12.1 IEER	11.9 EER 13.7 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.5 EER 12.5 IEER	12.5 EER 13.9 IEER	
		All other	Split System and Single Package	12.3 EER 12.5 IEER	12.3 EER 13.7 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.4 EER 12.6 IEER	12.4 EER 13.6 IEER	
		All other	Split System and Single Package	12.2 EER 12.4 IEER	12.2 EER 13.4 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.2 EER 12.4 IEER	12.2 EER 13.5 IEER	
		All other	Split System and Single Package	12.0 EER 12.2 IEER	12.0 EER 13.3 IEER	

(continued)

TABLE C403.2.3(1)—continued
MINIMUM EFFICIENCY REQUIREMENTS:
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE[a]
				Before 1/1/2016	As of 1/1/2016	
Air conditioners, evaporatively cooled	< 65,000 Btu/h[b]	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 340/360
		All other	Split System and Single Package	11.9 EER 12.1 IEER	11.9 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	12.0 EER 12.2 IEER	12.0 EER 12.2 IEER	
		All other	Split System and Single Package	11.8 EER 12.0 IEER	11.8 EER 12.0 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.9 EER 12.1 IEER	11.9 EER 12.1 IEER	
		All other	Split System and Single Package	11.7 EER 11.9 IEER	11.7 EER 11.9 IEER	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.7 EER 11.9 IEER	11.7 EER 11.9 IEER	
		All other	Split System and Single Package	11.5 EER 11.7 IEER	11.5 EER 11.7 IEER	
Condensing units, air cooled	≥ 135,000 Btu/h			10.5 EER 11.8 IEER	10.5 EER 11.8 IEER	AHRI 365
Condensing units, water cooled	≥ 135,000 Btu/h			13.5 EER 14.0 IEER	13.5 EER 14.0 IEER	
Condensing units, evaporatively cooled	≥ 135,000 Btu/h			13.5 EER 14.0 IEER	13.5 EER 14.0 IEER	

For SI: 1 British thermal unit per hour = 0.2931 W.
a. Chapter 6 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.
c. Minimum efficiency as of January 1, 2015.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWH * CF$$

Where:

ΔkWH = Annual electricity savings, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor for Cooling

= 0.0009106840

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

Measure Code:

2.6 Lighting

Building Type	Fixture Annual Operating Hours[176] (Hours)	Waste Heat Cooling Energy Factor[177] (WHFe)	Summer Demand Factor[178] (CF)	Waste Heat Electric Resistance Heating[179] (IFkWh)	Waste Heat Electric Heat Pump Heating (IFkWh)	Waste Heat Gas Heating IFTherms[180]
Large Office	3170	1.06	0.0002555753	0.32	0.14	0.014
Medium Office	3170	1.14	0.0002596721	0.19	0.08	0.008
Small Office	2884	1.11	0.0002154904	0.21	0.09	0.009
Warehouse	2827	1.04	0.0001361421	0.26	0.11	0.011
Stand-alone Retail	3421	1.08	0.0002844436	0.21	0.09	0.009
Strip Mall	3694	1.08	0.0002830978	0.22	0.10	0.009
Primary School	3466	1.08	0.0001747332	0.28	0.12	0.012
Secondary School	3466	1.14	0.0001643556	0.30	0.13	0.013
Supermarket	3765	1.07	0.0002892094	0.26	0.11	0.011
Quick Service Restaurant	6443	1.12	0.0001572418	0.27	0.12	0.012
Full Service Restaurant	6443	1.11	0.0001432272	0.22	0.10	0.009
Hospital	3812	1.11	0.0002249500	0.34	0.15	0.015
Outpatient Health Care	3898	1.21	0.0000693793	0.28	0.12	0.012
Small Hotel - Building	3713	1.21	0.0001225280	0.22	0.09	0.009
Large Hotel - Building	3713	1.24	0.0000877617	0.01	0.00	0.000
Midrise Apartment - Building	2876	1.14	0.0002048600	0.44	0.19	0.019
C&I Average	3351	1.09	0.0001861116	0.24	0.10	0.010

[176]Fixtures hours of use are based upon schedule assumptions used in the computer models. Nonresidential Average is a weighted average of indoor spaces using the relative area of each building type in the region (CBECS).

[177] The Waste Heat Factor for Energy is developed using computer models for the various building types. Exterior and garage values are 1, unknown is a weighted average of the other building types.

[178]Summer peak coincidence demand (kW) to annual energy (kWh) factor. Calculated using modeling results and Ameren Missouri coincident peak demand methodology.

[179] Electric heat penalty assumptions are based on converting the IFTherm multiplier value in to kWh and then applying relative heating system efficiencies. The gas efficiency was assumed to be 80% AFUE, electric resistance is assumed to be 100%, Heat Pump is assumed to be 2.3COP.

[180] IF Therms value is developed using computer models consistent with methodology for Waste Heat Factor for Energy.

2.6.1 Fluorescent Delamping

DESCRIPTION

This measure entails the permanent removal of an existing 4-foot or 8-foot T8 lamp and the associated lamp holders and ballasts from the fixture.

Customers are responsible for determining whether or not to use reflectors in combination with lamp removal in order to maintain adequate lighting levels. Lighting levels are expected to meet the Illuminating Engineering Society of North America (IESNA) recommended light levels. Unused lamps, lamp holders, and ballasts must be permanently removed from the fixture and disposed of in accordance with local regulations.

This measure was developed to be applicable to RF.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient condition will vary depending on the existing fixture and number of lamps removed, however for the purposes of this measure, savings are defined on a per removed lamp basis. The retrofit wattage (efficient condition) is therefore assumed to be zero.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is a T8 lamp with default wattages provided below.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life is assumed to be 11 years.[181]

DEEMED MEASURE COST

Measure	Cost
8-Foot Lamp Removal	\$16.00
4-Foot Lamp Removal	\$12.00
8-Foot Lamp Removal with reflector	\$30.00
4-Foot Lame Removal with Reflector	\$25.00

LOADSHAPE

Lighting BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS[182]

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * Hours * WHFe * ISR$$

Where:

[181] KCP&L measure life assumption.
[182] The savings numbers are for the straight lamp removal measures, as well as the lamp removal and install reflector measures.

$Watts_{Base}$ = Wattage reduction of lamp removed. Custom input, otherwise assume:

T8 Lamp Size	Wattage[183]
8-ft T8	38.6
4-ft T8	19.4

$Watts_{EE}$ = 0

Hours = Average annual lighting hours of use as provided by the customer. If unknown, the default value based on building type may be selected from the Lighting Reference Table in Section 2.8.

WHF_e = Waste heat factor for energy to account for cooling energy savings from light removal is selected from the Lighting Reference Table in Section 2.8 for each building type. If building is un-cooled, the value is 1.0 and if unknown use C&I Average value.

ISR = In Service Rate, 100% since permanent removal is assumed.

Heating Penalty[184]

If electrically heated building:

$$\Delta kWhheatpenalty = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * -IFkWh$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Lighting Reference Table in Section 2.8. If unknown, use the C&I Average value.

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001899635

Natural Gas Energy Savings[185]

Heating Penalty if fossil fuel heated building (or if heating fuel is unknown):

$$\Delta Therms = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * -IFTherms$$

Where:

[183] Default wattage reduction is based on averaging the savings from moving from a 2 to 1, 3 to 2 and 4 to 3 lamp fixture, as provided in the Standard Performance Contract Procedures Manual: Appendix B: Table of Standard Fixture Wattages (http://www.sce.com/NR/rdonlyres/7A3455F0-A337-439B-9607-10A016D32D4B/0/spc_B_Std_Fixture_Watts.pdf).
An adjustment is made to the T8 delamped fixture to account for the significant increase in ballast factor that can be expected when delamping fixtures with parallel ballasts. See "Delamping calculation.xlsx" for details.

[184] Negative value because this is an increase in heating consumption due to the efficient lighting.

[185] Negative value because this is an increase in heating consumption due to the efficient lighting.

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficent lighting.Values are provided in the Lighting Reference Table in Section 2.8. If unknown, use the C&I Average value.

Other factors as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.6.2 High Performance and Reduced Wattage T8 Fixtures and Lamps

DESCRIPTION

This measure applies to High Performance T8 (HPT8) lamp/ballast systems that have higher lumens per watt than standard T8 systems. This measure applies to the installation of new equipment with efficiencies that exceed that of the equipment that would have been installed following standard market practices and is applicable to time of sale as well as retrofit measures. Retrofit measures may include new fixtures or relamp/reballast measures. In addition, options have been provided to allow for the "Reduced Wattage T8 lamps" or RWT8 lamps that result in re-lamping opportunities that produce equal or greater light levels than standard T8 lamps while using fewer watts.

This measure was developed to be applicable to the following program types: TOS, RF, and DI.

If applied to other program types, the measure savings should be verified.

The measure applies to all commercial HPT8 installations excluding new construction and major renovation or change of use measures (see lighting power density measure). Lookup tables have been provided to account for the different types of installations. Whenever possible, actual costs and hours of use should be utilized for savings calculations. Default new and baseline assumptions have been provided in the reference tables. Default component costs and lifetimes have been provided for O&M calculations. Please see the Definition Table to determine applicability for each program. HPT8 configurations not included in the TRM may be included in custom program design using the provided algorithms as long as energy savings is achieved. The following table defines the applicability for different programs

Time of Sale (TOS)	Retrofit (RF) and Direct Install (DI)
This measure relates to the installation of new equipment with efficiency that exceeds that of equipment that would have been installed following standard market practices. In general, the measure will include qualifying high-efficiency, low ballast-factor ballasts paired with high-efficiency, long- life lamps as detailed in the attached tables. High-bay applications use this system paired with qualifying high ballast factor ballasts and high performance 32 w lamps. Custom lighting designs can use qualifying low, normal or high ballast-factor ballasts and qualifying lamps in lumen equivalent applications where total system wattage is reduced when calculated using the calculation of savings algorithms.	This measure relates to the replacement of existing equipment with new equipment with efficiency that exceeds that of the existing equipment. In general, the retrofit will include qualifying high efficiency low-ballast factor ballasts paired with high efficiency long life lamps as detailed in the attached tables. Custom lighting designs can use qualifying low, normal or high-ballast factor ballasts and qualifying lamps in lumen equivalent applications where total system wattage is reduced when calculated using the calculation of savings algorithms. High-efficiency troffers (new/or retrofit) utilizing HPT8 technology can provide even greater savings. When used in a high-bay application, high-performance T8 fixtures can provide equal light to HID high-bay fixtures, while using fewer watts; these systems typically utilize high ballast-factor ballasts, but qualifying low and normal ballast factor ballasts may be used when appropriate light levels are provided and overall wattage is reduced.

Definition of Efficient Equipment

This characterization assumes the efficient condition for all applications are qualifying HP or RWT8 fixture and lamp/ballast combinations listed on the CEE website under qualifying HP T8 products[186] and qualifying RWT8 products.[187]

The definition of efficient equipment varies based on the program and is defined below:

Time of Sale (TOS)	Retrofit (RF) and Direct Install (DI)
High-efficiency troffers combined with high efficiency lamps and ballasts allow for fewer lamps to be used to provide a given lumen output. High-efficiency troffers must have a fixture efficiency of 80% or greater to qualify. High bay fixtures must have fixture efficiencies of 85% or greater.	High-efficiency troffers (new or retrofit kits) combined with high efficiency lamps and ballasts allow for fewer lamps to be used to provide a given lumen output. High efficiency troffers must have a fixture efficiency of 80% or greater to qualify. High bay fixtures will have fixture efficiencies of 85% or greater.

Definition of Baseline Equipment

The definition of baseline equipment varies based on the program and is defined below:

Time of Sale (TOS)	Retrofit (RF) and Direct Install (DI)
The baseline is standard efficiency T8 systems that would have been installed. The baseline for high-bay fixtures is pulse start metal halide fixtures.	The baseline is the existing system. In July 14, 2012, federal standards were enacted that were expected to eliminate T12s as an option for linear fluorescent fixtures. However, due to significant loopholes in the legislation, T12 compliant product is still freely available. There will be a baseline shift applied to all T12 in 2020, at which point it is assumed no remaining T12 products will remain in operation.

Deemed Lifetime of Efficient Equipment

The deemed lifetime of efficient equipment varies based on the program and is defined below:

186 http://library.cee1.org/content/cee-high-performance-t8-specification
187 http://library.cee1.org/content/reduced-wattage-t8-specification

Time of Sale (TOS)	Retrofit (RF) and Direct Install (DI)
Fixture lifetime is 15 years.[188] Fixture retrofits which utilize RWT8 lamps have a lifetime equivalent to the life of the lamp, capped at 15 years. There is no guarantee that a reduced wattage lamp will be installed at time of burnout, but if one is, savings will be captured in the RWT8 measure below. RWT8 lifetime is the life of the product, at the reported operating hours (lamp life in hours divided by operating hours per year – see reference table "RWT8 Component Costs and Lifetime"), capped at 15 years.[189]	Fixture lifetime is 15 years. Note, since the fixture lifetime is deemed at 15 years, the replacement cost of both the lamp and ballast should be incorporated in to the O&M calculation.

DEEMED MEASURE COST

The deemed measure cost is found in the reference table at the end of this characterization.

LOADSHAPE

Lighting BUS Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = ((Watts_{base} - Watts_{EE})/1000) * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$ = Input wattage of the existing system which depends on the baseline fixture configuration (number and type of lamp) and number of fixtures. Value can be selected from the appropriate reference table as shown below, or a custom value can be entered if the configurations in the tables is not representative of the exisitng system.

Program	Reference Table
Time of Sale	A-1: HPT8 and RWT8 New and Baseline Assumptions
Retrofit	A-2: HPT8 and RWT8 New and Baseline Assumptions
High-Bay T8 Time of Sale and Retrofit	A-3: High Bay T8 New and Baseline Assumptions

$Watts_{EE}$ = New Input wattage of EE fixture which depends on new fixture configuration (number of lamps) and ballast factor and number of fixtures. Value can be selected

[188] 15 years from GDS Measure Life Report, June 2007.
[189] 15 years from GDS Measure Life Report, June 2007.

from the appropriate reference table, or a custom value can be entered if the configurations in the tables is not representative of the exisiting system.

Hours = Average hours of use per year as provided by the customer or selected from the Reference Table in Section 2.8. If hours or building type are unknown, use the C&I Average value.

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Reference Table in Section 2.8 for each building type. If building is un-cooled, the value is 1.0.

ISR = In Service Rate is assumed to be 100%

Heating Penalty

If electrically heated building:

$$\Delta kWh_{heatpenalty}{}^{190} = (((WattsBase-WattsEE)/1000) * ISR * Hours * -IFkWh$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Reference Table in Section 2.8. If unknown, use the C&I Average value.

Midlife Adjustment

A midlife savings adjustment should be applied to retrofit projects in 2020 to account for the baseline lamp replacement assumption changing from a T12 to 100% Standard T8 by 2020.[191] The savings adjustment is calculated as follows, and is provided in the HP/RW T8 Reference Table below:

$$\%\, Adjustment = \left(\frac{Watts_{\mathrm{T8base}} - Watts_{\mathrm{EE}}}{Watts_{\mathrm{Base}} - Watts_{\mathrm{EE}}}\right)$$

Where:

$Watts_{T8Base}$ = Input wattage of the of a 100% T8 fixture baseline.

$Watts_{Base}$ = Input wattage of the T12 baseline

SUMMER COINCIDENT DEMAND SAVINGS

$\Delta kW = \Delta kWh * CF$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001899635

[190] Negative value because this is an increase in heating consumption due to the efficient lighting.

[191] As of July 1, 2010, a federal mandate states that the magnetic ballasts used in many T12 fixtures can no longer be produced for commercial and industrial applications. However, there have been many loopholes that have meant T12 lamps continue to hold a significant market share. It is expected that new mandates will close the loophole within the next few years. T12 lamps have an average life of 20,000 hours and if we assume they are operated on average for 4500 hours annually, this would mean a lamp would have to be replaced every 4.5 years. We therefore assume that by 2020 all replacement lamps are Standard T8s. Therefore, while the more likely scenario would be a gradual shift in baseline to T8s over the timeframe, to simplify this assumption, a single midlife adjustment in 2020 is assumed.

NATURAL GAS SAVINGS

ΔTherms[192] = ((WattsBase-WattsEE)/1000) * ISR * Hours *- IFTherms

Where:

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Please select from the Reference Table in Section 2.8 for each building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

Actual operation and maintenance costs will vary by specific equipment installed/replaced. See Reference Tables for O&M values;

Program	Reference Table
TOS	B-1: HPT8 and RWT8 New and Baseline Assumptions
RF	B-2: HPT8 and RWT8 New and Baseline Assumptions
High-Bay T8 Time of Sale and Retrofit	B-3: High Bay T8 New and Baseline Assumptions

REFERENCE TABLES

A-1: Time of Sale: HPT8 and RWT8 New and Baseline Assumptions[193]

EE Measure Description	$Watts_{EE}$	Baseline Description	$Watts_{BASE}$	Incremental Cost
1-Lamp 32w HPT8 (BF < 0.79)	24.0	Standard T8	29.1	$15.00
2-Lamp 32w HPT8 (BF < 0.77)	48.0	Standard T8	57.0	$17.50
3-Lamp 32w HPT8 (BF < 0.76)	71.0	Standard T8	84.5	$20.00
4-Lamp 32w HPT8 (BF < 0.78)	98.0	Standard T8	112.6	$22.50
6-Lamp 32w HPT8 (BF < 0.76)	142.0	Standard T8	169.0	$40.00
1-Lamp 28w RWT8 (BF < 0.76)	21.3	Standard T8	29.1	$15.00
2-Lamp 28w RWT8 (BF < 0.76)	42.6	Standard T8	57.0	$17.50
3-Lamp 28w RWT8 (BF < 0.77)	63.0	Standard T8	84.5	$20.00
4-Lamp 28w RWT8 (BF < 0.79)	88.5	Standard T8	112.6	$22.50
6-Lamp 28w RWT8 (BF < 0.77)	126.0	Standard T8	169.0	$40.00

A-2: Retrofit: HPT8 and RWT8 New and Baseline Assumptions

[192] Negative value because this is an increase in heating consumption due to the efficient lighting.

[193] Watt, lumen, lamp life, and ballast factor assumptions for efficient measures are based upon Consortium for Energy Efficiency (CEE) Commercial Lighting Qualifying Product Lists. Watt, lumen, lamp life, and ballast factor assumptions for baseline fixtures are based upon manufacturer specification sheets. Baseline and efficient measure cost data comes from lighting suppliers, past Efficiency Vermont projects, and professional judgment. See "HPT8 TRM Reference Tables.xlsx" for more information and specific product links. Currently, 25WT8 are not considered under this measure as their lower light trade off and limitations on temperature and dimming have caused most distributers/contractors to use 28W almost exclusively in other markets.

EE Measure Description	$Watts_{EE}$	Baseline Description	$Watts_{BASE}$	Full Cost	Mid Life Savings Adjustment (2020)
1-Lamp Relamp/Reballast T12 to HPT8	24.0	1-Lamp 40w T12	31.0	$50.00	73%
2-Lamp Relamp/Reballast T12 to HPT8	48.0	2-Lamp 40w T12	62.0	$55.00	64%
3-Lamp Relamp/Reballast T12 to HPT8	71.0	3-Lamp 40w T12	108.0	$60.00	36%
4-Lamp Relamp/Reballast T12 to HPT8	98.0	4-Lamp 40w T12	144.0	$65.00	32%
6-Lamp Relamp/Reballast T12 to HPT8	142.0	6-Lamp 40w T12	216.0	$75.00	36%
1-Lamp Relamp/Reballast T12 to RWT8	21.3	1-Lamp 40w T12	31.0	$50.00	81%
2-Lamp Relamp/Reballast T12 to RWT8	42.6	2-Lamp 40w T12	62.0	$55.00	74%
3-Lamp Relamp/Reballast T12 to RWT8	63.0	3-Lamp 40w T12	108.0	$60.00	48%
4-Lamp Relamp/Reballast T12 to RWT8	88.5	4-Lamp 40w T12	144.0	$65.00	44%
6-Lamp Relamp/Reballast T12 to RWT8	126.0	6-Lamp 40w T12	216.0	$75.00	48%
1-Lamp Relamp/Reballast T8 to HPT8	24.0	1-Lamp 32w T8	29.1	$50.00	N/A
2-Lamp Relamp/Reballast T8 to HPT8	48.0	2-Lamp 32w T8	57.0	$55.00	N/A
3-Lamp Relamp/Reballast T8 to HPT8	71.0	3-Lamp 32w T8	84.5	$60.00	N/A
4-Lamp Relamp/Reballast T8 to HPT8	98.0	4-Lamp 32w T8	112.6	$65.00	N/A
6-Lamp Relamp/Reballast T8 to HPT8	142.0	6-Lamp 32w T8	169.0	$75.00	N/A
1-Lamp Relamp/Reballast T8 to RWT8	21.3	1-Lamp 32w T8	29.1	$50.00	N/A
2-Lamp Relamp/Reballast T8 to RWT8	42.6	2-Lamp 32w T8	57.0	$55.00	N/A
3-Lamp Relamp/Reballast T8 to RWT8	63.0	3-Lamp 32w T8	84.5	$60.00	N/A
4-Lamp Relamp/Reballast T8 to RWT8	88.5	4-Lamp 32w T8	112.6	$65.00	N/A
6-Lamp Relamp/Reballast T8 to RWT8	126.0	6-Lamp 32w T8	169.0	$75.00	N/A

* New T12's that meeting EISA efficacy standards changed from 34w to 40w to meet the lumen/per watt requirement.

A-2: Retrofit: HPT8 and RWT8 New and Baseline Assumptions

EE Measure Description	$Watts_{EE}$	Baseline Description	$Watts_{BASE}$	Full Cost	Mid Life Savings Adjustment (2020)
1-Lamp Relamp/Reballast T12 to HPT8	24.0	1-Lamp 40w T12	31.0	$50.00	73%
2-Lamp Relamp/Reballast T12 to HPT8	48.0	2-Lamp 40w T12	62.0	$55.00	64%
3-Lamp Relamp/Reballast T12 to HPT8	71.0	3-Lamp 40w T12	108.0	$60.00	36%
4-Lamp Relamp/Reballast T12 to HPT8	98.0	4-Lamp 40w T12	144.0	$65.00	32%
6-Lamp Relamp/Reballast T12 to HPT8	142.0	6-Lamp 40w T12	216.0	$75.00	36%
1-Lamp Relamp/Reballast T12 to RWT8	21.3	1-Lamp 40w T12	31.0	$50.00	81%
2-Lamp Relamp/Reballast T12 to RWT8	42.6	2-Lamp 40w T12	62.0	$55.00	74%
3-Lamp Relamp/Reballast T12 to RWT8	63.0	3-Lamp 40w T12	108.0	$60.00	48%
4-Lamp Relamp/Reballast T12 to RWT8	88.5	4-Lamp 40w T12	144.0	$65.00	44%
6-Lamp Relamp/Reballast T12 to RWT8	126.0	6-Lamp 40w T12	216.0	$75.00	48%
1-Lamp Relamp/Reballast T8 to HPT8	24.0	1-Lamp 32w T8	29.1	$50.00	N/A
2-Lamp Relamp/Reballast T8 to HPT8	48.0	2-Lamp 32w T8	57.0	$55.00	N/A
3-Lamp Relamp/Reballast T8 to HPT8	71.0	3-Lamp 32w T8	84.5	$60.00	N/A
4-Lamp Relamp/Reballast T8 to HPT8	98.0	4-Lamp 32w T8	112.6	$65.00	N/A
6-Lamp Relamp/Reballast T8 to HPT8	142.0	6-Lamp 32w T8	169.0	$75.00	N/A
1-Lamp Relamp/Reballast T8 to RWT8	21.3	1-Lamp 32w T8	29.1	$50.00	N/A

EE Measure Description	$Watts_{EE}$	Baseline Description	$Watts_{BASE}$	Full Cost	Mid Life Savings Adjustment (2020)
2-Lamp Relamp/Reballast T8 to RWT8	42.6	2-Lamp 32w T8	57.0	$55.00	N/A
3-Lamp Relamp/Reballast T8 to RWT8	63.0	3-Lamp 32w T8	84.5	$60.00	N/A
4-Lamp Relamp/Reballast T8 to RWT8	88.5	4-Lamp 32w T8	112.6	$65.00	N/A
6-Lamp Relamp/Reballast T8 to RWT8	126.0	6-Lamp 32w T8	169.0	$75.00	N/A

A–3: Time of Sale/Retrofit: High Bay T8 New and Baseline Assumptions

EE Measure Description	$Watts_{EE}$	Baseline Description	$Watts_{BASE}$	Incremental Cost	Full Cost
4-Lamp HPT8 w/ High-BF Ballast High-Bay	218.5	200 Watt Pulse Start Metal-Halide	232.0	$75	$200
4-Lamp HPT8 w/ High-BF Ballast High-Bay	218.5	250 Watt Metal Halide	295.0	$75	$200
6-Lamp HPT8 w/ High-BF Ballast High-Bay	330.1	320 Watt Pulse Start Metal-Halide	348.8	$75	$225
6-Lamp HPT8 w/ High-BF Ballast High-Bay	330.1	400 Watt Pulse Start Metal Halide	455.0	$75	$225
8-Lamp HPT8 w/ High-BF Ballast High-Bay	418.6	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 320 PSMH	476.0	$75	$250
8-Lamp HPT8 w/ High-BF Ballast High-Bay	418.6	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 400 W Metal Halide	618.0	$75	$250

B-1: Time of Sale: HPT8 and RWT8 Component Costs and Lifetime

		EE Measure				Baseline			
EE Measure Description	Lamp Quantity	Lamp Life (hrs)	Total Lamp Replacement Cost	Ballast Life (hrs)	Total Ballast Replacement Cost	Lamp Life (hrs)	Total Lamp Replacement Cost	Ballast Life (hrs)	Total Ballast Replacement Cost
1-Lamp 32w HPT8 (BF < 0.79)	1	24,000	$8.17	70,000	$52.50	20,000	$5.67	70,000	$35.00
2-Lamp 32w HPT8 (BF < 0.77)	2	24,000	$16.34	70,000	$52.50	20,000	$11.34	70,000	$35.00
3-Lamp 32w HPT8 (BF < 0.76)	3	24,000	$24.51	70,000	$52.50	20,000	$17.01	70,000	$35.00
4-Lamp 32w HPT8 (BF < 0.78)	4	24,000	$32.68	70,000	$52.50	20,000	$22.68	70,000	$35.00
6-Lamp 32w HPT8 (BF < 0.76)	6	24,000	$49.02	70,000	$105.00	20,000	$34.02	70,000	$35.00
1-Lamp 28w RWT8 (BF < 0.76)	1	18,000	$8.17	70,000	$52.50	20,000	$5.67	70,000	$35.00
2-Lamp 28w RWT8 (BF < 0.76)	2	18,000	$16.34	70,000	$52.50	20,000	$11.34	70,000	$35.00
3-Lamp 28w RWT8 (BF < 0.77)	3	18,000	$24.51	70,000	$52.50	20,000	$17.01	70,000	$35.00
4-Lamp 28w RWT8 (BF < 0.79)	4	18,000	$32.68	70,000	$52.50	20,000	$22.68	70,000	$35.00
6-Lamp 28w RWT8 (BF < 0.77)	6	18,000	$49.02	70,000	$105.00	20,000	$34.02	70,000	$35.00

B-2: Retrofit: HPT8 and RWT8 Component Costs and Lifetime

		EE Measure				Baseline			
EE Measure Description	Lamp Quantity	Lamp Life (hrs)	Total Lamp Replacement Cost	Ballast Life (hrs)	Total Ballast Replacement Cost	Lamp Life (hrs)	Total Lamp Replacement Cost	Ballast Life (hrs)	Total Ballast Replacement Cost
1-Lamp Relamp/Reballast T12 to HPT8	1	24,000	$8.17	70,000	$52.50	20,000	$5.87	40,000	$35.00
2-Lamp Relamp/Reballast T12 to HPT8	2	24,000	$16.34	70,000	$52.50	20,000	$11.74	40,000	$35.00
3-Lamp Relamp/Reballast T12 to HPT8	3	24,000	$24.51	70,000	$52.50	20,000	$17.61	40,000	$35.00
4-Lamp Relamp/Reballast T12 to HPT8	4	24,000	$32.68	70,000	$52.50	20,000	$23.48	40,000	$35.00
6-Lamp Relamp/Reballast T12 to HPT8	6	24,000	$49.02	70,000	$105.00	20,000	$35.22	40,000	$35.00
1-Lamp Relamp/Reballast T12 to RWT8	1	18,000	$8.17	70,000	$52.50	20,000	$5.87	40,000	$35.00
2-Lamp Relamp/Reballast T12 to RWT8	2	18,000	$16.34	70,000	$52.50	20,000	$11.74	40,000	$35.00
3-Lamp Relamp/Reballast T12 to RWT8	3	18,000	$24.51	70,000	$52.50	20,000	$17.61	40,000	$35.00
4-Lamp Relamp/Reballast T12 to RWT8	4	18,000	$32.68	70,000	$52.50	20,000	$23.48	40,000	$35.00
6-Lamp Relamp/Reballast T12 to RWT8	6	18,000	$49.02	70,000	$105.00	20,000	$35.22	40,000	$35.00
1-Lamp Relamp/Reballast T8 to HPT8	1	24,000	$8.17	70,000	$52.50	20,000	$5.67	70,000	$35.00

EE Measure Description	Lamp Quantity	EE Measure: Lamp Life (hrs)	EE Measure: Total Lamp Replacement Cost	EE Measure: Ballast Life (hrs)	EE Measure: Total Ballast Replacement Cost	Baseline: Lamp Life (hrs)	Baseline: Total Lamp Replacement Cost	Baseline: Ballast Life (hrs)	Baseline: Total Ballast Replacement Cost
2-Lamp Relamp/Reballast T8 to HPT8	2	24,000	$16.34	70,000	$52.50	20,000	$11.34	70,000	$35.00
3-Lamp Relamp/Reballast T8 to HPT8	3	24,000	$24.51	70,000	$52.50	20,000	$17.01	70,000	$35.00
4-Lamp Relamp/Reballast T8 to HPT8	4	24,000	$32.68	70,000	$52.50	20,000	$22.68	70,000	$35.00
6-Lamp Relamp/Reballast T8 to HPT8	6	24,000	$49.02	70,000	$105.00	20,000	$34.02	70,000	$35.00
1-Lamp Relamp/Reballast T8 to RWT8	1	18,000	$8.17	70,000	$52.50	20,000	$5.67	70,000	$35.00
2-Lamp Relamp/Reballast T8 to RWT8	2	18,000	$16.34	70,000	$52.50	20,000	$11.34	70,000	$35.00
3-Lamp Relamp/Reballast T8 to RWT8	3	18,000	$24.51	70,000	$52.50	20,000	$17.01	70,000	$35.00
4-Lamp Relamp/Reballast T8 to RWT8	4	18,000	$32.68	70,000	$52.50	20,000	$22.68	70,000	$35.00
6-Lamp Relamp/Reballast T8 to RWT8	6	18,000	$49.02	70,000	$105.00	20,000	$34.02	70,000	$35.00

B-3: High Bay HPT8 Component Costs and Lifetime

EE Measure					Baseline				
EE Measure Description	Lamp Life (hrs)	Total Lamp Replacement Cost	Ballast Life (hrs)	Total Ballast Replacement Cost	Baseline Description	Lamp Life (hrs)	Total Lamp Replacement Cost	Ballast Life (hrs)	Total Ballast Replacement Cost
4-Lamp HPT8 w/ High-BF Ballast High-Bay	24000	$46.68	70000	$47.50	200 Watt Pulse Start Metal-Halide	12000	$35.67	40000	$110.25
					250 Watt Metal Halide	10000	$27.67	40000	$114.50
6-Lamp HPT8 w/ High-BF Ballast High-Bay	24000	$70.02	70000	$47.50	320 Watt Pulse Start Metal-Halide	20000	$78.67	40000	$131.85
					400 Watt Metal-Halide	20000	$23.67	40000	$136.50
8-Lamp HPT8 w/ High-BF Ballast High-Bay	24000	$93.36	70000	$47.50	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 320 PSMH	20000	$23.67	40000	$131.85

MEASURE CODE:

2.6.3 LED Bulbs and Fixtures

DESCRIPTION

The installation of Light-Emitting Diode (LED) lighting systems have comparable luminosity to incandescent bulbs and equivalent fluorescent lamps at significantly less wattage, lower heat, and with significantly longer lifetimes.

This measure provides savings assumptions for a variety of efficient lighting fixtures including internal and external LED fixtures, recess (troffer), canopy, and pole fixtures as well as refrigerator and display case lighting.

This measure was developed to be applicable to the following program types: TOS and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, all LED fixtures are assumed to be ENERGY STAR® labeled or on the Design Light Consortium qualifying fixture list.[194]

DEFINITION OF BASELINE EQUIPMENT

For TOS and RF installations, the baselines efficiency case is project specific and is determined using actual fixture types and counts from the existing space. The existing fluorescent fixture end connectors and ballasts must be completely removed to qualify.

Where the installation technology is not known, the assumed baselines condition for an outdoor pole/arm, wall-mounted, garage/canopy fixture and high-bay luminaire with a high intensity discharge light source is a metal halide fixture. Deemed fixture wattages are provided in reference tables at the end of this characterization.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

Lifetime is the life of the product at the reported operating hours (lamp life in hours divided by operating hours per year – see reference table "LED component Costs and Lifetime." The analysis period is the same as the lifetime, capped at 15 years.[195]

DEEMED MEASURE COST

Actual incremental costs should be used if available. For default values, refer to the reference tables below.

LOADSHAPE

Lighting BUS

Ext Lighting BUS

Miscellaneous BUS

[194] Design Lights Consortium Qualified Products List http://www.designlights.org/qpl.
[195] GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * Hours * WHFe * ISR$$

Where:

$Watts_{Base}$ = Input wattage of the existing or baseline system. Reference the "LED New and Baseline Assumptions" table for default values.

$Watts_{EE}$ = Actual wattage of LED fixture purchased / installed. If unknown, use default provided in "LED New and Baseline Assumptions."

Hours = Average annual lighting hours of use as provided by the customer or selected from the Lighting Reference Table in Section 2.8. by building type. If hours or building type are unknown, use the C&I Average value.

WHFe = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Lighting Reference Table in Section 2.8 for each building type. If building is un-cooled, the value is 1.0.

ISR = In Service Rate is assumed to be 98.7% for Time of Sale and 100% for Retrofit.[196]

Heating Penalty:

If electrically heated building:

$$\Delta kWhheatpenalty = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFkWh)$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts;[197] this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Lighting Reference Table in Section 2.8. If unknown, use the C&I Average value.

Mid Life Adjustment:

A midlife savings adjustment should be applied to any retrofit measure using a T12 baseline. The adjustment should occur in 2020 to account for the baseline lamp replacement assumption changing from a T12 to 100% Standard T8 by 2020.[198] The savings adjustment is calculated as follows:

$$\%\ Adjustment = \left(\frac{Watts_{\mathrm{T8base}} - Watts_{\mathrm{EE}}}{Watts_{\mathrm{T12\ Base}} - Watts_{\mathrm{EE}}}\right)$$

Where:

WattsT8 Base = Input wattage of the existing system based on 100% T8 fixture.

WattsT12 Base = Input wattage of the existing T12 system.

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[196] Based on results presented in Ameren Missouri Lighting Impact and Process Evaluation: Program Year 2015 and consistent with other program ISR in neighboring states (Illinois and Iowa).

[197] Negative value because this is an increase in heating consumption due to the efficient lighting.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001899635 for indoor lighting

= 0.0000056160 for exterior lighting

= 0.0001379439 for 24/7 lighting

NATURAL GAS ENERGY SAVINGS

Heating penalty if fossil fuel heated building (or if heating fuel is unknown):

$$\Delta Therms = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFTherms)$$

Where:

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts.[199] This factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Lighting Reference Table in Section 2.8. If unknown, use the C&I Average value.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

See Reference Tables below for default assumptions.

REFERENCE TABLES[200]

LED New and Baseline Assumptions:

LED Category	EE Measure		Baseline		Incremental Cost
	Description	$Watts_{EE}$	Description	$Watts_{BASE}$	
LED Downlight Fixtures	LED Recessed, Surface, Pendant Downlights	17.6	40% CFL 26W Pin Based & 60% PAR30/38	54.3	$27
LED Interior Directional	LED Track Lighting	12.2	10% CMH PAR38 & 90% Halogen PAR38	60.4	$59
	LED Wall-Wash Fixtures	8.3	40% CFL 42W Pin Base & 60% Halogen PAR38	17.7	$59
LED Display Case	LED Display Case Light Fixture	7.1 / ft	50% 2’T5 Linear & 50% 50W Halogen	36.2 / ft	$11/ft

199 Negative value because this is an increase in heating consumption due to the efficient lighting.

200 Watt, lumen, lamp life, and ballast factor assumptions for efficient measures are based upon Consortium for Energy Efficiency (CEE) Commercial Lighting Qualifying Product Lists alongside past Efficiency Vermont projects and PGE refrigerated case study. Watt, lumen, lamp life, and ballast factor assumptions for baseline fixtures are based upon manufacturer specification sheets. Baseline cost data comes from lighting suppliers, past Efficiency Vermont projects, and professional judgment. Efficient cost data comes from 2012 DOE “Energy Savings Potential of Solid-State Lighting in General Illumination Applications,” Table A.1. See "LED Lighting Systems TRM Reference Tables.xlsx" for more information and specific product links.

LED Category	EE Measure		Baseline		Incremental Cost
	Description	$Watts_{EE}$	Description	$Watts_{BASE}$	
	LED Undercabinet Shelf-Mounted Task Light Fixtures	7.1 / ft	50% 2’T5 Linear & 50% 50W Halogen	36.2 / ft	$11/ft
	LED Refrigerated Case Light, Horizontal or Vertical	7.6 / ft	5’T8	15.2 / ft	$11/ft
	LED Freezer Case Light, Horizontal or Vertical	7.7 / ft	6’T12HO	18.7 / ft	$11/ft
LED Linear Replacement Lamps	LED 4' Linear Replacement Lamp	18.7	Lamp Only 32w T8	32.0	$24
	LED 2' Linear Replacement Lamp	9.7	Lamp Only 17w T8	17.0	$13
LED Troffers	LED 2x2 Recessed Light Fixture, 2000-3500 lumens	34.1	2-Lamp 32w T8 (BF < 0.89)	57.0	$48
	LED 2x2 Recessed Light Fixture, 3501-5000 lumens	42.8	3-Lamp 32w T8 (BF < 0.88)	84.5	$91
	LED 2x4 Recessed Light Fixture, 3000-4500 lumens	37.9	2-Lamp 32w T8 (BF < 0.89)	57.0	$62
	LED 2x4 Recessed Light Fixture, 4501-6000 lumens	54.3	3-Lamp 32w T8 (BF < 0.88)	84.5	$99
	LED 2x4 Recessed Light Fixture, 6001-7500 lumens	72.7	4-Lamp 32w T8 (BF < 0.88)	112.6	$150
	LED 1x4 Recessed Light Fixture, 1500-3000 lumens	18.1	1-Lamp 32w T8 (BF <0.91)	29.1	$36
	LED 1x4 Recessed Light Fixture, 3001-4500 lumens	39.6	2-Lamp 32w T8 (BF < 0.89)	57.0	$76
	LED 1x4 Recessed Light Fixture, 4501-6000 lumens	53.1	3-Lamp 32w T8 (BF < 0.88)	84.5	$130
LED Linear Ambient Fixtures	LED Surface & Suspended Linear Fixture, ≤ 3000 lumens	19.7	1-Lamp 32w T8 (BF <0.91)	29.1	$54
	LED Surface & Suspended Linear Fixture, 3001-4500 lumens	37.8	2-Lamp 32w T8 (BF < 0.89)	57.0	$104
	LED Surface & Suspended Linear Fixture, 4501-6000 lumens	55.9	3-Lamp 32w T8 (BF < 0.88)	84.5	$158
	LED Surface & Suspended Linear Fixture, 6001-7500 lumens	62.6	T5HO 2L-F54T5HO - 4'	120.0	$215
	LED Surface & Suspended Linear Fixture, > 7500 lumens	95.4	T5HO 3L-F54T5HO - 4'	180.0	$374
LED High & Low Bay Fixtures	LED Low-Bay Fixtures, ≤ 10,000 lumens	90.3	3-Lamp T8HO Low-Bay	157.0	$191
	LED High-Bay Fixtures, 10,001-15,000 lumens	127.5	4-Lamp T8HO High-Bay	196.0	$331
	LED High-Bay Fixtures, 15,001-20,000 lumens	191.0	6-Lamp T8HO High-Bay	294.0	$482
	LED High-Bay Fixtures, > 20,000 lumens	249.7	8-Lamp T8HO High-Bay	392.0	$818
LED Agricultural Interior Fixtures	LED Ag Interior Fixtures, ≤ 2,000 lumens	17.0	25% 73 Watt EISA Inc, 75% 1L T8	42.0	$33

LED Category	EE Measure		Baseline		Incremental Cost
	Description	$Watts_{EE}$	Description	$Watts_{BASE}$	
	LED Ag Interior Fixtures, 2,001-4,000 lumens	27.8	25% 146 Watt EISA Inc, 75% 2L T8	81.0	$54
	LED Ag Interior Fixtures, 4,001-6,000 lumens	51.2	25% 217 Watt EISA Inc, 75% 3L T8	121.0	$125
	LED Ag Interior Fixtures, 6,001-8,000 lumens	71.7	25% 292 Watt EISA Inc, 75% 4L T8	159.0	$190
	LED Ag Interior Fixtures, 8,001-12,000 lumens	103.5	200W Pulse Start Metal Halide	227.3	$298
	LED Ag Interior Fixtures, 12,001-16,000 lumens	143.8	320W Pulse Start Metal Halide	363.6	$450
	LED Ag Interior Fixtures, 16,001-20,000 lumens	183.3	350W Pulse Start Metal Halide	397.7	$595
	LED Ag Interior Fixtures, > 20,000 lumens	305.0	(2) 320W Pulse Start Metal Halide	727.3	$998
LED Exterior Fixtures	LED Exterior Fixtures, ≤ 5,000 lumens	42.6	100W Metal Halide	113.6	$190
	LED Exterior Fixtures, 5,001-10,000 lumens	68.2	175W Pulse Start Metal Halide	198.9	$287
	LED Exterior Fixtures, 10,001-15,000 lumens	122.5	250W Pulse Start Metal Halide	284.1	$391
	LED Exterior Fixtures, > 15,000 lumens	215.0	400W Pulse Start Metal Halide	454.5	$793

LED Component Costs and Lifetimes:

		EE Measure				Baseline			
LED Category	EE Measure Description	Lamp Life (hrs)	Total Lamp Replace Cost	LED Driver Life (hrs)	Total LED Driver Replace Cost	Lamp Life (hrs)	Total Lamp Replace Cost	Ballast Life (hrs)	Total Ballast Replace Cost
LED Downlight Fixtures	LED Recessed, Surface, Pendant Downlights	35,000	$30.75	70,000	$47.50	2,500	$8.86	40,000	$14.40
LED Interior Directional	LED Track Lighting	35,000	$39.00	70,000	$47.50	2,500	$12.71	40,000	$11.00
	LED Wall-Wash Fixtures	35,000	$39.00	70,000	$47.50	2,500	$9.17	40,000	$27.00
LED Display Case	LED Display Case Light Fixture	35,000	$9.75/ft	70,000	$11.88/ft	2,500	$6.70	40,000	$5.63
	LED Undercabinet Shelf-Mounted Task Light Fixtures	35,000	$9.75/ft	70,000	$11.88/ft	2,500	$6.70	40,000	$5.63
	LED Refrigerated Case Light, Horizontal or Vertical	35,000	$8.63/ft	70,000	$9.50/ft	15,000	$1.13	40,000	$8.00
	LED Freezer Case Light, Horizontal or Vertical	35,000	$7.88/ft	70,000	$7.92/ft	12,000	$0.94	40,000	$6.67
LED Linear Replacement Lamps	LED 4' Linear Replacement Lamp	35,000	$8.57	70,000	$13.67	20,000	$6.17	70,000	$11.96
	LED 2' Linear Replacement Lamp	35,000	$5.76	70,000	$13.67	20,000	$6.17	70,000	$11.96

		EE Measure				Baseline			
LED Category	EE Measure Description	Lamp Life (hrs)	Total Lamp Replace Cost	LED Driver Life (hrs)	Total LED Driver Replace Cost	Lamp Life (hrs)	Total Lamp Replace Cost	Ballast Life (hrs)	Total Ballast Replace Cost
LED Troffers	LED 2x2 Recessed Light Fixture, 2000-3500 lumens	35,000	$46.68	70,000	$40.00	20,000	$11.34	70,000	$35.00
	LED 2x2 Recessed Light Fixture, 3501-5000 lumens	35,000	$56.31	70,000	$40.00	20,000	$17.01	70,000	$35.00
	LED 2x4 Recessed Light Fixture, 3000-4500 lumens	35,000	$49.58	70,000	$40.00	20,000	$11.34	70,000	$35.00
	LED 2x4 Recessed Light Fixture, 4501-6000 lumens	35,000	$57.76	70,000	$40.00	20,000	$17.01	70,000	$35.00
	LED 2x4 Recessed Light Fixture, 6001-7500 lumens	35,000	$68.89	70,000	$40.00	20,000	$22.68	70,000	$35.00
	LED 1x4 Recessed Light Fixture, 1500-3000 lumens	35,000	$43.43	70,000	$40.00	20,000	$5.67	70,000	$35.00
	LED 1x4 Recessed Light Fixture, 3001-4500 lumens	35,000	$52.31	70,000	$40.00	20,000	$11.34	70,000	$35.00
	LED 1x4 Recessed Light Fixture, 4501-6000 lumens	35,000	$63.86	70,000	$40.00	20,000	$17.01	70,000	$35.00
LED Linear Ambient Fixtures	LED Surface & Suspended Linear Fixture, ≤ 3000 lumens	35,000	$45.01	70,000	$40.00	20,000	$5.67	70,000	$35.00
	LED Surface & Suspended Linear Fixture, 3001-4500 lumens	35,000	$58.73	70,000	$40.00	20,000	$11.34	70,000	$35.00
	LED Surface & Suspended Linear Fixture, 4501-6000 lumens	35,000	$73.50	70,000	$40.00	20,000	$17.01	70,000	$35.00
	LED Surface & Suspended Linear Fixture, 6001-7500 lumens	35,000	$88.69	70,000	$40.00	30,000	$26.33	70,000	$60.00
	LED Surface & Suspended Linear Fixture, > 7500 lumens	35,000	$123.91	70,000	$40.00	30,000	$39.50	70,000	$60.00
LED High & Low Bay Fixtures	LED Low-Bay Fixtures, ≤ 10,000 lumens	35,000	$90.03	70,000	$62.50	18,000	$64.50	70,000	$92.50

		EE Measure				Baseline			
LED Category	**EE Measure Description**	**Lamp Life (hrs)**	**Total Lamp Replace Cost**	**LED Driver Life (hrs)**	**Total LED Driver Replace Cost**	**Lamp Life (hrs)**	**Total Lamp Replace Cost**	**Ballast Life (hrs)**	**Total Ballast Replace Cost**
	LED High-Bay Fixtures, 10,001-15,000 lumens	35,000	$122.59	70,000	$62.50	18,000	$86.00	70,000	$92.50
	LED High-Bay Fixtures, 15,001-20,000 lumens	35,000	$157.22	70,000	$62.50	18,000	$129.00	70,000	$117.50
	LED High-Bay Fixtures, > 20,000 lumens	35,000	$228.52	70,000	$62.50	18,000	$172.00	70,000	$142.50
LED Agricultural Interior Fixtures	LED Ag Interior Fixtures, ≤ 2,000 lumens	35,000	$37.00	70,000	$40.00	1,000	$1.23	40,000	$26.25
	LED Ag Interior Fixtures, 2,001-4,000 lumens	35,000	$44.96	70,000	$40.00	1,000	$1.43	40,000	$26.25
	LED Ag Interior Fixtures, 4,001-6,000 lumens	35,000	$63.02	70,000	$40.00	1,000	$1.62	40,000	$26.25
	LED Ag Interior Fixtures, 6,001-8,000 lumens	35,000	$79.78	70,000	$40.00	1,000	$1.81	40,000	$26.25
	LED Ag Interior Fixtures, 8,001-12,000 lumens	35,000	$119.91	70,000	$62.50	15,000	$63.00	40,000	$112.50
	LED Ag Interior Fixtures, 12,001-16,000 lumens	35,000	$151.89	70,000	$62.50	15,000	$68.00	40,000	$122.50
	LED Ag Interior Fixtures, 16,001-20,000 lumens	35,000	$184.62	70,000	$62.50	15,000	$73.00	40,000	$132.50
	LED Ag Interior Fixtures, > 20,000 lumens	35,000	$285.75	70,000	$62.50	15,000	$136.00	40,000	$202.50
LED Exterior Fixtures	LED Exterior Fixtures, ≤ 5,000 lumens	35,000	$86.92	70,000	$62.50	15,000	$58.00	40,000	$102.50
	LED Exterior Fixtures, 5,001-10,000 lumens	35,000	$111.81	70,000	$62.50	15,000	$63.00	40,000	$112.50
	LED Exterior Fixtures, 10,001-15,000 lumens	35,000	$138.32	70,000	$62.50	15,000	$68.00	40,000	$122.50
	LED Exterior Fixtures, > 15,000 lumens	35,000	$223.67	70,000	$62.50	15,000	$73.00	40,000	$132.50

MEASURE CODE:

2.6.4 LED Screw Based Omnidirectional Bulb

Description

LEDs lighting systems convert electricity to light and emit more lumens per watt when compared to baseline EISA incandescent, halogen, or compact fluorescent lamps.

This specific characterization provides savings assumptions for LED lamps that replace standard screw-in connections (e.g., A-Type lamp) such as interior/exterior omnidirectional bulb options.

This characterization assumes that the LED is installed in a commercial location. This is, therefore, appropriate for commercially targeted programs, or, if the implementation strategy does not allow for the installation location to be known (e.g., an upstream retail program), utilities should develop an assumption of the residential versus nonresidential split and apply the relevant assumptions to each portion.

Federal legislation stemming from the Energy Independence and Security Act of 2007 (EISA) requires all general-purpose light bulbs between 40W and 100W to be approximately 30% more energy efficient than standard incandescent bulbs. Production of 100W, standard efficacy incandescent lamps ended in 2012, followed by restrictions on 75W in 2013 and 60W and 40W in 2014. The baseline for this measure has therefore become bulbs (improved incandescent or halogen) that meet the new standard.

This measure was developed to be applicable to the following program types: TOS and RF.

If applied to other program types, the measure savings should be verified.

Definition of Efficient Equipment

In order for this characterization to apply, new LED screw-based lamps must be ENERGY STAR® qualified based upon the ENERGY STAR® specification v2.0 which will become effective on 1/2/2017 (https://www.energystar.gov/sites/default/files/Luminaires%20V2%200%20Final.pdf).
Qualification could also be based or on the Design Light Consortium's qualified product list.[201]

Definition of Baseline Equipment

The baseline condition for this measure is assumed to be an EISA-qualified halogen or incandescent. From 2020 the baseline will begin transitioning to a CFL[202] based upon what is available in the market and therefore a midlife adjustment is provided.

Deemed Lifetime of Efficient Equipment

The lifetime of the product is the lamp life in hours divided by operating hours per year. Depending on operating conditions (currents and temperatures) and other factors (settings and building use), LED rated life is assumed to be 50,000 hours. [203]

Deemed Measure Cost

Wherever possible, actual incremental costs should be used. If unavailable, assume $3.26 (baseline cost of $1.80 and efficient cost of $5.06).[204]

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201 https://www.designlights.org/QPL

202 A provision in the EISA regulations requires that by January 1, 2020, all lamps meet efficiency criteria of at least 45 lumens per watt, in essence making the baseline equivalent to a current day CFL.

203 LED Fixture Component Costs & Lifetime Table found on page 372 of the IL TRM v6.0 Volume 2.

204 Incandescent/halogen and LED cost assumptions based on Cadmus "LED Incremental Cost Study: Overall Final Report," February 2016
(http://ma-eeac.org/wordpress/wp-content/uploads/MA-Task-5b-LED-Incremental-Cost-Study_FINAL_01FEB2016.pdf), p.19.

LOADSHAPE

Lighting BUSExt Lighting BUS

Miscellaneous BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * Hours * WHFe * ISR$$

Where:

$Watts_{Base}$ = Based on lumens of LED bulb installed

$Watts_{EE}$ = Actual wattage of LED purchased/installed. If unknown, use default provided below.[205]

Lower Lumen Range	Upper Lumen Range	$Watts_{Base}$	$Watts_{EE}$ LED	Delta Watts
250	309	25	4.0	21
310	749	29	6.7	22.3
750	1,049	43	10.1	32.9
1,050	1,489	53	12.8	40.2
1,490	2,600	72	17.4	54.6
2,601	3,000	150	43.1	106.9
3,001	3,999	200	53.8	146.2
4,000	6,000	300	76.9	223.1

Hours = Average hours of use per year as provided by the customer or selected from the Lighting Reference Table in Section 2.8 and based upon building type. If unknown, use the C&I Average value.

WHFe = Waste heat factors for energy to account for cooling energy savings from efficient lighting are provided for each building type in the Lighting Reference Table in Section 2.8. If unknown, use the C&I Average value.

ISR = In-Service Rate or the percentage of units rebated that get installed

[205] $Watts_{EE}$ defaults are based upon the average available ENERGY STAR® product, accessed 06/18/2015. For any lumen range where there is no ENERGY STAR® product currently available, $Watts_{EE}$ is based upon the ENERGY STAR® minimum luminous efficacy (55Lm/W for lamps with rated wattages less than 15W and 65 Lm/W for lamps with rated wattages ≥ 15 watts) for the mid-point of the lumen range. See calculation at “cerified-light-bulbs-2015-06-18.xlsx.” These assumptions should be reviewed regularly to ensure they represent the available product.

= 98.7%[206]

Mid-Life Baseline Adjustment

During the lifetime of a standard omnidirectional LED, the baseline incandescent/halogen bulb would need to be replaced multiple times. Since the baseline bulb changes to a CFL equivalent in 2020 due to the EISA backstop provision (except for <310 and 2600+ lumen lamps), the annual savings claim must be reduced within the life of the measure to account for this baseline shift. This reduced annual savings will need to be incorporated in to cost effectiveness screening calculations. The baseline adjustment also impacts the O&M schedule.

For example, for 43W equivalent LED lamp installed in 2016, the full savings (as calculated above in the Algorithm) should be claimed for the first four years, but a reduced annual savings (calculated energy savings above multiplied by the adjustment factor in the table below) should be claimed for the remainder of the measure life.[207]

Lower Lumen Range	Upper Lumen Range	Mid Lumen Range	Watts EE	WattsBase before EISA 2020	Delta Watts before EISA 2020	WattsBase after EISA 2020[208]	Delta Watts after EISA 2020	Mid Life adjustment (in 2020) to first year savings
250	309	280	4.0	25	21	25	21	100.0%
310	749	530	6.7	29	22.3	9.4	2.7	12.1%
750	1049	900	10.1	43	32.9	13.4	3.3	10.0%
1050	1489	1270	12.8	53	40.2	18.9	6.1	15.2%
1490	2600	2045	17.4	72	54.6	24.8	7.4	13.6%
2,550	3,000	2,775	43.1	150	106.9	150	106.9	100.0%
3,001	3,999	3,500	53.8	200	146.2	200	146.2	100.0%
4,000	6,000	5,000	76.9	300	223.1	300	223.1	100.0%

Heating Penalty:

If electrically heated building:[209]

$$\Delta kWhheatpenalty = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFkWh)$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Lighting Reference Table in Section 2.8 and based upon building type. If unknown, use the C&I Average value.

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206 Based on results presented in Ameren Missouri Lighting Impact and Process Evaluation: Program Year 2015. This value takes into account the time-delay of when bulbs are installed over subsequent program years. The reported ISR is based on the net present value (NPV) of the savings over 4 year installation period from the PY15 bulbs, discounted back to Year 1 at 6.95% (utility discount rate).

207 These adjustments should be applied to kW and gas impacts as well.

208 Calculated with EISA requirement of 45lumens/watt.

209 Results in a negative value because this is an increase in heating consumption due to the efficient lighting.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001899635 for indoor lighting

= 0.0000056160 for exterior lighting

= 0.0001379439 for 24/7 lighting

NATURAL GAS ENERGY SAVINGS

Heating penalty if fossil fuel heated building (or if heating fuel is unknown): [210]

$$\Delta Therms = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFTherms)$$

Where:

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Lighting Reference Table in Section 2.8 and based upon building type. If unknown, use the C&I Average value.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

In order to account for the falling EISA-Qualified backdrop provision, an equivalent annual levelized baseline replacement cost over the lifetime of the LED bulb is calculated. The key assumptions used in this calculation are documented below:[211]

Incandescent / Halogen	CFL	LED A-Lamp
$1.80	$2.20	$5.06

The present value of replacement lamps and annual levelized replacement costs using utilities' average real discount rate of 6.91% are presented below:

Location	PV of replacement costs for period			Levelized annual replacement cost savings		
	2016 - 2017	2017 - 2018	2018 - 2019	2016 - 2017	2017 - 2018	2018 - 2019
C&I Average	$18.66	$14.70	$10.46	$2.04	$1.60	$1.14

[210] Results in a negative value because this is an increase in heating consumption due to the efficient lighting.
[211] All cost assumptions based on Cadmus "LED Incremental Cost Study: Overall Final Report," February 2016 (http://ma-eeac.org/wordpress/wp-content/uploads/MA-Task-5b-LED-Incremental-Cost-Study_FINAL_01FEB2016.pdf), p.19.

Note: incandescent lamps in lumen range <310 and >2600 are exempt from EISA. For these bulb types, an O&M cost should be applied as follows. If unknown building type, assume C&I Average:

Building Type	Replacement Period (years)[212]	Replacement Cost
Large Office	0.32	$1.80[213]
Medium Office	0.32	
Small Office	0.35	
Warehouse	0.35	
Stand-alone Retail	0.29	
Strip Mall	0.27	
Primary School	0.29	
Secondary School	0.29	
Supermarket	0.27	
Quick Service Restaurant	0.16	
Full Service Restaurant	0.16	
Hospital	0.26	
Outpatient Health Care	0.26	
Small Hotel - Building	0.27	
Large Hotel - Building	0.27	
Midrise Apartment - Building	0.35	
C&I Average	0.30	

MEASURE CODE:

[212] Calculated by dividing assumed rated life of baseline bulb by hours of use. Assumed lifetime of EISA-qualified halogen/incandescent is 1000 hours (manufacturers are simply using a regular incandescent lamp with halogen fill gas rather than Halogen Infrared to meet the standard (as provided by G. Arnold, NEEP and confirmed by N. Horowitz at NRDC)).

[213] Incandescent/halogen cost assumptions based on Cadmus "LED Incremental Cost Study: Overall Final Report," February 2016 (http://ma-eeac.org/wordpress/wp-content/uploads/MA-Task-5b-LED-Incremental-Cost-Study_FINAL_01FEB2016.pdf), p.19.

2.6.5 T5 Fixtures and Lamps

DESCRIPTION

T5 HO lamp/ballast systems have greater lumens per watt than a typical T8 system. The smaller lamp diameter of the T5HO also increases optical control efficiency and allows for more precise control and directional distribution of lighting. These characteristics make it easier to design light fixtures that can produce equal or greater light than standard T8 or T12 systems, while using fewer watts. In addition, when lighting designers specify T5 HO lamps/ballasts, they can use fewer luminaries per project, especially for large commercial projects, thus increasing energy savings further.[214]

The main markets served by T5 HO fixtures and lamps include retrofit in the commercial and nonresidential sector, specifically industrial, warehouse, and grocery facilities with higher ceiling heights that require maximum light output.

This measure was developed to be applicable to the following program types: TOS and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The definition of the efficient equipment is T5 HO high-bay (>15ft mounting height) fixtures with 3, 4, 6, or 8-lamp configurations.

DEFINITION OF BASELINE EQUIPMENT

The definition of baseline equipment varies based on number of lamps in a fixture and is defined in the baseline reference table at the end of this characterization. The default baseline is assumed to be a Pulse-Start Metal Halide fixture.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The deemed lifetime of the efficient equipment fixture is 15 years.[215]

DEEMED MEASURE COST

The deemed measure cost is found in Reference Table at the end of this characterization. For retrofit applications, actual costs should be used if available, or, if not available, $10/lamp and $37.50/ballast can be used to account for installation labor costs.

LOADSHAPE

Lighting BUS

Ext Lighting BUS

Miscellaneous BUS

[214] Lighting Research Center. T5 Fluorescent Systems. http://www.lrc.rpi.edu/programs/nlpip/lightingAnswers/lat5/abstract.asp
[215] Focus on Energy Evaluation "Business Programs: Measure Life Study" Final Report, August 9, 2009, prepared by PA Consulting Group.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * Hours * WHFe * ISR$$

Where:

$Watts_{Base}$ = Custom input. If unknown, input wattage of the baseline system is dependant on new fixture configuration and found in the 'T5HO Efficient and Baseline Wattage and Cost Assumptions' reference table below.

$Watts_{EE}$ = Custom Input. If unknown, input wattage depends on new fixture configuration (number of lamps) and ballast factor and number of fixtures. Value can be selected from the 'T5HO Efficient and Baseline Wattage and Cost Assumptions' reference table below.

Hours = Average annual lighting hours of use as provided by the customer or selected from the Lighting Reference Table in Section 2.8 as annual operating hours, by building type. If hours or building type are unknown, use the C&I Average value.

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Lighting Reference Table in Section 2.8 for each building type. If building is un-cooled, the value is 1.0.

ISR = In Service Rate or the percentage of units rebated that get installed.

= 98%.[216]

<u>Heating Penalty:</u>

If electrically heated building:[217]

$$\Delta kWhheatpenalty = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFkWh)$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Lighting Reference Table in Section 2.8. If unknown, use the C&I Average value.

SUMMER COINCIDENT DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001899635 for indoor lighting

[216] Based upon review of PY5-6 evaluations from ComEd, IL commercial lighting program (BILD).
[217] Negative value because this is an increase in heating consumption due to the efficient lighting.

= 0.0000056160 for exterior lighting

= 0.0001379439 for 24/7 lighting

Natural Gas Energy Savings

Heating penalty if fossil fuel heated building (or if heating fuel is unknown):

$$\Delta Therms = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFTherms)$$

Where:

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Lighting Reference Table in Section 2.8.[218] If unknown, use the C&I Average value.

Deemed O&M Cost Adjustment Calculation

See reference tables for different cost assumptions for lamps and ballasts. When available, actual costs and hours of use should be used.

Reference Tables

T5HO Efficient and Baseline Wattage and Cost Assumptions[219]

EE Measure Description	WattsEE	Baseline Description	WattsBASE	Incremental Cost
3-Lamp T5 High-Bay	176	200 Watt Pulse Start Metal-Halide	227	$100.00
4-Lamp T5 High-Bay	235	320 Watt Pulse Start Metal-Halide	364	$100.00
6-Lamp T5 High-Bay	352	400 Watt Pulse Start Metal-Halide	455	$100.00
8-Lamp T5 High-Bay	470	750 Watt Pulse Start Metal-Halide	825	$100.00

T5 HO Component Costs and Lifetimes[220]

	EE Measure				Baseline			
EE Measure Description	Lamp Life (hrs)	Total Lamp Replacement Cost	Ballast Life (hrs)	Total Ballast Replacement Cost	Lamp Life (hrs)	Total Lamp Replacement Cost	Ballast Life (hrs)	Total Ballast Replacement Cost
3-Lamp T5 High-Bay	30,000	$63.00	70,000	$87.50	15,000	$63.00	40,000	$107.50
4-Lamp T5 High-Bay	30,000	$84.00	70,000	$87.50	20,000	$68.00	40,000	$117.50
6-Lamp T5 High-Bay	30,000	$126.00	70,000	$112.50	20,000	$73.00	40,000	$127.50
8-Lamp T5 High-Bay	30,000	$168.00	70,000	$137.50	20,000	$78.00	40,000	$137.50

[218] Negative value because this is an increase in heating consumption due to the efficient lighting.
[219] Reference Table adapted from Efficiency Vermont TRM, T5 Measure Savings Algorithms and Cost Assumptions, October, 2014. Refer to "T5HO-adjusted deemed costs.baselines.xlsx" for more information.
[220] Costs include labor cost – see "T5HO-adjusted deemed costs.baselines.xlsx" for more information.

MEASURE CODE:

2.6.6 LED Exit Sign

This measure characterizes the savings associated with installing a new LED exit sign (or retrofit kit) in place of a CFL or incandescent exit sign in a commercial building. LED exit signs use less power (≤ 5 watts), have a significantly longer lifetime, and have less maintenance costs when compared to incandescent or CFL exit signs.[221]

This measure applies to the following program types: RF and DI.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is an LED exit sign with an input power demand of 5 watts or less.[222]

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is the existing exit sign (either a CFL or incandescent unit).

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life is assumed to be 16 years.[223]

DEEMED MEASURE COST

Actual program delivery costs should be used if available. If not, use the full cost of $39[224] for a new LED exit sign and $25 for a retrofit kit, plus $6.25 in labor,[225] for a total measure cost of $45.25 and $31.25, respectively.

LOADSHAPE

Miscellaneous BUS

[221] ENERGY STAR® "*Save Energy, Money and Prevent Pollution with LED Exit Signs*."
[222] ENERGY STAR ® "*Program Requirements for Exit Signs Version 3.0.*" While the EPA suspended the ENERGY STAR® Exit Sign specification effective May 1, 2008, Federal requirements specify minimum efficiency standards for electrically-powered, single-faced exit signs with integral lighting sources that are equivalent to ENERGY STAR® levels for input power demand of 5 watts or less per face.
[223] California Database for Energy Efficiency Resources (DEER) 2014 Estimated Useful Life (EUL) Table Update.
[224] Cost of new LED exit sign from ENERGY STAR® Exit Signs Calculator.xlsx.
[225] Assumption based on 15 minutes (including portion of travel time) and $25 per hour, which is in line with the typical prevailing wage of a General Laborer, as per the Annual Wage Order No. 23 published by the Missouri Department of Labor.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS [226]

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1,000} * Hours * WHFe$$

Where:

$Watts_{Base}$ = Actual wattage if known, if unknown assume the following:

Baseline Type	$Watts_{Base}$
Incandescent (dual sided)	50W[227]
Incandescent (single sided)	25W
CFL (dual sided)	14W[228]
CFL (single sided)	7W

$Watts_{EE}$ = Actual wattage if known; if unknown assume 2W for singled sided and 4W.[229]for dual sided

Hours = Annual operating hours

= 8,766

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Lighting Reference Table in Section 2.8 for each building type. If building is un-cooled, the value is 1.0.

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{heatpenalty}{}^{230} = \frac{Watts_{Base} - Watts_{EE}}{1,000} * Hours * (-IFkWh)$$

Where:

IFkWh = Lighting-HVAC Interation Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Reference Table in Section 2.8. If unknown, use the C&I Average value.

Other factors as defined above.

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[226] There is no ISR calculation. Exit signs and emergency lighting are required by federal regulations to be installed and functional in all public buildings as outlined by the U.S. Occupational Safety and Health Standards (USOSHA 1993).

[227] Average incandescent single sided (5W, 10W, 15W, 20W, 25W, 34W, 40W, 50W) from Appendix B 2013-14 Table of Standard Fixture Wattages. Available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/App%20B%20Standard%20Fixture%20Watts.pdf

[228] Average CFL single sided (5W, 7W, 9W) from Appendix B 2013-14 Table of Standard Fixture Wattages. Available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/App%20B%20Standard%20Fixture%20Watts.pdf

[229] Average Exit LED watts are assumed as a 2W as listed in Appendix B 2013-14 Table of Standard Fixture Wattages. Available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/App%20B%20Standard%20Fixture%20Watts.pdf

[229] Average LED single sided (2W) from Appendix B 2013-14 Table of Standard Fixture Wattages. Available at: http://www.aesc-inc.com/download/spc/2013SPCDocs/PGE/App%20B%20Standard%20Fixture%20Watts.pdf

[230] Results in a negative value because this is an increase in heating consumption due to the efficient lighting.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, including cooling savings, as calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

Other factors as defined above.

NATURAL GAS ENERGY SAVINGS

Heating penalty if fossil fuel heated buiding (or if heating is unknown):[231]

$$\Delta Therms = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * Hours * (-IFTherms)$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Please select from the Reference Table in Section 2.8 for each building type.

Other factors as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

The annual O&M cost adjustment savings should be calculated using the following component costs and lifetimes.

Component	Baseline Measure	
	Cost	Life (yrs)
CFL lamp	$8.91[232]	0.63 years[233]
Incandescent lamp	$7.39[234]	0.14 years[235]

[231] Results in a negative value because this is an increase in heating consumption due to the efficient lighting.

[232] Includes cost of labor and new replacement bulb. Labor cost of $6.25 based on 15 minutes (including portion of travel time) and $25 per hour, which is in line with the typical prevailing wage of a General Laborer, as per the Annual Wage Order No. 23 published by the Missouri Department of Labor. Cost of new 7W CFL bulb is $2.66, from Itron "2010-2012 WO017 Ex Ante Measure Cost Study Final Report." Prepared for California Public Utilities Commission, May 27, 2014.

[233] ENERGY STAR® "Save Energy, Money and Prevent Pollution with LED Exit Signs" states that CFL bulbs for exit signs typically have an average rated life of 5,000-6,000 hours. Given 24/7 run time, assume a CFL in an exit sign will require replacement every 0.63 years (5,500 hours/8,766 hours).

[234] Includes cost of labor and new replacement bulb. Labor cost of $6.25 based on 15 minutes (including portion of travel time) and $25 per hour, which is in line with the typical prevailing wage of a General Laborer, as per the Annual Wage Order No. 23 published by the Missouri Department of Labor. Cost of new 29W incandescent A-lamp is $1.14, from Itron "2010-2012 WO017 Ex Ante Measure Cost Study Final Report." Prepared for California Public Utilities Commission, May 27, 2014.

[235] ENERGY STAR® "*Save Energy, Money and Prevent Pollution with LED Exit Signs*" states that a typical incandescent exit sign bulb will have a rated life of 500-2,000 hours. Given 24/7 run time, assume an incandescent in an exit sign will require replacement every 0.14 years (1,250 hours/8,766 hours).

MEASURE CODE:

2.6.7 LED Specialty Lamp

Description

This characterization provides savings assumptions for LED directional, decorative, and globe lamps. This characterization assumes that the LED is installed in a commercial location. This is therefore appropriate for commercially targeted programs, or, if the implementation strategy does not allow for the installation location to be known (e.g., an upstream retail program), utilities should develop an assumption of the Residential v Nonresidential split and apply the relevant assumptions to each portion.

Federal legislation stemming from the EISA requires all general-purpose light bulbs between 40W and 100W to be approximately 30% more energy efficient than standard incandescent bulbs. Production of 100W, standard efficacy incandescent lamps ended in 2012, followed by restrictions on 75W lamps in 2013 and 60W and 40W lamps in 2014. The baseline for this measure has therefore become bulbs (improved incandescent or halogen) that meet the new standard.

A provision in the EISA regulations requires that by January 1, 2020, all lamps meet efficiency criteria of at least 45 lumens per watt, in essence making the baseline equivalent to a current day CFL.

This measure was developed to be applicable to the following program types: TOS and RF.

If applied to other program types, the measure savings should be verified.

Definition of Efficient Equipment

In order for this characterization to apply, new lamps must be ENERGY STAR® labeled based upon the ENERGY STAR® specification v2.0 which will become effective on1/2/2017.https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2_0%20Revised%20AUG-2016.pdf). Qualification could also be based on the Design Light Consortium's qualified product list.[236]

Definition of Baseline Equipment

The baseline condition for this measure is assumed to be an EISA-qualified halogen or incandescent. From 2020 the baseline will begin transitioning to a CFL based upon what is available in the market.

Deemed Lifetime of Efficient Equipment

The lifetime of the product is the lamp life in hours divided by operating hours per year. Depending on operating conditions (currents and temperatures) and other factors (settings and building use), LED rated life is assumed to be 50,000 hours.[237]

Deemed Measure Cost

Wherever possible, actual incremental costs should be used. If unavailable, assume the following incremental costs:[238]

[236] https://www.designlights.org/QPL

[237] LED Fixture Component Costs & Lifetime Table found on page 372 of the IL TRM v6.0 Volume 2.

[238] Incandescent based on "2010-2012 WA017 Ex Ante Measure Cost Study Draft Report," Itron, February 28, 2014. LED lamp costs are based on a 2014/2015 VEIC review of a year's worth of LED sales through VEIC implemented programs. The retail cost was averaged and then DOE price projection trends (from Department of Energy, 2012; "Energy Savings Potential of Solid-State Lighting in General Illumination Applications," Table A.1) used to decrease the cost for a 2017 TRM assumption (see 2015 LED Sales Review.xls). LED costs are falling rapidly and should be reviewed in each update cycle.

Bulb Type	LED Wattage	LED	Incandescent	Incremental Cost
Directional	< 20W	$14.52	$6.31	$8.21
	≥20W	$45.85		$39.54
Decorative	<15W	$8.09	$3.92	$4.17
	15 to <25W	$15.86		$11.94
	≥25W	$15.86		$11.94

LOADSHAPE

Lighting BUS

Ext Lighting BUS

Miscellaneous BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1,000} * Hours * WHFe * ISR$$

Where:

$Watts_{Base}$ = Based on bulb type and lumens of LED bulb installed. See table below.

$Watts_{EE}$ = Actual wattage of LED purchased / installed - If unknown, use default provided below:[239]

Bulb Type	Lower Lumen Range	Upper Lumen Range	$Watts_{Base}$	$Watts_{EE}$	Delta Watts
Directional	250	349	25	5.6	19.4
	350	399	35	6.3	28.7
	400	599	40	7.5	32.5
	600	749	60	9.7	50.3
	750	999	75	12.7	62.3
	1000	1250	100	16.2	83.8
Decorative	70	89	10	1.8	8.2
	90	149	15	2.7	12.3
	150	299	25	3.2	21.8
	300	499	40	4.7	35.3

[239] $Watts_{EE}$ defaults are based upon the average available ENERGY STAR® product, accessed 06/18/2015. For any lumen range where there is no ENERGY STAR® product currently available, $Watts_{EE}$ is based upon the ENERGY STAR® minimum luminous efficacy (55Lm/W for lamps with rated wattages less than 15W and 65 Lm/W for lamps with rated wattages ≥ 15 watts) for the mid-point of the lumen range. See calculation at "cerified-light-bulbs-2015-06-18.xlsx." These assumptions should be reviewed regularly to ensure they represent the available product.

Bulb Type	Lower Lumen Range	Upper Lumen Range	$Watts_{Base}$	$Watts_{EE}$	Delta Watts
	500	699	60	6.9	53.1
Globe	250	349	25	4.1	20.9
	350	499	40	5.9	34.1
	500	574	60	7.6	52.4
	575	649	75	13.6	61.4
	650	1099	100	17.5	82.5
	1100	1300	150	13.0	137.0

Hours = Average hours of use per year as provided by the customer or selected from the Lighting Reference Table in Section 2.8 and based upon building type. If unknown, use the C&I Average value.

WHFe = Waste heat factors for energy to account for cooling energy savings from efficient lighting are provided for each building type in the Lighting Reference Table in Section 2.8. If unknown, use the C&I Average value.

ISR = In Service Rate or the percentage of units rebated that get installed

= 98.7%[240]

Heating Penalty:

If electrically heated building:[241]

$$\Delta kWhheatpenalty = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFkWh)$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Lighting Reference Table in Section 2.8 and based upon building type. If unknown, use the C&I Average value.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001899635 for indoor lighting

[240] Based on results presented in Ameren Missouri Lighting Impact and Process Evaluation: Program Year 2015. This value takes into account the time-delay of when bulbs are installed over subsequent program years. The reported ISR is based on the net present value (NPV) of the savings over 4 year installation period from the PY15 bulbs, discounted back to Year 1 at 6.95% (utility discount rate).

[241] Results in a negative value because this is an increase in heating consumption due to the efficient lighting.

= 0.0000056160 for exterior lighting

= 0.0001379439 for 24/7 lighting

for measure is provided in the Lighting Reference Table in Section 2.8 and based upon building type. If unknown, use the C&I Average value.

Other factors as defined above.

NATURAL GAS SAVINGS

Heating penalty if fossil fuel heated building (or if heating fuel is unknown):[242]

$$\Delta Therms \ = \ \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * \ ISR \ * \ Hours \ * (-\ IFTherms)$$

Where:

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Lighting Reference Table in Section 2.8 and based upon building type. If unknown, use the C&I Average value.

DEEMED O&M COST ADJUSTMENT CALCULATION

O&M cost should be applied as follows:

Installation Location	Replacement Period (years)[243]	Replacement Cost[244]
Large Office	0.32	Decorative: $6.31 Directional: $3.92
Medium Office	0.32	
Small Office	0.35	
Warehouse	0.35	
Stand-alone Retail	0.29	
Strip Mall	0.27	
Primary School	0.29	
Secondary School	0.29	
Supermarket	0.27	
Quick Service Restaurant	0.16	
Full Service Restaurant	0.16	
Hospital	0.26	
Outpatient Health Care	0.26	
Small Hotel - Building	0.27	
Large Hotel - Building	0.27	
Midrise Apartment - Building	0.35	
C&I Average	0.30	

[242] Results in a negative value because this is an increase in heating consumption due to the efficient lighting.
[243] Calculated by dividing assumed rated life of baseline bulb by hours of use. Assumed lifetime of EISA qualified Halogen/ Incandescent is 1000 hours. The manufacturers are simply using a regular incandescent lamp with halogen fill gas rather than Halogen Infrared to meet the standard (as provided by G. Arnold, NEEP and confirmed by N. Horowitz at NRDC).
[244] Incandescent costs based on "2010-2012 WA017 Ex Ante Measure Cost Study Draft Report," Itron, February 28, 2014.

MEASURE CODE:

2.6.8 Lighting Power Density

DESCRIPTION

This measure entails the installation of efficient lighting systems in either new construction or during substantial renovation of commercial buildings that triggers compliance with code. This methodology applies to situations where code specifies maximum lighting power density allowances (W/ft^2). Either the Building Area Method or Space by Space (not recognized by IECC 2009) method as defined in IECC 2009, 2012 or 2015, can be used for calculating the Interior Lighting Power Density.[245] The measure consists of a design that is more efficient (has a lower lighting power density in watts/square foot) than code requires.

This measure was developed to be applicable to the following program type: NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the lighting system must be more efficient than the baseline energy code lighting power density in watts/square foot for either the interior space or exterior space.

DEFINITION OF BASELINE EQUIPMENT

The baseline is assumed to be a lighting power density that meets the building code recognized by the local jurisdiction. For illustrative purposes in this characterization, IECC 2009, 2012 and 2015, are highlighted to demonstrate the methodology.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[246]

DEEMED MEASURE COST

The actual incremental cost over a baseline system should be collected from the customer if possible, or quantified using an alternative suitable source.

LOADSHAPE

Lighting BUS

Ext Lighting BUS

Miscellaneous BUS

Algorithm

CALCULATION OF SAVINGS

ENERGY SAVINGS

$$\Delta kWh = (WSF_{base} - WSF_{effic})/1000 * SF * Hours * WHF_e$$

Where:

[245] Refer to the referenced code documents for specifics on calculating lighting power density using either the whole building method (IECC) or the Space by Space method (ASHRAE 90.1).
[246] Measure Life Report, Residential and Commercial/Industrial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.

WSF_{base} = Baseline lighting watts per square foot or linear foot as determined by building or space type. IECC example whole building analysis values are presented in the Reference Tables below.[247]

WSF_{effic} = The actual installed lighting watts per square foot or linear foot.

SF = Provided by customer based on square footage of the building area applicable to the lighting design for new building.

Hours = Annual site-specific hours of operation of the lighting equipment collected from the customer or selected from the Reference Table in Section 2.8 if unavailable.

WHF_e = Waste Heat Factor for Energy to account for cooling savings from efficient lighting is as provided in the Reference Table in Section 2.8 for each building type. If building is not cooled, the value is 1.0.

<u>Heating Penalty</u>

If electrically heated building:

$$\Delta kWh_{heatpenalty}{}^{248} = (WSF_{base} - WSF_{effic})/1000 * SF * Hours * -IFkWh$$

Where:

IFkWh = Lighting-HVAC Interation Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Reference Table in Section 2.8. If unknown, use the C&I Average value.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001899635 for indoor lighting

= 0.0000056160 for exterior lighting

= 0.0001379439 for 24/7 lighting

Other factors as defined above

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = (WSF_{base} - WSF_{effic})/1000 * SF * Hours * - IFTherms$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Please select from the Reference Table in Section 2.8 for each building type.

[247] See IECC 2009, 2012 and 2015 - Reference Code documentation for additional information.

[248] Negative value because this is an increase in heating consumption due to the efficient lighting.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

REFERENCE TABLES

Lighting Power Density Values from IECC 2009, 2012 and 2015 for Interior Commercial New Construction and Substantial Renovation Building Area Method:

Building Area Type [249]	IECC 2009 Lighting Power Density (w/ft^2)	IECC 2012 Lighting Power Density (w/ft^2)	IECC 2015 Lighting Power Density (w/ft^2)
Automotive Facility	0.9	0.9	0.80
Convention Center	1.2	1.2	1.01
Court House	1.2	1.2	1.01
Dining: Bar Lounge/Leisure	1.3	1.3	1.01
Dining: Cafeteria/Fast Food	1.4	1.4	0.9
Dining: Family	1.6	1.6	0.95
Dormitory	1.0	1.0	0.57
Exercise Center	1.0	1.0	0.84
Fire station	1.0	0.8	0.67
Gymnasium	1.1	1.1	0.94
Healthcare – clinic	1.0	1.0	0.90
Hospital	1.2	1.2	1.05
Hotel	1.0	1.0	0.87
Library	1.3	1.3	1.19
Manufacturing Facility	1.3	1.3	1.17
Motel	1.0	1.0	0.87
Motion Picture Theater	1.2	1.2	0.76
Multifamily	0.7	0.7	0.51
Museum	1.1	1.1	1.02
Office	1.0	0.9	0.82
Parking Garage	0.3	0.3	0.21
Penitentiary	1.0	1.0	0.81
Performing Arts Theater	1.6	1.6	1.39
Police Station	1.0	1.0	0.87
Post Office	1.1	1.1	0.87
Religious Building	1.3	1.3	1.0
Retail[250]	1.5	1.4	1.26
School/University	1.2	1.2	0.87
Sports Arena	1.1	1.1	0.91
Town Hall	1.1	1.1	0.89
Transportation	1.0	1.0	0.70
Warehouse	0.8	0.6	0.66
Workshop	1.4	1.4	1.19

[249] In cases where both a general building area type and a more specific building area type are listed, the more specific building area type shall apply.

[250] Where lighting equipment is specified to be installed to highlight specific merchandise in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the small of the actual wattage of the lighting equipment installed specifically for merchandise, or additional lighting power as determined below shall be added to the interior lighting power determined in accordance with this line item.

Lighting Power Density Values from IECC 2012 for Interior Commercial New Construction and Substantial Renovation Space by Space Method:

TABLE C405.5.2(2)
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD

COMMON SPACE-BY-SPACE TYPES	LPD (w/ft^2)
Atrium – First 40 feet in height	0.03 per ft. ht.
Atrium – Above 40 feet in height	0.02 per ft. ht.
Audience/seating area – permanent	
For auditorium	0.9
For performing arts theater	2.6
For motion picture theater	1.2
Classroom/lecture/training	1.30
Conference/meeting/multipurpose	1.2
Corridor/transition	0.7
Dining area	
Bar/lounge/leisure dining	1.40
Family dining area	1.40
Dressing/fitting room performing arts theater	1.1
Electrical/mechanical	1.10
Food preparation	1.20
Laboratory for classrooms	1.3
Laboratory for medical/industrial/research	1.8
Lobby	1.10
Lobby for performing arts theater	3.3
Lobby for motion picture theater	1.0
Locker room	0.80
Lounge recreation	0.8
Office – enclosed	1.1
Office – open plan	1.0
Restroom	1.0
Sales area	1.6[a]
Stairway	0.70
Storage	0.8
Workshop	1.60
Courthouse/police station/penetentiary	
Courtroom	1.90
Confinement cells	1.1
Judge chambers	1.30
Penitentiary audience seating	0.5
Penitentiary classroom	1.3
Penitentiary dining	1.1
BUILDING SPECIFIC SPACE-BY-SPACE TYPES	
Automotive – service/repair	0.70
Bank/office – banking activity area	1.5
Dormitory living quarters	1.10
Gymnasium/fitness center	
Fitness area	0.9
Gymnasium audience/seating	0.40
Playing area	1.40

(continued)

TABLE C405.5.2(2)—continued
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD

COMMON SPACE-BY-SPACE TYPES	LPD (w/ft^2)
Healthcare clinic/hospital	
Corridors/transition	1.00
Exam/treatment	1.70
Emergency	2.70
Public and staff lounge	0.80
Medical supplies	1.40
Nursery	0.9
Nurse station	1.00
Physical therapy	0.90
Patient room	0.70
Pharmacy	1.20
Radiology/imaging	1.3
Operating room	2.20
Recovery	1.2
Lounge/recreation	0.8
Laundry – washing	0.60
Hotel	
Dining area	1.30
Guest rooms	1.10
Hotel lobby	2.10
Highway lodging dining	1.20
Highway lodging guest rooms	1.10
Library	
Stacks	1.70
Card file and cataloguing	1.10
Reading area	1.20
Manufacturing	
Corridors/transition	0.40
Detailed manufacturing	1.3
Equipment room	1.0
Extra high bay (> 50-foot floor-ceiling height)	1.1
High bay (25- – 50-foot floor-ceiling height)	1.20
Low bay (< 25-foot floor-ceiling height)	1.2
Museum	
General exhibition	1.00
Restoration	1.70
Parking garage – garage areas	0.2
Convention center	
Exhibit space	1.50
Audience/seating area	0.90
Fire stations	
Engine room	0.80
Sleeping quarters	0.30
Post office	
Sorting area	0.9
Religious building	
Fellowship hall	0.60
Audience seating	2.40
Worship pulpit/choir	2.40
Retail	
Dressing/fitting area	0.9
Mall concourse	1.6
Sales area	1.6[a]

(continued)

TABLE C405.5.2(2)—continued
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD

BUILDING SPECIFIC SPACE-BY-SPACE TYPES	LPD (w/ft²)
Sports arena	
Audience seating	0.4
Court sports area – Class 4	0.7
Court sports area – Class 3	1.2
Court sports area – Class 2	1.9
Court sports area – Class 1	3.0
Ring sports area	2.7
Transportation	
Air/train/bus baggage area	1.00
Airport concourse	0.60
Terminal – ticket counter	1.50
Warehouse	
Fine material storage	1.40
Medium/bulky material	0.60

Lighting Power Density Values from IECC 2015 for Interior Commercial New Construction and Substantial Renovation Space by Space Method:

TABLE C405.4.2(2)
INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/sq.ft)
Atrium	
Less than 40 feet in height	0.03 per foot in total height
Greater than 40 feet in height	0.40 + 0.02 per foot in total height
Audience seating area	
In an auditorium	0.63
In a convention center	0.82
In a gymnasium	0.65
In a motion picture theater	1.14
In a penitentiary	0.28
In a performing arts theater	2.43
In a religious building	1.53
In a sports arena	0.43
Otherwise	0.43
Banking activity area	1.01
Breakroom (See Lounge/Breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	1.34
Otherwise	1.24
Conference/meeting/multipurpose room	1.23
Copy/print room	0.72
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.92
In a hospital	0.79
In a manufacturing facility	0.41
Otherwise	0.66
Courtroom	1.72
Computer room	1.71
Dining area	
In a penitentiary	0.96
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.9
In bar/lounge or leisure dining	1.07
In cafeteria or fast food dining	0.65
In family dining	0.89
Otherwise	0.65
Electrical/mechanical room	0.95
Emergency vehicle garage	0.56

(continued)

TABLE C405.4.2(2)—continued
INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/sq.ft)
Food preparation area	1.21
Guest room	0.47
Laboratory	
In or as a classroom	1.43
Otherwise	1.81
Laundry/washing area	0.6
Loading dock, interior	0.47
Lobby	
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.8
For an elevator	0.64
In a hotel	1.06
In a motion picture theater	0.59
In a performing arts theater	2.0
Otherwise	0.9
Locker room	0.75
Lounge/breakroom	
In a healthcare facility	0.92
Otherwise	0.73
Office	
Enclosed	1.11
Open plan	0.98
Parking area, interior	0.19
Pharmacy area	1.68
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	1.21
Otherwise	0.98
Sales area	1.59
Seating area, general	0.54
Stairway (See space containing stairway)	
Stairwell	0.69
Storage room	0.63
Vehicular maintenance area	0.67
Workshop	1.59
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/sq.ft)**
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	2.21
In a recreation room (and not used primarily by the staff)	2.41
Automotive (See Vehicular Maintenance Area above)	
Convention Center—exhibit space	1.45
Dormitory—living quarters	0.38
Fire Station—sleeping quarters	0.22
Gymnasium/fitness center	
In an exercise area	0.72
In a playing area	1.2

(continued)

TABLE C405.4.2(2)—continued
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD

BUILDING TYPE SPECIFIC SPACE TYPES[a]	LPD (watts/sq.ft)
healthcare facility	
In an exam/treatment room	1.66
In an imaging room	1.51
In a medical supply room	0.74
In a nursery	0.88
In a nurse's station	0.71
In an operating room	2.48
In a patient room	0.62
In a physical therapy room	0.91
In a recovery room	1.15
Library	
In a reading area	1.06
In the stacks	1.71
Manufacturing facility	
In a detailed manufacturing area	1.29
In an equipment room	0.74
In an extra high bay area (greater than 50′ floor-to-ceiling height)	1.05
In a high bay area (25-50′ floor-to-ceiling height)	1.23
In a low bay area (less than 25′ floor-to-ceiling height)	1.19
Museum	
In a general exhibition area	1.05
In a restoration room	1.02
Performing arts theater—dressing room	0.61
Post Office—Sorting Area	0.94
Religious buildings	
In a fellowship hall	0.64
In a worship/pulpit/choir area	1.53
Retail facilities	
In a dressing/fitting room	0.71
In a mall concourse	1.1
Sports arena—playing area	
For a Class I facility	3.68
For a Class II facility	2.4
For a Class III facility	1.8
For a Class IV facility	1.2
Transportation facility	
In a baggage/carousel area	0.53
In an airport concourse	0.36
At a terminal ticket counter	0.8
Warehouse—storage area	
For medium to bulky, palletized items	0.58
For smaller, hand-carried items	0.95

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply

b. A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

The exterior lighting design will be based on the building location and the applicable "Lighting Zone" as defined in

IECC 2015 Table C405.5.2(1) which follows. This table is identical to IECC 2012 Table C405.6.2(1) and IECC 2009 Table 505.6.2(1).

TABLE C405.5.2(1)
EXTERIOR LIGHTING ZONES

LIGHTING ZONE	DESCRIPTION
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed-use areas
3	All other areas not classified as lighting zone 1, 2 or 4
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

The lighting power density savings will be based on reductions below the allowable design levels as specified in IECC 2009 Table 505.6.2(2), IECC 2012 Table C405.6.2(2) or IECC 2015 Table C405.5.2(2).

Allowable Design Levels from IECC 2009:

TABLE 505.6.2(2)
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance may be used in tradable or nontradable surfaces.)		500W	600W	750W	1300W
Tradable Surfaces (Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas may be traded.)	**Uncovered Parking Areas**				
	Parking areas and drives	0.04 W/ft²	0.06 W/ft²	0.10 W/ft²	0.13 W/ft²
	Building Grounds				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater, plaza areas special feature areas	0.14 W/ft²	0.14 W/ft²	0.16 W/ft²	0.2 W/ft²
	Stairways	0.75 W/ft²	1.0 W/ft²	1.0 W/ft²	1.0 W/ft²
	Pedestrian tunnels	0.15 W/ft²	0.15 W/ft²	0.2 W/ft²	0.3 W/ft²
	Building Entrances and Exits				
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry canopies	0.25 W/ft²	0.25 W/ft²	0.4 W/ft²	0.4 W/ft²
	Sales Canopies				
	Free-standing and attached	0.6 W/ft²	0.6 W/ft²	0.8 W/ft²	1.0 W/ft²
	Outdoor Sales				
	Open areas (including vehicle sales lots)	0.25 W/ft²	0.25 W/ft²	0.5 W/ft²	0.7 W/ft²
	Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	1OW/linear foot	1OW/linear foot	30 W/linear foot
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	No allowance	0.1 W/ft² for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft² for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft² for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

Allowable Design Levels from IECC 2012:

TABLE C405.6.2(2)
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

		LIGHTING ZONES			
		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance is usable in tradable or nontradable surfaces.)		500 W	600 W	750 W	1300 W
Tradable Surfaces (Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas are tradable.)	**Uncovered Parking Areas**				
	Parking areas and drives	0.04 W/ft^2	0.06 W/ft^2	0.10 W/ft^2	0.13 W/ft^2
	Building Grounds				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater, plaza areas special feature areas	0.14 W/ft^2	0.14 W/ft^2	0.16 W/ft^2	0.2 W/ft^2
	Stairways	0.75 W/ft^2	1.0 W/ft^2	1.0 W/ft^2	1.0 W/ft^2
	Pedestrian tunnels	0.15 W/ft^2	0.15 W/ft^2	0.2 W/ft^2	0.3 W/ft^2
	Building Entrances and Exits				
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry canopies	0.25 W/ft^2	0.25 W/ft^2	0.4 W/ft^2	0.4 W/ft^2
	Sales Canopies				
	Free-standing and attached	0.6 W/ft^2	0.6 W/ft^2	0.8 W/ft^2	1.0 W/ft^2
	Outdoor Sales				
	Open areas (including vehicle sales lots)	0.25 W/ft^2	0.25 W/ft^2	0.5 W/ft^2	0.7 W/ft^2
	Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	No allowance	0.1 W/ft^2 for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft^2 for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft^2 for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = $W/0.0929\ m^2$.

Allowable Design Levels from IECC 2015:

TABLE C405.5.2(2)
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

		LIGHTING ZONES			
		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance is usable in tradable or nontradable surfaces.)		500 W	600 W	750 W	1300 W
Tradable Surfaces (Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas are tradable.)	Uncovered Parking Areas				
	Parking areas and drives	0.04 W/ft²	0.06 W/ft²	0.10 W/ft²	0.13 W/ft²
	Building Grounds				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater, plaza areas special feature areas	0.14 W/ft²	0.14 W/ft²	0.16 W/ft²	0.2 W/ft²
	Stairways	0.75 W/ft²	1.0 W/ft²	1.0 W/ft²	1.0 W/ft²
	Pedestrian tunnels	0.15 W/ft²	0.15 W/ft²	0.2 W/ft²	0.3 W/ft²
	Building Entrances and Exits				
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry canopies	0.25 W/ft²	0.25 W/ft²	0.4 W/ft²	0.4 W/ft²
	Sales Canopies				
	Free-standing and attached	0.6 W/ft²	0.6 W/ft²	0.8 W/ft²	1.0 W/ft²
	Outdoor Sales				
	Open areas (including vehicle sales lots)	0.25 W/ft²	0.25 W/ft²	0.5 W/ft²	0.7 W/ft²
	Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	No allowance	0.075 W/ft² of gross above-grade wall area	0.113 W/ft² of gross above-grade wall area	0.15 W/ft² of gross above-grade wall area
	Automated teller machines (ATM) and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².
W = watts.

MEASURE CODE:

2.6.9 Metal Halide Fixtures and Lamps

Description

This measure involves the installation of high efficiency pulse start metal halide fixtures and lamps in place of a standard metal halide. Pulse start metal halide luminaires produce more lumens per watt and have an improved lumen maintenance compared to standard probe start technology. Similarly, the high efficiency pulse start metal halide ballast lasts longer than a standard system due to their cooler operating temperatures.[251]

This measure was developed to be applicable for the following program type: RF.

Definition of Efficient Equipment

The efficient condition is an EISA-compliant pulse start metal halide lamp and ballasts for luminaires. Under 2009 federal rulings metal halide ballasts in low-watt options (150W-500W fixtures) must be pulse start and have a minimum ballast efficiency of 88%.[252] Amendments made in 2014 require more stringent energy conservations standards with compliance required by February 10, 2017.[253]

Definition of Baseline Equipment

The baseline condition is the existing bulb and fixture. If unknown assume, High Intensity Discharge (HID) Metal Halide lighting with probe start fixture and a standard ≤ 400 Watt lamp.

Deemed Lifetime of Efficient Equipment

The measure life is assumed to be 15 years.[254]

Deemed Measure Cost

As a retrofit measure, actual costs should be used. If unknown, cost is assumed to be $267.[255]

Loadshape

Lighting BUS

Ext Lighting BUS

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[251] Building a Brighter Future: Your Guide to EISA-Compliant Ballast and Lamp Solutions from Philips Lighting: http://1000bulbs.com/pdf/advance%20eisa%20brochure.pdf

[252] Under EISA rulings, metal halide ballasts in low-watt options must be pulse start and have a minimum ballast efficiency of 88%. This ruling virtually eliminates the manufacture of probe start (ceramic) fixtures but some exemptions exist including significantly the 150w wet location fixtures (as rated per NEC 2002, section 410.4 (A)). These will be replaced by 150W. Department of Energy – 10 CFR Part 431 – Energy Conservation Program: Energy Conservation Standards for Metal Halide Lamp Fixtures; Final Rule 7746 Federal Register / Vol. 79, No. 27 / Monday, February 10, 2014 / Rules and Regulations https://www.federalregister.gov/articles/2014/02/10/2014-02356/energy-conservation-program-energy-conservation-standards-for-metal-halide-lamp-fixtures#h-9

[253] The revised 2014 efficiency standards for metal halides require that luminaires produced on or after February 10, 2017, must **not** contain a probe-start metal halide ballast. Exceptions to this ruling include, metal halide luminaires with a regulated-lag ballast that utilize an electronic ballasts which operates at 480V and those which utilize a high-frequency (≥1000Hz) electronic ballast. Department of Energy – 10 CFR Part 431 – Energy Conservation Program: Energy Conservation Standards for Metal Halide Lamp Fixtures; Final Rule 7746 Federal Register / Vol. 79, No. 27 / Monday, February 10, 2014 / Rules and Regulations https://www.federalregister.gov/articles/2014/02/10/2014-02356/energy-conservation-program-energy-conservation-standards-for-metal-halide-lamp-fixtures#h-9

[254] GDS Associates, *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*, June 2007, http://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights&HVACGDS_1Jun2007.pdf

[255] Assuming cost of lamp and fixture combined per Itron, Inc. *2010-2012 WO017 Ex Ante Measure Cost Study – Final Report (Deemed Measures)*, May 27, 2014.

Miscellaneous BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * Hours * WHFe * ISR$$

Where:

$Watts_{Base}$ = Input wattage of the existing system which depends on the baseline fixture configuration (number and type of lamp). Value can be selected from the reference table at the end of the characterization or a custom value can be used.

$Watts_{EE}$ = New Input wattage of EE fixture, which depends on new fixture configuration. Value can be selected from the appropriate reference table at the end of the characterization, or a custom value can be used.

Hours = Average annual lighting hours of use as provided by the customer or selected from the Lighting Reference Table in Section 2.8. If hours or building type are unknown, use the C&I Average value.

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Reference Table in Section 2.8 for each building type. If building is un-cooled, the value is 1.0.

ISR = In Service Rate is assumed to be 100%

<u>Heating Penalty:</u>

If electrically heated building:

$$\Delta kWh_{heatpenalty}{}^{256} = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFkWh)$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Reference Table in Section 2.8. If unknown, use the C&I Average value.

SUMMER COINCIDENT DEMAND SAVINGS

$\Delta kW = \Delta kWh * CF$

Where:

ΔkWh = as calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001899635 for indoor lighting

= 0.0000056160 for exterior lighting

[256] Negative value because this is an increase in heating consumption due to the efficient lighting.

= 0.0001379439 for 24/7 lighting

NATURAL GAS SAVINGS

$$\Delta Therms^{257} = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (-IFTherms)$$

Where:

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Please select from the Reference Table in Section 2.8 for each building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

No O&M adjustments apply to this measure.[258]

REFERENCE TABLES[259]

Lamp $Watt_{EE}$	Efficient Fixture Ballast	Efficient System Lumen	System $Watt_{EE}$	Lamp $Watt_{Base}$	Baselines Ballast[260]	System $Watts_{Base}$	Baseline System Lumen
Pulse Start MH 150W	Pulse Start-CWA Ballast	10500	185	Probe Start MH 175W	standard C&C	210	9100
Pulse Start MH 175W	Pulse Start-CWA Ballast	11200	208	Probe Start MH 175W	standard C&C	210	9100
Pulse Start MH 200W	Pulse Start-CWA Ballast	16800	232	Probe Start MH250W	standard C&C	295	13500
Pulse Start MH 250W	Pulse Start-CWA Ballast	16625	290	Probe Start MH250W	standard C&C	295	13500
Pulse Start MH 320W	Pulse Start-CWA Ballast	21000	368	Probe Start MH400W	standard C&C	458	24000
Pulse Start MH350W	Pulse Start-CWA Ballast	25200	400	Probe Start MH400W	standard C&C	458	24000
Pulse Start MH 400W	Pulse Start-CWA Ballast	29820	452	Probe Start MH400W	standard C&C	458	24000

MEASURE CODE:

257 Negative value because this is an increase in heating consumption due to the efficient lighting.
258 Given that probe start MH technology is becoming a technology of the past, it is assumed that upon failure they would have been replaced with pulse start technology.
259 Per lamp/ballast.
260 Standard Magnetic Core and Coil ballast systems are common for Metal Halide lamp wattages 175-400. See Panasonic "Metal Halide: Probe Start vs. Pulse Start."

2.6.10 Occupancy Lighting Sensor Controls

DESCRIPTION

Occupancy sensors are devices that reduce lighting levels by turning lights on or off in response to the presence (or absence) of people in a defined area. Associated energy savings depends on the building type, location area covered, type of lighting and activity, and occupancy pattern.[261]

This measure relates to the installation of interior occupancy sensors on an existing lighting system. Lighting control types covered by this measure include switch-mounted, remote-mounted, and fixture-mounted. It does not cover automatic photo sensors, time clocks, and energy management systems. All sensors must be hard wired and control interior lighting.

This measure was developed to be applicable to the following program types: TOS and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

It is assumed that this measure characterization applies to only those automatic controlled lighting occupancy sensors that control a minimum average wattage greater than 45W per control.

DEFINITION OF BASELINE EQUIPMENT

The baseline efficiency case assumes lighting fixtures with no occupancy controls.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life for all lighting controls is assumed to be 8 years.[262]

DEEMED MEASURE COST

When available, the actual cost of the measure shall be used. When not available, the following default values are provided:

Lighting control type	Cost[263]
Full cost of switch (wall) mounted occupancy sensor (interior)	$54
Full cost of fixture (bi-level) mounted occupancy sensor	$67
Full cost of remote (ceiling) mounted occupancy sensor	$105

LOADSHAPE

Lighting BUS

Miscellaneous BUS

[261] United States Department of the Interior. Greening the Department of Interior. http://www.doi.gov/archive/greening/energy/occupy.html

[262] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.

[263] Based on averaging typical prices quoted by online vendors. See reference table “Occupancy Sensor Reference Costs 2015.xls” for more information.

Ext Lighting BUS **Algorithm**

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kW_{Controlled} * Hours * ESF * WHFe$$

Where:

$kW_{Controlled}$ = Total lighting load connected to the control in kilowatts. Savings is per control. The total connected load per control should be collected from the customer, or use the default values presented below used;

Lighting Control Type Interior	Default kW controlled[264]
Switch (wall) mounted occupancy sensor	0.304 (per control)
Fixture-mounted occupancy sensor	0.180 (per fixture)
Remote (ceiling) mounted occupancy sensor	0.517 (per control)

Hours = The total annual operating hours of lighting for each type of building before occupancy sensors. This number should be collected from the customer. If no data is available, the deemed average number of operating hours by building type should be used as provided by Lighting Reference Table in Section 2.8. If buidling type is unknown, use the C&I Average value.

ESF = Energy Savings factor (represents the percentage reduction to the operating Hours from the non-controlled baseline lighting system). Determined on a site-specific basis or using the default values below:

Lighting Control Type	Energy Savings Factor[265]
Switch (wall) mounted occupancy sensor	24%
Fixture-mounted sensor	24%
Remote (ceiling) mounted occupancy sensor	24%

WHF_e = Waste heat factor for energy to account for cooling energy savings from more efficient lighting is provided in the Lighting Reference Table in Section 2.8.

<u>Heating Penalty:</u>

If electrically heated building:[266]

[264] Based on review of custom Efficiency Vermont program data of installed occupancy sensors from 2009-2014. See reference table "Updated-Occupancy-Sensor-ReferenceCosts-7-30-15.xls."
[265] Lawrence Berkeley National Laboratory. A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings. Page & Associates Inc. 2011.
http://eetd.lbl.gov/publications/meta-analysis-energy-savings-lighting-controls-commercial-buildings.
LBNL's meta study of energy savings from lighting controls in commercial buildings bases its savings analysis on over 240 actual field installations. The report found that savings are over-represented and do not filter for external factors such as building orientation, location, use, weather, blinds, commissioning, changes in behavior after controls are set, etc. As such, their value of 24% represented the best conservative estimate of occupancy controls energy savings achievable in the field today.
[266] Negative value because this is an increase in heating consumption due to the efficient lighting.

$$\Delta kWhheatpenalty = kW_{Controlled} * Hours * ESF * (-IFkWh)$$

Where:

IFkWh = Lighting-HVAC Interation Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Lighting Reference Table 2.8.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWh * CF$$

Where:

kWh = As calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor.

= 0.0001899635 for indoor lighting

= 0.0000056160 for exterior lighting

Natural Gas Energy Savings

If gas heated building (or unknown):

$$\Delta Therms = kW_{Controlled} * Hours * ESF * -IFTherms$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting and is provided in the Lighting Reference Table in Section 2.8 by building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.6.11 Street Lighting

Description

This measure characterizes the savings associated with LED street lighting conversions where a LED fixture replaces a high-intensity discharge (HID) outdoor lighting system, including metal halide, high pressure sodium, and mercury vapor. LED street lights provide considerable benefits compared to HID lights, including:

- Improved nighttime visibility and safety through better color rendering, more uniform light distribution and elimination of dark areas between poles.
- Reduced direct and reflected uplight which are the primary causes of urban sky glow.
- 40-80% energy savings (dependent on incumbent lighting source).
- 50-75% street lighting maintenance savings.[267]

This measure includes LED fixture housings including cobrahead and post-top and is applicable only where utility tariffs support LED street lighting conversions.

This measure was developed to be applicable for a one-to-one RF opportunity only.[268]

Definition of Efficient Equipment

The efficient equipment must be an LED fixture that meets the United Illuminating Rate Schedule, alongside all other luminary performance requirements, based on site characteristics[269] and all local, state and federal codes.

Definition of Baseline Equipment

The baseline equipment is the existing lighting system – a metal halide, high pressure sodium, or mercury vapor outdoor lamp, ballast, and fixture.

Deemed Lifetime of Efficient Equipment

The measure life is assumed to be 12.5 years.[270]

---

[267] See NEEP "LED Street Lighting Assessment and Strategies for the Northeast and Mid-Atlantic," January 2015, and the Municipal Solid State Street Lighting Consortium for more information http://www1.eere.energy.gov/buildings/ssl/consortium.html

[268] Many light fixtures were placed in service 20-50 years ago and may no longer service their intended purpose. It is important to conduct a comprehensive assessment of lighting needs with a lighting professional when considering a LED street lighting project. LED street lighting can result in removal of lighting altogether as LED lights provide better CRI and lighting levels than existing HID lighting types. While this measure only characterizes a one-to-one replacement value, it is recommended that this measure be updated following a Missouri assessment to see where LED street lighting has resulted in the removal of street lighting to ensure additional savings calculations are captured. Recommend using Street and Parking Facility Lighting Retrofit Financial Analysis Tool developed by DOE Municipal Solid-State Street Lighting Consortium and the Federal Energy Management Program.

[269] See DOE Municipal Solid-State Street Lighting Consortium "Model Specifications for LED Roadway Luminaires v.2.0," July 2014.

[270] The measure lifetime is calculated using 4,000 annual hours of use from Ameren Missouri "Light Emitting Diode (LED) Street and Area Lighting Report," July 2013 and a typical LED streetlight lifetime of 50,000 hours from Massachusetts Department of Energy Resources "LED Streetlights: What is Your Plan? (webinar)," September 11, 2013.

DEEMED MEASURE COST

Actual measure installation cost should be used, including material and labor.[271] If the actual cost of the LED unit is unknown, use the default values for typical LED streetlight retrofits provided below.[272]

Light output						
	Low (<50W)		Med (50W-100W)		High (>100W)	
Fixture Type	**min**	**max**	**min**	**max**	**min**	**max**
Decorative/Post Top	$350.00	$615.00	$550.00	$950.00	$750.00	$1,450.00
Cobrahead	$99.00	$225.00	$179.00	$451.00	$310.00	$720.00

LOADSHAPE

Ext Lighting BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS [273]

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * Hours$$

Where:

$Watts_{Base}$ = Actual wattage if known, if unknown assume the following nominal wattage based on technology[274]

Metal Halide = 554W

High Pressure Sodium = 157W

Mercury Vapor = 228W

$Watts_{EE}$ = Actual wattage[275]

Hours = Annual operating hours

= 4,000 hours[276]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

No summer peak savings should be claimed for street lighting, as street lights are not expected to be operational during system peak loads.

NATURAL GAS ENERGY SAVINGS

N/A

[271] Labor should include the removal of the old fixture and installation of the new fixture. Assume the typical prevailing wage as per the Annual Wage Order No. 23 published by the Missouri Department of Labor.
[272] LED unit costs from New York State Energy Research and Development Authority "Street Lighting in New York State: Opportunities and Challenges," Revised January 2015.
[273] There is no ISR input. Savings are per unit.
[274] Baseline wattages are a weighted average of products evaluated in Ameren Missouri "Light Emitting Diode (LED) Street and Area Lighting Report," July 2013. See "Street Lighting_Baseline Wattages.xlsx."
[275] It is important to ensure that retrofit opportunities base efficient wattage on a lumen per watt equivalence.
[276] Ameren Missouri "Light Emitting Diode (LED) Street and Area Lighting Report," July 2013.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

Annual O&M savings are estimated at $50/LED streetlight.[277]

MEASURE CODE:

[277] New York State Energy Research and Development Authority "Street Lighting in New York State: Opportunities and Challenges," Revised January 2015.

2.7 Miscellaneous

2.7.1 Laptop Computer

Description

This measure estimates savings for a laptop (or notebook) computer with that has been certified by ENERGY STAR® (ES) Version 6.0.

This measure was developed to be applicable to the following program type: TOS. If applied to other program types, the measure savings should be verified.

Definition of Efficient Equipment

The efficient product is laptop meeting the requirements set forth by ENERGY STAR® Version 6.0.

Definition of Baseline Equipment

Non ENERGY STAR® qualified laptop.

Deemed Lifetime of Efficient Equipment

The life of this measure is 4 years.[278]

Deemed Measure Cost[279]

The incremental cost is $5.

Loadshape

Miscellaneous BUS

Algorithm

Calculation of Energy Savings

Electric Energy Savings[280]

$$\Delta kWh = Hours_{idle} * (P_{idle\_base} - P_{idle\_eff}) + Hours_{sleep} * (P_{sleep\_base} - P_{sleep\_eff}) + Hours_{off} * (P_{off\_base} - P_{off\_eff})$$

Where:

$Hours_{idle}$ = Annual hours the computer is on and idling. Custom input or based on usage pattern (see table below).

P_{idle_base} = Power draw (kW) of baseline unit while idling. Based on computer performance level (see table below).

P_{idle_eff} = Power draw (kW) of efficient unit while idling. Based on computer performance level (see table below).

278 Based on Energy Star® Office Equipment Calculator. See "Office Equipment Calculator.xlsx."

279 Computer CASE Report, CA IOUs. http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2A_Consumer_Electronics/California_IOUs_Standards_Proposal_Computers_UPDATED_2013-08-06_TN-71813. The small incremental cost is in alignment with Energy Star® reporting, which lists an incremental cost of $0.

280 Based on the algorithms used by the Energy Star® Office Equipment Calculator. See "Office Equipment Calculator.xlsx."

$Hours_{sleep}$ = Annual hours the computer is in sleep mode. Custom input or based on usage pattern (see table below).

P_{sleep_base} = Power draw (kW) of baseline unit while in sleep mode. Based on computer performance level (see table below).

P_{sleep_eff} = Power draw (kW) of efficient unit while in sleep mode. Based on computer performance level (see table below).

$Hours_{off}$ = Annual hours the computer is off. Custom input or based on usage pattern (see table below).

P_{off_base} = Power draw (kW) of baseline unit while off. Based on computer performance level (see table below).

P_{off_eff} = Power draw (kW) of efficient unit while off. Based on computer performance level (see table below).

Table: Default Hours of Use[281]

Use Pattern	$Hours_{idle}$	$Hours_{sleep}$	$Hours_{off}$
Turned off at night, sleep enabled	803	1104	6854
Turned off at night, sleep disabled	1906	0	6854
Left on at night, sleep enabled	803	7957	0
Left on at night, sleep disabled	8760	0	0
Unknown	5853	439	2467

Table: Power Requirements[282]

Performance Level[283]	Baseline			Efficient		
	P_{idle_base}	P_{sleep_base}	P_{off_base}	P_{idle_eff}	P_{sleep_eff}	P_{off_eff}
Low	0.01104	0.00104	0.000563	0.0064	0.000787	0.000382
Medium	0.01482	0.00121	0.000606	0.00861	0.000889	0.000457
High	0.01724	0.00134	0.000619	0.01024	0.00122	0.000522

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy Savings as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

[281] Based on Energy Star® Office Equipment Calculator. See “Office Equipment Calculator.xlsx.” “Unknown” based on data suggesting 36% of computers are shut off at night and 8% have sleep mode enabled.
[282] Based on Energy Star® Office Equipment Calculator. See “Office Equipment Calculator.xlsx.”
[283] “Low” refers to budget or low-end models, “Medium” refers to mid-grade models and “High” refers to high-end models. For more specific performance definitions, refer to Energy Star® 6.0 Requirements.

NATURAL GAS SAVINGS

N/A

WATER AND OTHER NON-ENERGY IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.7.2 Computer Power Management Software

DESCRIPTION

Computer power management software is installed on a network of computers. This is software which monitors and records computer and monitor usage, as well as allows centralized control of computer power management settings.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is defined by the requirements listed below:

- Allow centralized control and override of computer power management settings of workstations which include both a computer monitor and CPU (i.e. a desktop or laptop computer on a distributed network).
- Be able to control on/off/sleep states on both the CPU and monitor according to the network administrator-defined schedules and apply power management policies to network groups.
- Have capability to allow networked workstations to be remotely wakened from power-saving mode (e.g. for system maintenance or power/setting adjustments).
- Have capability to detect and monitor power management performance and generate energy savings reports.
- Have capability to produce system reports to confirm the inventory and performance of equipment on which the software is installed.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF BASELINE EQUIPMENT

Baseline is defined as a computer network without software enforcing the power management capabilities in existing computers and monitors.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is 4 years.[284]

DEEMED MEASURE COST

The deemed measure cost is $29 per networked computer, including labor.[285]

LOADSHAPE

Miscellaneous BUS

[284] Consistent with the expected lifetimes of Energy Star® Office Equipment.
[285] Work Paper WPSCNROE0003 Revision 1, Power Management Software for Networked Computers. Southern California Edison

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

$\Delta kWh = kWh_{savings} * N$

Where:

$kWh_{savings}$ = Annual energy savings per workstation

= 200 kWh[286] for desktops, 50 kWh for laptops[287]

= If unknown, assume 161 kWh (based on 74% desktop and 26% laptop)[288]

N = Number of desktop or laptop workstations controlled by the power management software

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy Savings as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

NATURAL GAS SAVING

NA

DEEMED O&M COST ADJUSTMENT CALCULATION

Assumed to be $2/unit annually.[289]

MEASURE CODE:

[286] Based on average energy savings/computer from the following sources:
South California Edison, Work Paper WPSCNROE0003 (200k Wh)
Surveyor Network Energy Manager Evaluation Report, NEEA (68, 100, and 128kWh)
Regional Technical Forum http://rtf.nwcouncil.org/measures/measure.asp?id=95 (200 kWh)
EnergySTAR® Computer Power Management Savings Calculator (~190 kWh for a mix of laptop/desktop and assuming 30% are already turned off at night)
http://www.energystar.gov/ia/products/power_mgt/LowCarbonITSavingsCalc.xlsx?78c1-120e&78c1-120e
Power Management for Networked Computers: A Review of Utility Incentive Programs J. Michael Walker, Beacon Consultants Network Inc., 2009 ACEEE Summer Study on Energy Efficiency in Industry (330 kWh).

[287] Power Management for Networked Computers: A Review of Utility Incentive Programs J. Michael Walker, Beacon Consultants Network Inc., 2009 ACEEE Summer Study on Energy Efficiency in Industry.

[288] Based on PY6 ComEd Computer Software Program data showing a split of 74% desktop to 26% laptop.

[289] Based on Dimetrosky, S., Luedtke, J. S., & Seiden, K. (2005). Surveyor Network Energy Manager: Market Progress Evaluation Report, No. 2 (Northwest Energy Efficiency Alliance report #E05-136). Portland, OR: Quantec LLC and review of CLEARResult document providing Qualifying Software Providers for ComEd program and their licensing fees; "Qualifying Vendor Software Comparison.pdf."

2.7.3 Heat Pump Pool Heater

DESCRIPTION

This measure applies to the installation of a heat pump pool heater in place of a standard electric pool heater on an outdoor pool at a commercial location.

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be a new heat pump pool heater meeting program requirements.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a new, standard efficiency electric resistance pool heater.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[290]

DEEMED MEASURE COST

The incremental equipment cost difference between an electric resistance pool heater and a heat pump pool heater is $1,000 per unit.[291]

LOADSHAPE

Miscellaneous BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = Q_{PoolHeating} * (1/Eff_{Base} - 1/Eff_{EE})$$

Where:

$Q_{PoolHeating}$ = Required annual heat transfer to pool water (kWh), calculated as follows:[292]

= For an uncovered pool: [53.075 * (SQFT)] + 1631.1

= For a pool that is regularly covered when not in use: [8.079 * (SQFT)] + 1295.4

Where SQFT is the total surface area of the pool.

[290] Measure life is for a high-efficiency pool heater, from 2017 Michigan Energy Measures Database.

[291] Measure cost based on "The Definitive Guide to Heating Your Swimming Pool," AquaCal, July 2013. Electric resistance pool heaters can be purchased for less than $2,000, and heat pump pool heaters cost between $2,000 and $4,000.

[292] Based on the results of a swimming pool energy calculation tool found at http://noanderson.com/services/swimming-pool-energy-temperature-calculator/. Results use St. Louis weather-related assumptions and assume a pool season of May through October (per Energy Star® guidelines), with a water temperature of 80 degrees Fahrenheit.

Where:

Eff_{Base} = Efficiency of electric resistance pool heater

= 100%

Eff_{EE} = Efficiency (COP) of heat pump pool heater

= Actual

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$\Delta kW = \Delta kWh * CF$

Where:

ΔkWh = Calculated value above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.7.4 Computer Server

Description

This measure estimates savings for a computer server with that has been certified by ENERGY STAR® (ES) Version 2.0.

This measure was developed to be applicable to the following program type: TOS. If applied to other program types, the measure savings should be verified.

Definition of Efficient Equipment

The efficient product is computer server meeting the requirements set forth by ENERGY STAR® Version 2.0.

Definition of Baseline Equipment

Non ENERGY STAR® qualified computer server.

Deemed Lifetime of Efficient Equipment

The life of this measure is 4 years.[293]

Deemed Measure Cost[294]

The incremental cost is $9.80.

Loadshape

Miscellaneous BUS

Algorithm

Calculation of Energy Savings

Electric Energy Savings[295]

Annual energy savings are based on the rated output of the server's power supply, according to the following table:

Power Supply Rated Output (W)	Baseline Annual Energy Consumption (kWh)	Efficient Annual Energy Consumption (kWh)	Annual Energy Savings (kWh)
Up to 500	1,221	742	479
501-1000	3,024	1,837	1,187
1001-1500	5,883	3,575	2,308
1501-2000	9,152	5,561	3,591

[293] Consistent with Energy Star® computing equipment. It is important to note that lifetime doesn't necessarily reflect the expected functional lifetime of mechanical components, but rather the lifetime of operating system technology, which is generally assumed to become obsolete after a period of four years.
[294] Computer CASE Report, CA IOUs. http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2A_Consumer_Electronics/California_IOUs_Standards_Proposal_Computers_UPDATED_2013-08-06_TN-71813. The small incremental cost is in alignment with Energy Star® reporting, which lists an incremental cost of $0 for all office equipment.
[295] Based on current Energy Star® qualified product performance and assumptions drawn from the Energy Savings From Energy Star®- Qualified Servers report and Energy Star® Computer Specifications version 4.0. See "Computer Server Savings.xlsx" for additional details and methodology.

Power Supply Rated Output (W)	Baseline Annual Energy Consumption (kWh)	Efficient Annual Energy Consumption (kWh)	Annual Energy Savings (kWh)
2001-2500	8,667	5,266	3,401
2501-3000	19,633	11,929	7,704

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy Savings as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

NATURAL GAS SAVINGS

N/A

WATER AND OTHER NON-ENERGY IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.8 Motors

2.8.1 Motors

DESCRIPTION

This measure applies to the one-for-one replacement of an old, working or failed/near failure 1-350 horsepower, constant speed, uniformly loaded HVAC fan or pumping motor with a new motor of the same rated horsepower that meets or exceeds National Electrical Manufacturers Association (NEMA) Premium efficiency levels.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be a new motor that meets or exceeds NEMA Premium efficiency levels.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment efficiency is the efficiency of the existing motor, or if unknown, the federal minimum required efficiency is assumed.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[296]

DEEMED MEASURE COST

Actual incremental costs should be used if available. If actual costs are unknown, use default installed cost from table below.[297]

Motor Size (HP)	Installed Cost
1	$730
1.5	$725
2	$800
3	$840
5	$860
7.5	$1,165
10	$1,298
15	$2,242
20	$2,522
25	$2,873
30	$3,095
40	$3,716
50	$4,073
60	$5,128
75	$5,888
100	$7,392

[296] California Database for Energy Efficiency Resources (DEER) 2014 Estimated Useful Life (EUL) Table Update.
[297] Installed costs from 2015-2016 Demand-Side Management Plan, Xcel Energy.

Motor Size (HP)	Installed Cost
125	$9,076
150	$9,401
200	$11,250
250	$13,958
300	$17,744
350	$25,653

LOADSHAPE

Motors BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = HP * LF * 0.746 * (1/\eta_{Bmotor} - 1/\eta_{EEmotor}) * \ Hours$$

Where:

HP = Nominal horsepower (HP) of new motor

= Actual

LF = Load Factor; Motor Load at Fan/Pump Design CFM

= 75%[298]

0.746 = Conversion factor from HP to kWh

η_{Bmotor} = Actual efficiency of existing motor, or if unknown, use federal baseline nominal/nameplate motor efficiency as shown in table below for Open Drip Proof (ODP) and Totally Enclosed Fan Cooled (TEFC)[299]

Motor Size (HP)	Open Drip Proof (ODP) # of Poles			Totally Enclosed Fan-Cooled (TEFC) # of Poles		
	6	4	2	6	4	2
	Speed (RPM)			Speed (RPM)		
	1200	1800	3600	1200	1800	3600
1	82.50%	85.50%	77.00%	82.50%	85.50%	77.00%
1.5	86.50%	86.50%	84.00%	87.50%	86.50%	84.00%
2	87.50%	86.50%	85.50%	88.50%	86.50%	85.50%
3	88.50%	89.50%	85.50%	89.50%	89.50%	86.50%
5	89.50%	89.50%	86.50%	89.50%	89.50%	88.50%
7.5	90.20%	91.00%	88.50%	91.00%	91.70%	89.50%
10	91.70%	91.70%	89.50%	91.00%	91.70%	90.20%
15	91.70%	93.00%	90.20%	91.70%	92.40%	91.00%
20	92.40%	93.00%	91.00%	91.70%	93.00%	91.00%

[298] Motor efficiency curves typically result in motors being most efficient at approximately 75% of the rated load. *Determining Electric Motor Load and Efficiency*, US DOE Motor Challenge, a program of the US Department of Energy, https://energy.gov/sites/prod/files/2014/04/f15/10097517.pdf.

[299] For 1-200 HP motors, baseline efficiency is from NEMA MG 1 Table 12-12. For motors over 200 hp, baseline efficiency is from NEMA MG 1 Table 12-11.

Motor Size (HP)	Open Drip Proof (ODP) # of Poles			Totally Enclosed Fan-Cooled (TEFC) # of Poles		
	6	4	2	6	4	2
	Speed (RPM)			Speed (RPM)		
	1200	1800	3600	1200	1800	3600
25	93.00%	93.60%	91.70%	93.00%	93.60%	91.70%
30	93.60%	94.10%	91.70%	93.00%	93.60%	91.70%
40	94.10%	94.10%	92.40%	94.10%	94.10%	92.40%
50	94.10%	94.50%	93.00%	94.10%	94.50%	93.00%
60	94.50%	95.00%	93.60%	94.50%	95.00%	93.60%
75	94.50%	95.00%	93.60%	94.50%	95.40%	93.60%
100	95.00%	95.40%	93.60%	95.00%	95.40%	94.10%
125	95.00%	95.40%	94.10%	95.00%	95.40%	95.00%
150	95.40%	95.80%	94.10%	95.80%	95.80%	95.00%
200	95.40%	95.80%	95.00%	95.80%	96.20%	95.40%
250	95.40%	95.80%	95.00%	95.80%	96.20%	95.80%
300	95.40%	95.80%	95.40%	95.80%	96.20%	95.80%
350	95.40%	95.80%	95.40%	95.80%	96.20%	95.80%

$\eta_{EEmotor}$ =Efficient motor nominal/nameplate motor efficiency

= Actual

Hours = Annual hours of operation for motor; see table below for HVAC motors[300]

Building Type	Hot Water Pump Hours	Chilled Water Pump Hours	Fan Motor Run Hours
Large Office	5,233	6,385	6,753
Medium Office	3,437	5,921	6,968
Small Office	3,715	3,774	6,626
Warehouse	4,587	1,292	6,263
Stand-alone Retail	4,040	2,713	6,679
Strip Mall	3,908	2,548	6,687
Primary School	4,754	5,160	5,906
Secondary School	5,594	5,279	6,702
Supermarket	4,868	4,255	6,900
Quick Service Restaurant	4,231	3,378	7,679
Full Service Restaurant	4,595	4,897	7,664
Hospital	8,760	8,717	8,760
Outpatient Health Care	8,760	8,689	8,760
Small Hotel - Building	3,533	7,976	8,760
Large Hotel - Building	5,538	8,308	8,760

300 Hours per year are estimated using the eQuest models as the total number of hours the heating or cooling system is operating for each building type. “Heating and Cooling Run Hours” are estimated as the total number of hours fans are operating for heating, cooling and ventilation for each building type. This may over claim certain applications (e.g. pumps) and so where possible actual hours should be used for these applications.

Building Type	Hot Water Pump Hours	Chilled Water Pump Hours	Fan Motor Run Hours
Midrise Apartment - Building	5,197	4,347	8,728
Nonresidential Average	4,411	3,539	6,773

SUMMER COINCIDENT PEAK DEMAND SAVINGS[301]

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy Savings as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[301] Since savings will be constant and without fluctuation over the period of operation, demand savings are simply the energy savings divided by the hours of operation. Demand savings are expected to coincide with peak demand period definitions, consistent with assumptions in VFD measures on HVAC pumps and fans.

2.8.2 Pool Pump

DESCRIPTION

This measure applies to the installation of a variable frequency drive (VFD) on an existing single-speed pool pump at a commercial location. VFDs save energy by reducing the speed of the pool pump motor to match the pool's required flow rate. Additionally, VFD's soft-starting extends motor life by reducing wear.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be a new VFD meeting program requirements.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is an existing, single-speed pool pump without a VFD or other motor control device.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years.[302]

DEEMED MEASURE COST

Actual costs (equipment and labor) should be used if available. If actual costs are unknown, assume equipment costs of $200/motor horsepower and labor cost of $46.[303]

LOADSHAPE

Motors BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = 1{,}747 * HP$$

Where:

1,747 = Average annual energy savings per pool pump motor horsepower (kWh/HP)[304]

HP = Pool pump motor horsepower

= Custom input, actual horsepower rating of the pump motor.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta \mathrm{kW} = \Delta \mathrm{kWh} * \mathrm{CF}$$

[302] Measure life from 2017 Michigan Energy Measures Database.
[303] Costs from 2017 Michigan Energy Measures Database.
[304] Energy savings based on monitoring performed at commercial pool facilities, from "Commercial Variable Speed Pool Pump Market Characterization and Metering Study," Southern California Edison, February 2015.

Where:

kWh = Electric energy savings, as calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.8.3 Pool Pump Timer

DESCRIPTION

This measure applies to the installation of a pump timer on an existing single-speed pool pump at a commercial location. Many times, it is not necessary to run a pool's circulation pump 24 hours a day.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be a new pump timer meeting program requirements.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is an existing, single-speed pool pump without a VFD or other motor control device.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years.

DEEMED MEASURE COST

Actual costs (equipment and labor) should be used if available. If actual costs are unknown, assume equipment costs of $100.[305]

LOADSHAPE

Motors BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = HRS * HP * .746$$

Where:

HRS = Hours Timer will shut off pump annually

= Actual.

HP = Pool pump motor horsepower

= Custom input, actual horsepower rating of the pump motor.

[305] Costs from Ameren Missouri MEEIA 2016-18 TRM.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

kWh = Electric energy savings, as calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.8.4 Pump Optimization

DESCRIPTION

Pump improvements can be done to optimize the design and control of centrifugal water pumping systems, including water solutions with freeze protection up to 15% concentration by volume. Other fluid and gas pumps cannot use this measure calculation. The measurement of energy and demand savings for commercial and industrial applications will vary with the type of pumping technology, operating hours, efficiency, and existing and proposed controls. Depending on the specific application slowing the pump, trimming or replacing the impeller may be suitable options for improving pumping efficiency. Pumps up to 40 HP are allowed to use this energy savings calculation. Larger motors should use a custom calculation (which may result in larger savings than this measure would claim).

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is proven to be an optimized centrifugal pumping system meeting the applicable program efficiency requirements:

- Pump balancing valves no more than 15% throttled; and
- Balancing valves on at least one load 100% open.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be the existing pumping system including existing controls and sequence of operations.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years.[306]

DEEMED MEASURE COST

The incremental capital cost for this measure can vary considerably depending upon the strategy employed to achieve the required efficiency levels and should be determined on a site-specific basis.

LOADSHAPE

Process BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (HP_{motor} * 0.746 * LF / \eta_{motor}) * HOURS * ESF$$

Where:

HP_{motor} = Installed nameplate motor horsepower

= Actual

[306] Martin, N. et al., Emerging Energy-Efficient Industrial Technologies: New York State Edition, American Council for an Energy Efficient Economy (ACEEE), March 2001 (as stated in the OH State TRM, page 269).

0.746 = Conversion factor from horse-power to kW (kW/hp)

LF / η_{motor} = Combined as a single factor since efficiency is a function of load

= 0.65[307]

Where:

LF = Load Factor; Ratio of the peak running load to the nameplate rating of the motor

η_{motor} = Motor efficiency at pump operating conditions

HOURS = Annual operating hours of the pump

= Actual

ESF = Energy Savings Factor; assume a value of 15%.[308]

Summer Coincident Peak Demand Savings

$\Delta kW = \Delta kWh * CF$

Where:

CF = Summer Coincident Peak Factor for measure

= 0.0001379439[309]

Natural Gas Energy Savings

N/A

Water Impact Descriptions and Calculation

N/A

Deemed O&M Cost Adjustment Calculation

N/A

Measure Code:

[307] "Measured Loading of Energy Efficient Motors - the Missing Link in Engineering Estimates of Savings," ACEEE 1994 Summer Study Conference, Asilomar, CA.

[308] Published estimates of typical pumping efficiency improvements range from 5 to 40%. For analysis purposes, assume 15%. United States Industrial Electric Motor Systems Market Opportunities Assessment December 2002, Table E-7, Page 18, https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/mtrmkt.pdf.

[309] Based on Ameren Missouri 2016 Process Loadshape.

2.8.5 Variable Frequency Drives for Chilled Water and Hot Water Distribution Pumps

DESCRIPTION

This measure applies to VFDs installed on HVAC chilled water and hot water distribution pumps. There is a separate measure for HVAC supply and return fans. The VFD will modulate the speed of the motor when it does not need to run at full load. Since the power of the motor is proportional to the cube of the speed for these types of applications, significant energy savings will result.

This measure was developed to be applicable to the following program types: TOS and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The VFD is applied to a pump motor 1-75 HP that does not have a VFD. The hydronic system that the VFD is applied to must have a variable or reduced load. Installation is to include the necessary control points and parameters (example: differential pressure, differential temperature, return water temperature) as determined by a qualified engineer.

DEFINITION OF BASELINE EQUIPMENT

The time of sale baseline is a new motor installed without a VFD or other methods of control. Retrofit baseline is an existing motor operating as is.

Installations of new equipment with VFDs which are required by regional code adoption should not claim savings.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life for HVAC application is 15 years.[310]

DEEMED MEASURE COST

Customer-provided costs will be used when available. Default measure costs are listed below for 1 to 75 HP motors.[311] The average of the values below is $179/HP.

HP	Cost
1-9 HP	$1,874
10-19 HP	$2,967
20-29 HP	$4,060
30-39 HP	$5,154
40-49 HP	$6,247
50-59 HP	$7,340
60-69 HP	$8,433
70-75 HP	$9,526

LOADSHAPE

Cooling BUS
Heating BUS
HVAC BUS

[310] Consistent with Ameren Missouri program assumptions.
[311] Average costs observed by other Midwestern states energy efficiency programs – specific data reflects results from Iowa program costs.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$\Delta kWh = BHP / EFFi * Hours * ESF$

Where:

BHP = System Brake Horsepower

(Nominal motor HP * Motor load factor)

Motors are assumed to have a load factor of 65% for calculating kW if actual values cannot be determined.[312] Custom load factor may be applied if known.

EFFi = Motor efficiency, installed. Actual motor efficiency shall be used to calculate kW. If not known, a default value of 93% is an appropriate assumption.

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type.[313] When available, actual hours should be used.

Building Type	Hot Water Pump Hours	Chilled Water Pump Hours
Large Office	5233	6385
Medium Office	3437	5921
Small Office	3715	3774
Warehouse	4587	1292
Stand-alone Retail	4040	2713
Strip Mall	3908	2548
Primary School	4754	5160
Secondary School	5594	5279
Supermarket	4868	4255
Quick Service Restaurant	4231	3378
Full Service Restaurant	4595	4897
Hospital	8760	8717
Outpatient Health Care	8760	8689
Small Hotel - Building	3533	7976
Large Hotel - Building	5538	8308
Midrise Apartment - Building	5197	4347

[312] Del Balso, Ryan J. "Investigation into the Reliability of Energy Efficiency/Demand Side Management Savings Estimates for Variable Frequency Drives in Commercial Applications," University of Colorado, Department of Civil, Environmental and Architectural Engineering, 2013.

[313] Hours per year are estimated using the eQuest models as the total number of hours the heating or cooling system is operating for each building type. "Heating and Cooling Run Hours" are estimated as the total number of hours fans are operating for heating, cooling and ventilation for each building type. This may over claim certain applications (e.g. pumps) and so where possible actual hours should be used for these applications.

Building Type	Hot Water Pump Hours	Chilled Water Pump Hours
Nonresidential Average	4411	3539

ESF = Energy savings factor varies by VFD application. Units are kW/HP.

Application	ESF[314]
Hot Water Pump	0.3577
Chilled Water Pump	0.3389

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy Savings as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439 Chilled Water Pumps

= 0.000443983 Hot Water Pumps

FOSSIL FUEL IMPACT DESCRIPTIONS AND CALCULATION

If fossil fuel impacts are expected, a custom analysis should be used to support them.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[314] Developed from datasets produced from the Northeast Energy Efficiency Partnerships Variable Speed Drive Loadshape Project. See supporting workbook "VSD HVAC Pump Savings.xlsx" for derivation.

2.8.6 Variable Frequency Drives for HVAC Supply and Return Fans

DESCRIPTION

This measure applies to VFDs installed on HVAC supply fans and return fans. There is a separate measure for HVAC Pumps. The VFD will modulate the speed of the motor when it does not need to run at full load. Since the power of the motor is proportional to the cube of the speed for these types of applications, significant energy savings will result.

This measure is applicable to the following program types: TOS and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The VFD is applied to an HVAC fan motor that does not have a VFD. The air distribution system must have a variable or reduced load, and installation is to include the necessary control point as determined by a qualified engineer (example: differential pressure, temperature, or volume). Savings are based on the application of VFDs to a range of baseline system conditions, including no control, inlet guide vanes, outlet guide vanes, relief dampers, and throttling valves.

DEFINITION OF BASELINE EQUIPMENT

The TOS baseline is a new motor installed without a VFD or other methods of control. The RF baseline is an existing motor operating as is. RF baselines may or may not include guide vanes, throttling valves, or other methods of control.

Installations of new equipment with VFDs which are required by regional code adoption should not claim savings.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life for HVAC application is 15 years.[315]

DEEMED MEASURE COST

Customer provided costs will be used when available. Default measure costs are listed below for up to 100 hp motors.[316] The average of the values below is $168/HP.

HP	Cost
1-9 HP	$1,874
10-19 HP	$2,967
20-29 HP	$4,060
30-39 HP	$5,154
40-49 HP	$6,247
50-59 HP	$7,340
60-69 HP	$8,433
70-79 HP	$9,526
80-89 HP	$10,620
90-100 HP	$11,713

LOADSHAPE

HVAC BUS

[315] Consistent with Ameren Missouri program assumptions.
[316] Average costs observed by energy efficiency programs in Iowa.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS[317]

kWh$_{Base}$ = $\left(0.746 * HP * \frac{LF}{\eta_{motor}}\right) * RHRS_{Base} * \sum_{0\%}^{100\%}(\%FF * PLR_{Base})$

kWh$_{Retrofit}$ = $\left(0.746 * HP * \frac{LF}{\eta_{motor}}\right) * RHRS_{base} * \sum_{30\%}^{100\%}(\%FF * PLR_{Retrofit})$

ΔkWh$_{fan}$ = $kWh_{Base} - kWh_{Retrofit}$

ΔkWh$_{total}$ = $\Delta kWh_{fan} * (1 + IE_{energy})$

Where:

kWh_{Base} = Baseline annual energy consumption (kWh/yr)

$kWh_{Retrofit}$ = Retrofit annual energy consumption (kWh/yr)

ΔkWh_{fan} = Fan-only annual energy savings

ΔkWh_{total} = Total project annual energy savings

0.746 = Conversion factor for HP to kWh

HP = Nominal horsepower of controlled motor

LF = Load Factor; Motor Load at Fan Design CFM (Default = 65%)[318]

η_{motor} = Installed nominal/nameplate motor efficiency

= Actual. If unknown, default can be assumed as a NEMA Premium Efficiency, ODP, 4-pole/1800 RPM fan motor, with efficiency indicated in the following table:

[317] Methodology developed and tested in Del Balso, Ryan Joseph. "Investigation into the Reliability of Energy Efficiency/Demand Side Management Savings Estimates for Variable Frequency Drives in Commercial Applications." A project report submitted to the Faculty of the Graduate School of the University of Colorado, 2013.
[318] Lawrence Berkeley National Laboratory, and Resource Dynamics Corporation. (2008). "Improving Motor and Drive System Performance; A Sourcebook for Industry," U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Golden, CO: National Renewable Energy Laboratory.

NEMA Premium Efficiency Motors Default Efficiencies[319]

Size HP	Open Drip Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
	# of Poles			# of Poles		
	6	4	2	6	4	2
	Speed (RPM)			Speed (RPM)		
	1200	1800 Default	3600	1200	1800	3600
1	0.825	0.855	0.770	0.825	0.855	0.770
1.5	0.865	0.865	0.840	0.875	0.865	0.840
2	0.875	0.865	0.855	0.885	0.865	0.855
3	0.885	0.895	0.855	0.895	0.895	0.865
5	0.895	0.895	0.865	0.895	0.895	0.885
7.5	0.902	0.910	0.885	0.910	0.917	0.895
10	0.917	0.917	0.895	0.910	0.917	0.902
15	0.917	0.930	0.902	0.917	0.924	0.910
20	0.924	0.930	0.910	0.917	0.930	0.910
25	0.930	0.936	0.917	0.930	0.936	0.917
30	0.936	0.941	0.917	0.930	0.936	0.917
40	0.941	0.941	0.924	0.941	0.941	0.924
50	0.941	0.945	0.930	0.941	0.945	0.930
60	0.945	0.950	0.936	0.945	0.950	0.936
75	0.945	0.950	0.936	0.945	0.954	0.936
100	0.950	0.954	0.936	0.950	0.954	0.941
125	0.950	0.954	0.941	0.950	0.954	0.950
150	0.954	0.958	0.941	0.958	0.958	0.950
200	0.954	0.958	0.950	0.958	0.962	0.954
250	0.954	0.958	0.950	0.958	0.962	0.958
300	0.954	0.958	0.954	0.958	0.962	0.958
350	0.954	0.958	0.954	0.958	0.962	0.958
400	0.958	0.958	0.958	0.958	0.962	0.958
450	0.962	0.962	0.958	0.958	0.962	0.958
500	0.962	0.962	0.958	0.958	0.962	0.958

$RHRS_{Base}$ = Annual operating hours for fan motor based on building type.

Default hours are provided for HVAC applications which vary by building type.[320] When available, actual hours should be used.

Building Type	Total Fan Run Hours
Large Office	6753
Medium Office	6968
Small Office	6626

[319] Douglass, J. (2005). Induction Motor Efficiency Standards. Washington State University and the Northwest Energy Efficiency Alliance, Extension Energy Program, Olympia, WA. Retrieved October 17, 2013, from http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/motor_efficiency_standards.pdf.

[320] Hours per year are estimated using the modeling results and represent the total number of hours the fans are operating for heating, cooling and ventilation for each building type.

Building Type	Total Fan Run Hours
Warehouse	6263
Stand-alone Retail	6679
Strip Mall	6687
Primary School	5906
Secondary School	6702
Supermarket	6900
Quick Service Restaurant	7679
Full Service Restaurant	7664
Hospital	8760
Outpatient Health Care	8760
Small Hotel - Building	8760
Large Hotel - Building	8760
Midrise Apartment - Building	8728
Nonresidential Average	6773

%FF = Percentage of run-time spent within a given flow fraction range[321]

Flow Fraction (% of design cfm)	Percent of Time at Flow Fraction
0% to 10%	0.0%
10% to 20%	1.0%
20% to 30%	5.5%
30% to 40%	15.5%
40% to 50%	22.0%
50% to 60%	25.0%
60% to 70%	19.0%
70% to 80%	8.5%
80% to 90%	3.0%
90% to 100%	0.5%

PLR_{Base} = Part load ratio for a given flow fraction range based on the baseline flow control type (see table below)

$PLR_{Retrofit}$ = Part load ratio for a given flow fraction range based on the retrofit flow control type (see table below)

Control Type	Flow Fraction									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
No Control or Bypass Damper	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Discharge Dampers	0.46	0.55	0.63	0.70	0.77	0.83	0.88	0.93	0.97	1.00
Outlet Damper, BI & Airfoil Fans	0.53	0.53	0.57	0.64	0.72	0.80	0.89	0.96	1.02	1.05
Inlet Damper Box	0.56	0.60	0.62	0.64	0.66	0.69	0.74	0.81	0.92	1.07

321 Based on 2012 ASHRAE Handbook; HVAC Systems and Equipment, page 45.11, Figure 12.

Control Type	Flow Fraction									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Inlet Guide Vane, BI & Airfoil Fans	0.53	0.56	0.57	0.59	0.60	0.62	0.67	0.74	0.85	1.00
Inlet Vane Dampers	0.38	0.40	0.42	0.44	0.48	0.53	0.60	0.70	0.83	0.99
Outlet Damper, FC Fans	0.22	0.26	0.30	0.37	0.45	0.54	0.65	0.77	0.91	1.06
Eddy Current Drives	0.17	0.20	0.25	0.32	0.41	0.51	0.63	0.76	0.90	1.04
Inlet Guide Vane, FC Fans	0.21	0.22	0.23	0.26	0.31	0.39	0.49	0.63	0.81	1.04
VFD with duct static pressure controls	0.09	0.10	0.11	0.15	0.20	0.29	0.41	0.57	0.76	1.01
VFD with low/no duct static pressure	0.05	0.06	0.09	0.12	0.18	0.27	0.39	0.55	0.75	1.00

Provided below are the resultant values based upon the defaults provided above:

Control Type	$\sum_{0\%}^{100\%}(\%\boldsymbol{FF} \times \boldsymbol{PLR_{Base}})$
No Control or Bypass Damper	1.00
Discharge Dampers	0.80
Outlet Damper, BI & Airfoil Fans	0.78
Inlet Damper Box	0.69
Inlet Guide Vane, BI & Airfoil Fans	0.63
Inlet Vane Dampers	0.53
Outlet Damper, FC Fans	0.53
Eddy Current Drives	0.49
Inlet Guide Vane, FC Fans	0.39
VFD with duct static pressure controls	0.30
VFD with low/no duct static pressure	0.27

IE_{energy} = HVAC interactive effects factor for energy (default = 15.7%)[322]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{total} * CF$$

Where:

ΔkWh_{total} = As calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.000443983

NATURAL GAS ENERGY SAVINGS

If fossil fuel impacts are expected, a custom analysis should be used to support them.

322 Del Balso, Ryan Joseph. "Investigation into the Reliability of Energy Efficiency/Demand Side Management Savings Estimates for Variable Frequency Drives in Commercial Applications." A project report submitted to the Faculty of the Graduate School of the University of Colorado, 2013.

Water Impact Descriptions and Calculation

N/A

Deemed O&M Cost Adjustment Calculation

N/A

Measure Code:

2.9 Refrigeration

2.9.1 Commercial Solid and Glass Door Refrigerators & Freezers

DESCRIPTION

This measure applies to ENERGY STAR® vertical closed and horizontal closed refrigerators or freezers installed in a commercial kitchen. ENERGY STAR® commercial refrigerators and freezers are more energy efficient because they are designed with components such as ECM evaporator and condenser fan motors, hot gas anti-sweat heaters, or high-efficiency compressors, which will significantly reduce energy consumption.

This measure was developed to be applicable to the following program type: TOS.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be a new ENERGY STAR® certified vertical closed or horizontal closed, solid or glass door refrigerator or freezer meeting energy consumptions requirements as determined by door type (solid or glass) and refrigerated volume (V).

ENERGY STAR® Requirements (Version 3.0, Effective October 1, 2014)

Volume (ft^3)	Maximum Daily Energy Consumption (kWh/day)	
	Refrigerator	Freezer
Vertical Closed		
Solid Door		
$0 < V < 15$	$\leq 0.02V + 1.60$	$\leq 0.25V + 1.55$
$15 \leq V < 30$	$\leq 0.09V + 0.55$	$\leq 0.20V + 2.30$
$30 \leq V < 50$	$\leq 0.01V + 2.95$	$\leq 0.25V + 0.80$
$V \geq 50$	$\leq 0.06V + 0.45$	$\leq 0.14V + 6.30$
Glass Door		
$0 < V < 15$	$\leq 0.10V + 1.07$	$\leq 0.56V + 1.61$
$15 \leq V < 30$	$\leq 0.15V + 0.32$	$\leq 0.30V + 5.50$
$30 \leq V < 50$	$\leq 0.06V + 3.02$	$\leq 0.55V – 2.00$
$V \geq 50$	$\leq 0.08V + 2.02$	$\leq 0.32V + 9.49$
Horizontal Closed		
Solid or Glass Doors		
All Volumes	$\leq 0.06V + 0.60$	$\leq 0.10V + 0.20$

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a new vertical closed or horizontal closed, solid or glass door refrigerator or freezer that is not ENERGY STAR® certified.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years.[323]

[323] Measure life from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator which cites reference as "FSTC research on available models, 2009." https://www.energystar.gov/sites/default/files/asset/document/commercial_kitchen_equipment_calculator%2003-15-2016.xlsx.

DEEMED MEASURE COST

The incremental capital cost for this measure varies by size as shown in the table below:

Measure	Incremental Cost
Commercial Glass Door Freezers less than 15 ft^3	$220
Commercial Glass Door Freezers 15 to 30 ft^3	$950
Commercial Glass Door Freezers 30 to 50 ft^3	$1,307
Commercial Glass Door Freezers more than 50 ft^3	$2,300
Commercial Glass Door Refrigerators less than 15 ft^3	$250
Commercial Glass Door Refrigerators 15 to 30 ft^3	$500
Commercial Glass Door Refrigerators 30 to 50 ft^3	$1,307
Commercial Glass Door Refrigerators more than 50 ft^3	$2,300
Commercial Solid Door Freezers/Refrigerators less than 15 ft^3	$150
Commercial Solid Door Freezers/Refrigerators 15 to 30 ft^3	$400
Commercial Solid Door Freezers/Refrigerators 30 to 50 ft^3	$550
Commercial Solid Door Freezers/Refrigerators more than 50 ft^3	$700
Horizontal Closed - Solid or Glass Door Refrigerator (all volumes)	$525
Horizontal Closed - Solid or Glass Door Freezer (all volumes	$595

LOADSHAPE

Refrigeration BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation below.[324]

$$\Delta kWh = (kWh_{Base} - kWh_{ESTAR}) * Days$$

Where:

kWh_{Base} = Maximum daily energy consumption (kWh/day) of baseline refrigerator or freezer

= Calculated as shown in the table below using the actual refrigerated volume (V)

Equipment Type	kWh_{Base}[325]
Solid Door Refrigerator	0.10V + 2.04
Glass Door Refrigerator	0.12V + 3.34
Solid Door Freezer	0.40V + 1.38
Glass Door Freezer	0.75V + 4.10

kWh_{ESTAR} = Maximum daily energy consumption (kWh/day) of ENERGY STAR® refrigerator or freezer

[324] Algorithms and assumptions from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.
[325] 10 CFR §431.66 - Energy Conservation Standards for Commercial Refrigerators, Freezers and Refrigerator-Freezers.

= Custom or if unknown, calculated as shown in the table below using the actual refrigerated volume (V)

Volume (ft^3)	Maximum Daily Energy Consumption (kWh/day)	
	Refrigerator	**Freezer**
Vertical Closed		
Solid Door		
0 < V < 15	≤ 0.02V + 1.60	≤ 0.25V + 1.55
15 ≤ V < 30	≤ 0.09V + 0.55	≤ 0.20V + 2.30
30 ≤ V < 50	≤ 0.01V + 2.95	≤ 0.25V + 0.80
V ≥ 50	≤ 0.06V + 0.45	≤ 0.14V + 6.30
Glass Door		
0 < V < 15	≤ 0.10V + 1.07	≤ 0.56V + 1.61
15 ≤ V < 30	≤ 0.15V + 0.32	≤ 0.30V + 5.50
30 ≤ V < 50	≤ 0.06V + 3.02	≤ 0.55V – 2.00
V ≥ 50	≤ 0.08V + 2.02	≤ 0.32V + 9.49
Horizontal Closed		
Solid or Glass Doors		
All Volumes	≤ 0.06V + 0.60	≤ 0.10V + 0.20

V = Refrigerated volume (ft^3) calculated in accordance with the Department of Energy test procedure in 10 CFR §431.64

= Actual installed

Days = Days of refrigerator or freezer operation per year

= Custom, or if unknown assume 365.25 days per year

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001357383[326]

NATURAL GAS ENERGY SAVINGS

N/A

PEAK GAS SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

[326] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Refrigeration. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.9.2 Refrigerated Beverage Vending Machine

DESCRIPTION

This measure applies to new ENERGY STAR®, Class A or Class B refrigerated vending machines. ENERGY STAR® vending machines incorporate more efficient compressors, fan motors, and lighting systems as well as a low power mode option that allows the machine to be placed in low-energy lighting and/or low-energy refrigeration states during times of inactivity.

This measure was developed to be applicable to the following program type: TOS.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be a new or rebuilt ENERGY STAR®, Class A or Class B[327] refrigerated vending machine meeting energy consumptions requirements as determined by equipment type (Class A or Class B).

ENERGY STAR Requirements (Version 3.1, Effective March 1, 2013)

Equipment Type	Maximum Daily Energy Consumption (kWh/day)
Class A	≤ 0.0523V + 2.432
Class B	≤ 0.0657V + 2.844

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a new or rebuilt, Class A or Class B refrigerated vending machine that is not ENERGY STAR® certified.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years.[328]

DEEMED MEASURE COST

The incremental cost of this measure is $140.[329]

LOADSHAPE

Refrigeration BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation below.

$$\Delta kWh = (kWh_{Base} - kWh_{ESTAR}) * Days$$

[327] Class A means a refrigerated bottled or canned beverage vending machine that is fully cooled, and is not a combination vending machine. Class B means any refrigerated bottled or canned beverage vending machine not considered to be Class A, and is not a combination vending machine. See 10 CFR §431.292 "Definitions concerning refrigerated bottled or canned beverage vending machines."

[328] Average of measure lives recognized by Ameren Missouri (10 years) and KCPL (14 years). Also consistent with Energy Star® commercial refrigerator lifetime.

[329] Consistent with Ameren Missouri MEEIA 2016-18 and KCPL TRM assumptions.

Where:

kWh_{Base} = Maximum daily energy consumption (kWh/day) of baseline vending machine

= Calculated as shown in the table below using the actual refrigerated volume (V)

Equipment Type	kWh_{Base}[330]
Class A	0.055V + 2.56
Class B	0.073V + 3.16

kWh_{ESTAR} = Maximum daily energy consumption (kWh/day) of ENERGY STAR® vending machine

= Custom or if unknown, calculated as shown in the table below using the actual refrigerated volume (V)

Equipment Type	kWh_{EE}[331]
Class A	≤ 0.0523V + 2.432
Class B	≤ 0.0657V + 2.844

V = Refrigerated volume[332] (ft^3)

= Actual installed

Days = Days of vending machine operation per year

= 365.25 days per year

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001357383[333]

MEASURE CODE:

[330] 10 CFR §431.296 - Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines
[331] ENERGY STAR® Version 3.1 requirements for maximum daily energy consumption.
[332] *V* is measured by the American National Standards Institute (ANSI)/Association of Home Appliance Manufacturers (AHAM) HRF–1–2004, ‘‘Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers and Freezers.’’ Measurement of refrigerated volume must be in accordance with the methodology specified in Section 5.2, Total Refrigerated Volume (excluding subsections 5.2.2.2 through 5.2.2.4), of ANSI/AHAM HRF–1–2004.
[333] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Refrigeration. See reference “Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf.”

2.9.3 Door Heater Controls for Cooler or Freezer

DESCRIPTION

This measure applies to door heater controls installed on commercial coolers or freezers. There are two main categories of commercially available control strategies that achieve "on-off" control of door heaters based on either (1) the relative humidity of the air in the store or (2) the "conductivity" of the door (which drops when condensation appears). In the first strategy, the system activates door heaters when the relative humidity in a store rises above a specific set point and turns them off when the relative humidity falls below that set point. In the second strategy, the sensor activates the door heaters when the door conductivity falls below a certain set point and turns them off when the conductivity rises above that set point. Savings result from a reduction in electric energy use due to heaters not running continuously and from reduced cooling loads when heaters are off. The assumptions included within this measure assume that door heater controls which are properly designed and commissioned will achieve approximately equivalent savings, regardless of control strategy.

This measure applies to the following program type: RF.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be a door heater control installed on a commercial glass door cooler or freezer.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a door heater without controls, installed on a commercial glass door cooler or freezer.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years.[334]

DEEMED MEASURE COST

Actual incremental costs should be used if available. The incremental capital cost $151 per door.[335]

LOADSHAPE

Refrigeration BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kW_{Base} * \ DOORS * \ (\%ON_{Base} - \%ON_{Control}) * Hours$$

Where:

kW_{Base} = Per door electric energy consumption of door heater without controls

[334] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values," California Public Utilities Commission, December 16, 2008.
[335] Ameren Missouri Technical Resource Manual – Effective January 1, 2018.

= Assume 0.130 kW per door[336]

DOORS = Number of doors controlled with door heater controls

= Actual or if unknown, use 1 (a per door savings)

$\%ON_{Base}$ = Effective run time of uncontrolled door heater

= Actual or if unknown, use 90.7%[337]

$\%ON_{Control}$ = Effective run time with anti-sweat door heater controls

= Actual or if unknown, use 45.6%[338]

Hours = Annual hours of cooler or freezer operation

= Assume 8,766 hours per year

BF = Cooling Bonus factor for reduction in waste heat inside of the refrigerated space.

= 1.3 for a refrigerator (medium/high temp), 1.5 for freezers (low temp)[339]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor.

= 0.0001357383[340]

Other variables as defined above.

Savings calculated with default values as defined above.

Door Heater Control Application	ΔkWh/door	ΔkW/door
Refrigerator	668.1	0.0907
Freezer	770.9	0.1046

NATURAL GAS ENERGY SAVINGS

N/A

MEASURE CODE:

[336] The Cadmus Group, *Commercial Refrigeration Loadshape Project Final Report*, Northeast Energy Efficiency Partnerships, Regional Evaluation, Measurement, and Verification Forum, Lexington, MA 2015. Page 75, Table 42.

[337] The Cadmus Group, *Commercial Refrigeration Loadshape Project Final Report*, Northeast Energy Efficiency Partnerships, Regional Evaluation, Measurement, and Verification Forum, Lexington, MA 2015. Page 67, Table 37.

[338] The Cadmus Group, *Commercial Refrigeration Loadshape Project Final Report*, Northeast Energy Efficiency Partnerships, Regional Evaluation, Measurement, and Verification Forum, Lexington, MA 2015. Page 67, Table 37.

[339] The Cadmus Group, Commercial Refrigeration Loadshape Project Final Report, Northeast Energy Efficiency Partnerships, Regional Evaluation, Measurement, and Verification Forum, Lexington, MA 2015. Page 78, Figure 54.

[340] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Refrigeration. See reference “Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf”

2.9.4 Electronically Commutated Motors (ECM) for Walk-in and Reach-in Coolers/Freezers

DESCRIPTION

This measure consists of replacement of an existing, uncontrolled, and continuously operating standard-efficiency shaded-pole evaporator fan motor in refrigerated display cases or fan coil in walk-ins.

This measure achieves savings by installing a more efficient motor, thereby moving the same amount of air with less energy requirements. Additionally, less waste heat is produced, resulting in a decreased refrigeration load.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

This measure applies to the replacement of an existing standard-efficiency shaded-pole evaporator fan motor in refrigerated display cases or fan coil in walk-ins. The replacement unit must be an electronically commutated motor (ECM). Savings assume that efficient motors operate continuously.

DEFINITION OF BASELINE EQUIPMENT

The baseline is the existing shaded-pole motor(s) with no fan control operating 8760 hours continuously in a refrigerated display case or fan coil unit of a walk-in cooling unit.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[341]

DEEMED MEASURE COST

The measure cost is assumed to be $177 per motor for a walk in cooler and walk in freezer, including the cost of the motor plus installation.[342]

LOADSHAPE

Miscellaneous BUS

Algorithm

CALCULATION OF SAVINGS

Savings are based on a measure created by Energy & Resource Solutions for the California Municipal Utilities Association and supported by PGE workpaper PGE3PREF126. Note that climate differences across all California climate zones resulted in negligible savings differences, which indicates that the average savings for the California study should apply equally as well to Missouri. Savings found in the aforementioned source are presented in combination with savings from controllers, however for the purposes of this measure only those associated with the ECM upgrade are considered.

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341 DEER database.

342 Difference in the fully installed cost ($468) for ECM motor and controller, listed in Work Paper PGE3PREF126, "ECM for Walk-In Evaporator with Fan Controller," June 20, 2012, and the measure cost specified in the DEER database for controller ($291).

ELECTRIC ENERGY SAVINGS

ΔkWh = Savings per motor * motors

Where:

Savings per motor[343] = based on the motor rating of the ECM motor:

Evaporator Fan Motor Rating (of ECM)	Annual kWh Savings/motor
16W	408
1/15 - 1/20HP	1,064
1/5HP	1,409
1/3HP	1,994
1/2HP	2,558
3/4HP	2,782

motors = number of fan motors replaced

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, as calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001379439

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[343] See reference workbook “ECM Savings.xlsx” for derivation.

2.9.5 Strip Curtain for Walk-in Coolers and Freezers

DESCRIPTION

This commercial measure pertains to the installation of infiltration barriers (strip curtains) on walk-in coolers or freezers. Strip curtains impede heat transfer from adjacent warm and humid spaces into walk-ins when the main door is opened, thereby reducing the cooling load. As a result, compressor run time and energy consumption are reduced. The engineering assumption is that the walk-in door is open for varying durations per day based on facility type, and the strip curtain covers the entire door frame. All assumptions are based on values that were determined by direct measurement and monitoring of over 100 walk-in units in the 2006-2008 evaluation for the CA Public Utility Commission.[344]

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is a strip curtain added to a walk-in cooler or freezer. The new strip curtain must cover the entire area of the doorway when the door is opened.

DEFINITION OF BASELINE EQUIPMENT

The baseline assumption is a walk-in cooler or freezer that previously had either no strip curtain installed or an old, ineffective strip curtain installed.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 4 years.[345]

DEEMED MEASURE COST

The incremental capital cost for this measure is $10.22/sq ft of door opening.[346]

LOADSHAPE

Refrigeration BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS[347]

$$\Delta kWh = \Delta kWh/sq\ ft * A$$

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[344] The scale factors have been determined with tracer gas measurements on over 100 walk-in refrigeration units during the California Public Utility Commission's evaluation of the 2006-2008 CA investor owned utility energy efficiency programs. The door-open and close times, and temperatures of the infiltrating and refrigerated airs are taken from short term monitoring of over 100 walk-in units. http://www.calmac.org/publications/ComFac_Evaluation_V1_Final_Report_02-18-2010.pdf.

[345] DEER 2014 Effective Useful Life.

[346] The reference for incremental cost is $10.22 per square foot of door opening (includes material and labor). 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Cost Values and Summary Documentation," California Public Utilities Commission, December 16, 2008.

[347] The source algorithm from which the savings per square foot values are determined is based on Tamm's equation (an application of Bernoulli's equation) [Kalterveluste durch kuhlraumoffnungen. Tamm W,.Kaltetechnik-Klimatisierung 1966;18;142-144;] and the ASHRAE handbook [American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE). 2010. ASHRAE Handbook, Refrigeration: 13.4, 13.6].

Where:

ΔkWh/sq ft = Average annual kWh savings per square foot of infiltration barrier. Based on application type, as indicated by the following table:[348]

Type	Pre-Existing Curtains	Energy Savings ΔkWh/sq ft
Supermarket - Cooler	Yes	37
Supermarket - Cooler	No	108
Supermarket - Freezer	Yes	119
Supermarket - Freezer	No	349
Convenience Store - Cooler	Yes	5
Convenience Store - Cooler	No	20
Convenience Store - Freezer	Yes	8
Convenience Store - Freezer	No	27
Restaurant - Cooler	Yes	8
Restaurant - Cooler	No	30
Restaurant - Freezer	Yes	34
Restaurant - Freezer	No	119
Refrigerated Warehouse	Yes	254
Refrigerated Warehouse	No	729

A = Doorway area. Use actual measurements, if unknown assume the following:

Facility Type	Doorway Area (sq ft)
Supermarket - Cooler	35
Supermarket - Freezer	35
Convenience Store - Cooler	21
Convenience Store - Freezer	21
Restaurant - Cooler	21
Restaurant - Freezer	21
Refrigerated Warehouse	80

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001357383[349]

NATURAL GAS ENERGY SAVINGS

N/A

[348] See reference file "Strip Curtain Savings Calcs.docx" for details on derivation.
[349] 2016 Ameren Missouri Coincident Peak Demand Factor for Commercial Refrigeration. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.10 Shell

2.10.1 Windows

DESCRIPTION

Energy and demand saving are realized through the installation of windows that offer performance improvements over baseline windows. Savings may be realized from reducing air infiltration, improved insulating properties, and changes to solar heat gain through the glazed surfaces of the building.

This measure was developed to be applicable to the following program types: RF and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to exceed the efficiency requirements defined by the program.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline is assumed to meet the efficiency requirements set forth by local jurisdictions. In most cases, this will be some version of the IECC. For retrofit applications, the baseline condition is the existing condition and requires assessment of the existing window assemblies.

Local code shall be referenced to define baseline where applicable. As an example, the following is set forth by IECC 2012. An efficient window would have specifications not exceeding these values.

	Climate Zones 4 & 5
U-Factor	
Fixed Windows	0.38 Btu/ft^2.°F.h
Operable Windows	0.45 Btu/ft^2.°F.h
SHGC	0.40

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 20 years.[350]

DEEMED MEASURE COST

For retrofit projects, full installation costs should be used, including both material and labor costs to install the windows.

In all other scenarios, the incremental cost for this measure is assumed to be $1.50 per square foot of window area.[351]

LOADSHAPE

Cooling BUS

Algorithm

[350] Consistent with window measure lives specified by Ameren Missouri and KCP&L.
[351] Alliance to Save Energy Efficiency Windows Collaborative Report, December 2007. Consistent with other market reports.

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

Electric energy savings is calculated as the sum of energy saved when cooling the building and energy saved when heating the building.

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

Heating and cooling savings are composed of three components: infiltration, conduction and solar gains. In instances where infiltration savings do not apply or are not eligible, it may be disregarded.

If central cooling, the electric energy saved in annual cooling due to the added insulation is:

$$\Delta kWh_{cooling} = Infltration_{cooling} + Conduction_{cooling} + Solar_{cooling}$$

$$Infiltration_{cooling} = \frac{(CFM_{Pre} - CFM_{Post}) * 60 * EFLH_{cooling} * \Delta T_{AVG,cooling} * 0.018 * LM}{(1000 * \eta_{cooling})}$$

CFM_{Pre} = Infiltration at natural conditions as estimated by blower door testing before window upgrade

= Actual

CFM_{Post} = Infiltration at natural conditions as estimated by blower door testing after window upgrade

= Actual

60 = Converts Cubic Feet per Minute to Cubic Feet per Hour

$EFLH_{cooling}$ = Equivalent Full Load Hours for Cooling [hr] are provided in Section 2.7, HVAC End Use

$\Delta T_{AVG,cooling}$ = Average temperature difference [^{0}F] during cooling season between outdoor air temperature and assumed 75^{0}F indoor air temperature:

Weather Basis (City based upon)	$OA_{AVG,cooling}$ [°F][352]	$\Delta T_{AVG,cooling}$ [°F]
St Louis, MO	80.8	5.8

0.018 = Specific Heat Capacity of Air (Btu/ft^3 °F)

LM = Latent Multiplier to account for latent cooling demand: [353]

[352] National Solar Radiation Data Base -- 1991- 2005 Update: Typical Meteorological Year 3 http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html. Heating Season defined as September 17th through April 13th, cooling season defined as May 20 through August 15th. For cooling season, temperatures from 8AM to 8PM were used to establish average temperatures as this is when cooling systems are expected to be loaded.

[353] The Latent Multiplier is used to convert the sensible cooling savings calculated to a value representing sensible and latent cooling loads. The values are derived from the methodology outlined in Infiltration Factor Calculation Methodology by Bruce Harley, Senior Manager, Applied Building Science, CLEAResult 11/18/2015 and is based upon an 8760 analysis of sensible and total heat loads using hourly climate data.

Weather Basis (City based upon)	LM
St Louis, MO	3.0

1,000 = Conversion from Btu to kBtu

$\eta_{cooling}$ = Seasonal energy efficiency ratio (SEER) of cooling system (kBtu/kWh)

= Actual

$$Conduction_{\text{cooling}} = \frac{(U_{base} - U_{eff}) * A_{window} * EFLH_{cooling} * \Delta T_{AVG,cooling}}{(1{,}000 * \eta_{cooling})}$$

Where:

U_{base} = U-factor value of baseline window assembly (Btu/ft^2.°F.h)

= Dependent on Weather Basis and window type. See table below for IECC 2012 requirements:

U_{eff} = U-factor value of the efficient window assembly (Btu/ft^2.°F.h)

= Actual.

A_{window} = Area of insulated window (including visible frame and glass) (ft^2)

Other variables as defined above.

$$Solar_{\text{cooling}} = \frac{(SHGC_{base} - SHGC_{eff}) * A_{window} * \psi_{cooling}}{(1{,}000 * \eta_{cooling})}$$

Where:

$SHGC_{base}$ = Solar Heat Gain Coefficient of the baseline window assembly (fractional)

$SHGC_{eff}$ = Solar Heat Gain Coefficient of the efficient window assembly (fractional)

$\Psi_{cooling}$ = Incident solar radiation during the cooling season (Btu/ft^2):[354]

Weather Basis (City based upon)	$\Psi_{cooling}$
St Louis, MO	40996

Other variables as defined above.

If the building is heated with electric heat (resistance or heat pump), the electric energy saved in annual heating due to the window upgrade is:

$$\Delta\text{kWh}_{\text{heating}} = Infltration_{heating} + Conduction_{heating} - Solar_{heating}$$

[354] See "Windows SHG.xlsx" for derivation.

$$Infiltration_{\text{heating}} = \frac{(CFM_{Pre} - CFM_{Post}) * 60 * EFLH_{heating} * \Delta T_{AVG,heating} * 0.018}{(3{,}412 * \eta_{heating})}$$

Where:

$EFLH_{heating}$ = Equivalent Full Load Hours for Heating [hr] are provided in Section 2.7, HVAC end use

$\Delta T_{AVG,heating}$ = Average temperature difference [^{0}F] during heating season between outdoor air temperature and assumed 55^{0}F heating base temperature

Weather Basis (City based upon)	$OA_{AVG,heating}$ [°F][355]	$\Delta T_{AVG,heating}$ [°F]
St Louis, MO	43.2	11.8

3,412 = Conversion from Btu to kWh.

$\eta_{heating}$ = Efficiency of heating system

= Actual. Note: electric resistance heating and heat pumps will have an efficiency greater than or equal to 100%

Other variables as defined above.

$$Conduction_{\text{heating}} = \frac{\left(U_{base} - U_{eff}\right) * A_{window} * EFLH_{heating} * \Delta T_{AVG,heating}}{(3{,}412 * \eta_{heating})}$$

Variables as defined above.

$$Solar_{\text{heating}} = \frac{\left(SHGC_{base} - SHGC_{eff}\right) * A_{window} * \psi_{heating}}{(3{,}412 * \eta_{heating})}$$

Where:

$\Psi_{heating}$ = Incident solar radiation during the heading season (Btu/ft^2):

Weather Basis (City based upon)	$\Psi_{cooling}$
St Louis, MO	66592

Other variables as defined above.

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWH_{cooling} * CF$$

Where:

[355] National Solar Radiation Data Base -- 1991- 2005 Update: Typical Meteorological Year 3 http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html. Heating Season defined as September 17th through April 13th, cooling season defined as May 20 through August 15th. For cooling season, temperatures from 8AM to 8PM were used to establish average temperatures as this is when cooling systems are expected to be loaded.

$\Delta kWH_{cooling}$ = Annual electricity savings for cooling, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor for Cooling

= 0.000910684

NATURAL GAS SAVINGS

If building uses a gas heating system, the savings resulting from the window assembly is calculated with the following formula.

$$\Delta \text{Therms} = Infltration_{gasheating} + Conduction_{gasheating} - Solar_{gasheating}$$

$$Infiltration_{\text{gasheating}} = \frac{(CFM_{Pre} - CFM_{Post}) * 60 * EFLH_{heating} * \Delta T_{AVG,heating} * 0.018}{(100{,}000 * \eta_{heat})}$$

Where:

100,000 = Conversion from BTUs to Therms

η_{heat} = Efficiency of heating system

= Actual

Other variables as defined above.

$$Conduction_{\text{gasheating}} = \frac{(U_{base} - U_{eff}) * A_{window} * EFLH_{heating} * \Delta T_{AVG,heating}}{(100{,}000 * \eta_{heat})}$$

$$Solar_{\text{gasheating}} = \frac{(SHGC_{base} - SHGC_{eff}) * A_{window} * \psi_{heating}}{(100{,}000 * \eta_{heat})}$$

Variables as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

2.10.2 Ceiling and Wall Insulation

DESCRIPTION

Energy and demand saving are realized through reductions in the building cooling and heating loads.

This measure was developed to be applicable to the following program types: RF and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to exceed the efficiency requirements defined by the program.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline is assumed to meet the efficiency requirements set forth by local jurisdictions. In most cases, this will be some version of IECC. For retrofit applications, the baseline condition is the existing condition and requires assessment of the existing insulation. It should be based on the entire wall assembly.

Local code shall be referenced to define baseline where applicable. As an example, the following is set forth by IECC 2012:

	ASHRAE/IECC Climate Zone 5 (A, B, C) Nonresidential	
	Assembly Maximum	**Insulation Min. R-Value**
Mass	U-0.078	R-11.4 ci
Metal Building	U-0.052	R-13 + R-13 ci
Metal Framed	U-0.064	R-13 + R-7.5 ci
Wood Framed and Other	U-0.064	R-13 + R-3.8 ci or R-20

	ASHRAE/IECC Climate Zone 6 (A, B, C) Nonresidential	
	Assembly Maximum	**Insulation Min. R-Value**
Mass	U-0.078	R-13.1 ci
Metal Building	U-0.052	R-13 + R-13 ci
Metal Framed	U-0.064	R-13 + R-7.5 ci
Wood Framed and Other	U-0.051	R-13 + R-7.5 ci or R-20 + R-3.8 ci

Note: ci = continuous insulation

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure expected useful life (EUL) is assumed to be 20 years per DEER 2008. This is consistent with SDG&E's 9th Year Measure Retrofit Study (1996 & 1997 Residential Weatherization Programs), CPUC's Energy Efficiency Policy Manual v.2, and GDS's Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures (June 2007).

Deemed Measure Cost

For retrofit projects, full installation costs should be used.

For new construction projects, costs should be limited to incremental material and labor costs associated with the portion of insulation that exceeds code requirements.

Loadshape

HVAC BUS

Algorithm

Calculation of Energy Savings

Electric Energy Savings

Electric energy savings is calculated as the sum of energy saved when cooling the building and energy saved when heating the building

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

If central cooling, the electric energy saved in annual cooling due to the added insulation is

$$\Delta kWh_{cooling} = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * Area * CRF * EFLH_{cooling} * \Delta T_{AVG,cooling}}{(1{,}000 * \eta_{cooling})}$$

Where:

$R_{existing}$ = Assembly heat loss coefficient with existing insulation [(hr-^{0}F-ft^2)/Btu]

R_{new} = Assembly heat loss coefficient with new insulation [(hr-^{0}F-ft^2)/Btu]

Area = Area of the surface in square feet.

CRF = Correction Factor. Adjustment to account for the effects the framing has on the overall assembly R-value, when cavity insulation is used.

= 100% if Spray Foam or External Rigid Foam

= 50% if studs and cavity insulation[356]

$EFLH_{cooling}$ = Equivalent Full Load Hours for Cooling [hr] are provided in Section 2.7, HVAC End Use

$\Delta T_{AVG,cooling}$ = Average temperature difference [^{0}F] during cooling season between outdoor air temperature and assumed 75^{0}F indoor air temperature

Weather Basis (City based upon)	$OA_{AVG,cooling}$ [°F][357]	$\Delta T_{AVG,cooling}$ [°F]
St Louis, MO	80.8	5.8

356 Consistent with the information listed in ASHRAE, 2001, Table 5-1 Wall Sections with Steel Studs Parallel Path Correction Factors and experimental findings by the Oak Ridge National Laboratory, "Couple Secrets about How Framing is Effecting the Thermal Performance of Wood and Steel-Framed Walls."

357 National Solar Radiation Data Base -- 1991- 2005 Update: Typical Meteorological Year 3 http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html. Heating Season defined as September 17th through April 13th, cooling season defined as May 20 through August 15th. For cooling season, temperatures from 8AM to 8PM were used to establish average temperatures as this is when cooling systems are expected to be loaded.

1,000 = Conversion from Btu to kBtu

$\eta_{cooling}$ = Seasonal energy efficiency ratio (SEER) of cooling system (kBtu/kWh)

= Actual

If the building is heated with electric heat (resistance or heat pump), the electric energy saved in annual heating due to the added insulation is:

$$\Delta kWh_{heating} = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * Area * CRF * EFLH_{heating} * \Delta T_{AVG,heating}}{(3{,}412 * \eta_{heating})}$$

Where:

$EFLH_{heating}$ = Equivalent Full Load Hours for Heating [hr] are provided in Section 2.7, HVAC end use

$\Delta T_{AVG,heating}$ = Average temperature difference [^{0}F] during heating season between outdoor air temperature and assumed 55^{0}F heating base temperature

Weather Basis (City based upon)	$OA_{AVG,heating}$ [°F][358]	$\Delta T_{AVG,heating}$ [°F]
St Louis, MO	43.2	11.8

3,412 = Conversion from Btu to kWh.

$\eta_{heating}$ = Efficiency of heating system

= Actual. *Note: electric resistance heating and heat pumps will have an efficiency greater than or equal to 100%*

If the building is heated with a gas furnace, there will be some electric savings in heating the building attributed to extra insulation since the furnace fans will run less.

$$\Delta kWh_{heating} = \Delta Therms * Fe * 29.3$$

Where:

ΔTherms = Gas savings calculated with equation below.

Fe = Percentage of heating energy consumed by fans, assume 3.14%[359]

29.3 = Conversion from therms to kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWH_{cooling} * CF$$

Where:

$\Delta kWH_{cooling}$ = Annual electricity savings for cooling, as calculated above

[358] National Solar Radiation Data Base -- 1991- 2005 Update: Typical Meteorological Year 3 http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html. Heating Season defined as September 17th through April 13th, cooling season defined as May 20 through August 15th. For cooling season, temperatures from 8AM to 8PM were used to establish average temperatures as this is when cooling systems are expected to be loaded.

[359] F_e is not one of the AHRI certified ratings provided for furnaces, but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300 record sample (non-random) out of 1495 was 3.14% for residential units. This is, appropriately, ~50% greater than the Energy Star® version 3 criteria for 2% F_e. See "Programmable Thermostats Furnace Fan Analysis.xlsx" for reference. Assumed to be consistent with C&I applications.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor for Cooling

= 0.0004439830

NATURAL GAS SAVINGS

If building uses a gas heating system, the savings resulting from the insulation is calculated with the following formula.

$$\Delta \text{Therms} = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * Area * CRF * EFLH_{heating} * \Delta T_{AVG,heating}}{(100{,}000 * \eta_{heat})}$$

Where:

$R_{existing}$ = Assembly heat loss coefficient with existing insulation [(hr-^{0}F-ft^2)/Btu]

R_{new} = Assembly heat loss coefficient with new insulation [(hr-^{0}F-ft^2)/Btu]

Area = Area of the surface in square feet. Assume 1000 sq ft for planning.

$EFLH_{heating}$ = Equvalent Full Load Hours for Heating are provided in Section 2.7, HVAC end use

$\Delta T_{AVG,heating}$ = Average temperature difference [^{0}F] during heating season (see above)

100,000 = Conversion from BTUs to Therms

η_{heat} = Efficiency of heating system

= Actual

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

Measure Code:

Volume 3: Residential Measures

Ameren Missouri TRM – Volume 3: Residential Measures Revision Log

Revision	Date	Description
1.0	05/30/2018	Initial version filed for Commission approval.

Volume 3: Residential Measures

3.1 Appliances

3.1.1 Refrigerator and Freezer Recycling

DESCRIPTION

This measure describes savings from the retirement and recycling of inefficient but operational refrigerators and freezers. Savings are provided in two ways. First, a regression equation is provided that requires the use of key inputs describing the retired unit (or population of units) and is based on a 2013 workpaper provided by Cadmus using data from a 2012 ComEd metering study and metering data from a Michigan study. The second methodology is a deemed approach based on 2011 Cadmus analysis of data from a number of evaluations.[1]

The savings are equivalent to the unit energy consumption of the retired unit and should be claimed for the assumed remaining useful life of that unit. A Part Use Factor is applied to account for those secondary units that are not in use throughout the entire year. The user should note that the regression algorithm is designed to provide an accurate portrayal of savings for the population as a whole and includes those parameters that have a significant effect on the consumption. The precision of savings for individual units will vary. This measure also includes a section accounting for the interactive effect of reduced waste heat on the heating and cooling loads.

This measure was developed to be applicable to the following program type: ERET.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

N/A

DEFINITION OF BASELINE EQUIPMENT

The existing inefficient unit must be operational and have a capacity of between 10 and 30 cubic feet.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The estimated remaining useful life of the recycling units is 8 years.[2]

DEEMED MEASURE COST

Measure cost includes the cost of pickup and recycling of the refrigerator and should be based on actual costs of running the program. If unknown, assume $140 per unit.[3]

LOADSHAPE

Refrigeration RES
Freezer RES

Algorithm

CALCULATION OF SAVINGS

ENERGY SAVINGS

Regression analysis: Refrigerators

[1] Cadmus "2010 Residential Great Refrigerator Roundup Program – Impact Evaluation," 2011.
[2] KEMA "Residential Refrigerator Recycling Ninth Year Retention Study," 2004.
[3] Based on average program costs for SCE Refrigerator Appliance Recycling Program. Innovologie, "Appliance Recycling Program Retailer Trial Final Report," a report prepared for Southern California Edison, 2013.

Daily energy savings for refrigerators are based upon a linear regression model using the following coefficients:[4]

Independent Variable Description	Estimate Coefficient
Intercept	0.5822
Age (years)	0.0269
Pre-1990 (=1 if manufactured pre-1990)	1.0548
Size (cubic feet)	0.0673
Dummy: Side-by-Side (= 1 if side-by-side)	1.0706
Dummy: Single Door (= 1 if single door)	-1.9767
Dummy: Primary Usage Type (in absence of the program) (= 1 if primary unit)	0.6046
Interaction: Located in Unconditioned Space x CDD/365	0.0200
Interaction: Located in Unconditioned Space x HDD/365	-0.0447

$$\Delta kWh_{Unit} = \Big[0.5822 + (Age * 0.0269) + (Pre-1990 * 1.0548) + (Size * 0.0673) + (Side-by-side * 1.0706) + (Single-door * -1.9767) + (Primary\ Usage * 0.6046) + \left(\frac{CDD}{365} * Unconditioned * 0.0200\right) + \left(\frac{HDD}{365} * Unconditioned * -0.0447\right)\Big] * Days * \ Part\ Use\ Factor$$

Where:

Age = Age of retired unit
Pre-1990 = Pre-1990 dummy (=1 if manufactured pre-1990, else 0)
Size = Capacity (cubic feet) of retired unit
Side-by-Side = Side-by-side dummy (= 1 if side-by-side, else 0)
Single-Door = Single-door dummy (= 1 if single-door, else 0)
Primary Usage = Primary Usage Type (in absence of the program) dummy (= 1 if Primary, else 0)
CDD = Cooling Degree Days
= 1678:[5]

Unconditioned = If unit in unconditioned space = 1, otherwise 0
HDD = Heating Degree Days
= 4486[6]
Days = Days per year
= 365
Part Use Factor = To account for those units that are not running throughout the entire year. If available, Part-Use Factor participant survey results should be used. If not available, assume 0.87.[7]

<u>Deemed approach: Refrigerators</u>

$$\Delta kWh_{Unit} = UEC * Part\ Use\ Factor$$

Where:

UEC = Unit Energy Consumption
= 1181 kWh[8]
Part Use Factor = To account for those units that are not running throughout the entire year. If available, Part-Use Factor participant survey results should be used. If not available, assume 0.87.[9]
ΔkWh_{Unit} = 1181 * 0.87
= 1028 kWh

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[4] Coefficients provided in May 13, 2016, Cadmus evaluation report; Ameren Missouri Refrigerator Recycling Impact and Process Evaluation: Program Year 2015.
[5] Based on climate normals CDD data, with a base temp of 65°F.
[6] Based on climate normals HDD data, with a base temp of 65°F.
[7] Most recent refrigerator Part Use Factor from Ameren Missouri PY15 evaluation.
[8] This value is taken from the 2016 Cadmus evaluation of Ameren Missouri Refrigerator Recycling Program Year 2015.
[9] Most recent refrigerator Part Use Factor from Ameren Missouri PY15 evaluation.

Regression analysis: Freezers:

Daily energy savings for freezers are based upon a linear regression model using the following coefficients:[10]

Independent Variable Description	Estimate Coefficient
Intercept	-0.8918
Age (years)	0.0384
Pre-1990 (=1 if manufactured pre-1990)	0.6952
Size (cubic feet)	0.1287
Chest Freezer Configuration (=1 if chest freezer)	0.3503
Interaction: Located in Unconditioned Space x CDD	0.0695
Interaction: Located in Unconditioned Space x HDD	-0.0313

$$\Delta kWh_{Unit} = [-0.8918 + (Age * 0.0384) + (Pre-1990 * 0.6952) + (Size * 0.1287) + (Chest\ Freezer * 0.3503) + (CDD/365 * Unconditioned * 0.0695) + (HDD/365 * Unconditioned * -0.0313)] * Part\ Use\ Factor$$

Where:

Age = Age of retired unit

Pre-1990 = Pre-1990 dummy (=1 if manufactured pre-1990, else 0)

Size = Capacity (cubic feet) of retired unit

Chest Freezer = Chest Freezer dummy (= 1 if chest freezer, else 0)

CDD = Cooling Degree Days (see table in refrigerator section)

Unconditioned = If unit in unconditioned space = 1, otherwise 0

HDD = Heating Degree Days (see table in refrigerator section)

Days = Days per year
= 365

Part Use Factor = To account for those units that are not running throughout the entire year. If available, Part-Use Factor participant survey results should be used. If not available, assume 0.84.[11]

Deemed approach: Freezers

$$\Delta kWh_{Unit} = UEC * Part\ Use\ Factor$$

Where:

$UEC_{Reitred}$ = Unit Energy Consumption of retired unit
= 1061 kWh[12]

Part Use Factor = To account for those units that are not running throughout the entire year. If available, Part-Use Factor participant survey results should be used. If not available, assume 0.84.[13]

ΔkWh_{Unit} = 1061 * 0.85
= 891 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{unit} * CF$$

Where:

ΔkWh_{unit} = Savings provided in algorithm above (not including $\Delta kWh_{wasteheat}$)

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor[14]
Refrigerators = 0.0001285253
Freezers = 0.0001285253

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[10] Coefficients provided in May 13, 2016, Cadmus evaluation report; Ameren Missouri Refrigerator Recycling Impact and Process Evaluation: Program Year 2015.
[11] Most recent refrigerator Part Use Factor from Ameren Missouri PY15 evaluation.
[12] This value is taken from the 2016 Cadmus evaluation of Ameren Missouri refrigerator recycling program year 2015.
[13] Most recent refrigerator part-use factor from Ameren Missouri PY15 evaluation.
[14] Based on Ameren Missouri 2016 Loadshape for Residential Refrigeration and Freezer End-Use.

NATURAL GAS SAVINGS

$$\Delta Therms = \Delta kWh_{Unit} * WHFeHeatGas * \ 0.03412$$

Where:

ΔkWh_{Unit} = kWh savings calculated from either method above, not including the $\Delta kWh_{WasteHeat}$

WHFeHeatGas = Waste Heat Factor for Energy to account for gas heating increase from removing waste heat from refrigerator/freezer

= - (HF / $\eta Heat_{Gas}$) * %GasHeat

If unknown, assume 0

HF = Heating Factor or percentage of reduced waste heat that must now be heated

= 58% for unit in heated space[15]

= 0% for unit in heated space or unknown

$\eta Heat_{Gas}$ = Efficiency of heating system

=71%[16]

%GasHeat = Percentage of homes with gas heat

Heating Fuel	%GasHeat
Electric	0%
Gas	100%
Unknown	65%[17]

0.03412 = Converts kWh to therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[15] Based on 212 days where HDD 65>0, divided by 365.25.

[16] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences. The predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey). In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 16 years ago provide a reasonable proxy for the current mix of furnaces in the state. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

[17] Based on data from Energy Information Administration, 2009 Residential Energy Consumption Survey, see "HC6.9 Space Heating in Midwest Region.xls."

3.1.2 Air Purifier/Cleaner

DESCRIPTION

An air purifier (cleaner) meeting the efficiency specifications of ENERGY STAR® is purchased and installed in place of a model meeting the current federal standard.

This measure was developed to be applicable to the following program types: TOS and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is defined as an air purifier meeting the efficiency specifications of ENERGY STAR® as provided below.

1. Must produce a minimum 50 Clean Air Delivery Rate (CADR) for Dust[18] to be considered under this specification.
2. Minimum Performance Requirement: = 2.0 CADR/Watt (Dust)
3. Standby Power Requirement: = 2.0 Watts Qualifying models that perform secondary consumer functions (e.g., clock, remote control) must meet the Standby Power Requirement.
4. UL Safety Requirement: Models that emit ozone as a byproduct of air cleaning must meet UL Standard 867 (ozone production must not exceed 50ppb)

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is assumed to be a conventional unit.[19]

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life is assumed to be 9 years.[20]

DEEMED MEASURE COST

The incremental cost for this measure is $70.[21]

LOADSHAPE

Miscellaneous RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS[22]

$$Energy\ Savings\ (kWh\ Year)=\{CADR \times (1EffBL-1EffES)\times(Hroper)+(SBBL-SBES)\times(24-Hroper)\}\times 365/1000$$

Where:

CADR = Clean air recovery rate for dust

EffBL = Clean air recovery rate for dust per watt for baseline unit

EffES = Clean air recovery rate for dust per watt for ENERGY STAR® unit

Hroper = Hours per day of operation

SBBL = Standby for baseline unit

SBES = Standby for ENERGY STAR® unit

365 = Days/year

[18] Measured according to the latest ANSI/AHAM AC-1 (AC-1) Standard.

[19] As defined as the average of non-ENERGY STAR® products found in EPA research, 2011, ENERGY STAR® Qualified Room Air Cleaner Calculator.

[20] ENERGY STAR® Qualified Room Air Cleaner Calculator.

[21] Ameren Missouri MEEIA 2016-18 TRM, January 1, 2018.

[22] ENERGY STAR® Qualified Room Air Cleaner Calculator.

1,000 = CONVERSION FACTOR (WH/KWH)

Term	Value
CADR	144.42
EFF_{BL}	1.00
EFF_{ES}	2.91
Hr_{oper}	16
SB_{BL}	1.00
SB_{ES}	0.293

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Gross customer annual kWh savings for the measure

CF = 0.0004660805

NATURAL GAS SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

There are no operation and maintenance cost adjustments for this measure.[23]

MEASURE CODE:

[23] Some types of room air cleaners require filter replacement or periodic cleaning, but this is likely to be true for both efficient and baseline units and so no difference in cost is assumed.

3.1.3 Clothes Dryer

DESCRIPTION

This measure relates to the installation of a residential clothes dryer meeting the ENERGY STAR® criteria. ENERGY STAR® qualified clothes dryers save energy through a combination of more efficient drying and reduced runtime of the drying cycle. More efficient drying is achieved through increased insulation, modifying operating conditions such as air flow and/or heat input rate, improving air circulation through better drum design or booster fans, and improving efficiency of motors. Reducing the runtime of dryers through automatic termination by temperature and moisture sensors is believed to have the greatest potential for reducing energy use in clothes dryers.[24] ENERGY STAR® provides criteria for both gas and electric clothes dryers.

This measure was developed to be applicable to the following program types: TOS and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

Clothes dryer must meet the ENERGY STAR® criteria, as required by the program.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is a clothes dryer meeting the minimum federal requirements for units manufactured on or after January 1, 2015.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 14 years.[25]

DEEMED MEASURE COST

Dryer Size	Incremental Cost[26]
Standard	$75
Compact	$105

LOADSHAPE

Miscellaneous RES

[24] ENERGY STAR® Market & Industry Scoping Report. Residential Clothes Dryers. Table 8. November 2011. http://www.energystar.gov/ia/products/downloads/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf

[25] Based on an average estimated range of 12-16 years. ENERGY STAR® Market & Industry Scoping Report. Residential Clothes Dryers. November 2011. http://www.energystar.gov/ia/products/downloads/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf

[26] Cost based on ENERGY STAR® Savings Calculator for ENERGY STAR® Qualified Appliances. https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{Load}{CEFbase} - \frac{Load}{CEFeff}\right) * Ncycles * \%Electric$$

Where:

Load = The average total weight (lbs) of clothes per drying cycle. If dryer size is unknown, assume standard.

Dryer Size	Load (lbs)[27]
Standard	8.45
Compact	3

CEFbase = Combined energy factor (CEF) (lbs/kWh) of the baseline unit is based on existing federal standards energy factor and adjusted to CEF as performed in the ENERGY STAR® analysis.[28] If product class unknown, assume electric, standard.

Product Class	CEFbase
Vented Electric, Standard (≥ 4.4 ft^3)	3.11
Vented Electric, Compact (120V) (< 4.4	3.01
Vented Electric, Compact (240V) (<4.4	2.73
Ventless Electric, Compact (240V) (<4.4	2.13
Vented Gas	2.84[29]

CEFeff = CEF (lbs/kWh) of the ENERGY STAR® unit based on ENERGY STAR® requirements.[30] If product class unknown, assume electric, standard.

Product Class	CEFeff
Vented or Ventless Electric, Standard (≥ 4.4 ft^3)	3.93
Vented or Ventless Electric, Compact (120V) (< 4.4	3.80
Vented Electric, Compact (240V) (< 4.4 ft^3)	3.45
Ventless Electric, Compact (240V) (< 4.4 ft^3)	2.68
Vented Gas	3.48[31]

Ncycles = Number of dryer cycles per year. Use actual data if available. If unknown, use 283 cycles per year.[32]

%Electric = The percent of overall savings coming from electricity

= 100% for electric dryers, 5% for gas dryers[33]

Using defaults provided above:

Product Class	kWh
Vented Electric, Standard (≥ 4.4 ft^3)	145.7
Vented Electric, Compact (120V) (< 4.4 ft^3)	53.8
Vented Electric, Compact (240V) (<4.4 ft^3)	58.9
Ventless Electric, Compact (240V) (<4.4 ft^3)	74.3
Vented Gas	7.0

[27] Based on ENERGY STAR® test procedures. https://www.energystar.gov/index.cfm?c=clothesdry.pr_crit_clothes_dryers
[28] ENERGY STAR® Draft 2 Version 1.0 Clothes Dryers Data and Analysis.
[29] Federal standards report CEF for gas clothes dryers in terms of lbs/kWh. To determine gas savings, this number is later converted to therms.
[30] ENERGY STAR® Clothes Dryers Key Product Criteria. https://www.energystar.gov/index.cfm?c=clothesdry.pr_crit_clothes_dryers
[31] Federal standards report CEF for gas clothes dryers in terms of lbs/kWh. To determine gas savings, this number is later converted to therms.
[32] Appendix D to Subpart B of Part 430 – Uniform Test Method for Measuring the Energy Consumption of Dryers.
[33] One hundred percent for electric dryers accounts for the fact that some of the savings on gas dryers comes from electricity (motors, controls, etc.). Five percent for gas dryers was determined using a ratio of the electric to total savings from gas dryers given by ENERGY STAR® Draft 2 Version 1.0 Clothes Dryers Data and Analysis. Value reported in 2015 EPA ENERGY STAR® appliance calculator.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy Savings as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0001148238

Using defaults provided above:

Product Class	kW
Vented Electric, Standard (≥ 4.4 ft^3)	0.0251
Vented Electric, Compact (120V) (< 4.4	0.0092
Vented Electric, Compact (240V) (<4.4 ft^3)	0.0101
Ventless Electric, Compact (240V) (<4.4	0.0128
Vented Gas	0.0012

NATURAL GAS ENERGY SAVINGS

Natural gas savings only apply to ENERGY STAR® vented gas clothes dryers.

$$\Delta Therm = \left(\frac{Load}{CEFbase} - \frac{Load}{CEFeff}\right) * Ncycles * Therm\_convert * \%Gas$$

Where:

Therm_convert = Conversion factor from kWh to therm
= 0.03413

%Gas = Percent of overall savings coming from gas
= 0% for electric units and 84% for gas units[34]

Using defaults provided above:

ΔTherm = (8.45/2.84 – 8.45/3.48) * 257 * 0.03413 * 0.84
= 4.03 therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[34] Zero percent for gas dryers accounts for the fact that some of the savings on gas dryers comes from electricity (motors, controls, etc.). Eighty-four percent was determined using a ratio of the gas to total savings from gas dryers given by ENERGY STAR® Draft 2 Version 1.0 Clothes Dryers Data and Analysis.

3.1.4 Clothes Washer

DESCRIPTION

This measure relates to the installation of a clothes washer meeting the ENERGY STAR® (CEE Tier1), ENERGY STAR® Most Efficient (CEE Tier 2), or CEE Tier 3 minimum qualifications. If the Domestic Hot Water (DHW) and dryer fuels of the installations are unknown (for example through a retail program), savings are based on a weighted blend using RECS data (the resultant values (kWh, therms and gallons of water) are provided). The algorithms can also be used to calculate site-specific savings where DHW and dryer fuels are known.

This measure was developed to be applicable to the following program types: TOS and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

Clothes washer must meet the ENERGY STAR® (CEE Tier1), ENERGY STAR® Most Efficient (CEE Tier 2), or CEE Tier 3 minimum qualifications (provided in the table below), as required by the program.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is a standard-sized clothes washer meeting the minimum federal baseline as of March 2015.[35]

Efficiency Level		Top loading >2.5 Cu ft	Front Loading >2.5 Cu ft
Baseline	Federal Standard	≥1.29 IMEF, ≤8.4 IWF	≥1.84 IMEF, ≤4.7 IWF
Efficient	ENERGY STAR®, CEE Tier 1	≥2.06 IMEF, ≤4.3 IWF	≥2.38 IMEF, ≤3.7 IWF
	ENERGY STAR® Most Efficient, CEE Tier 2	≥2.76 IMEF, ≤3.5 IWF	≥2.74 IMEF, ≤3.2 IWF
	CEE Tier 3	≥2.92 IMEF, ≤3.2 IWF	

The Integrated Modified Energy Factor (IMEF) includes unit operation, standby, water heating, and drying energy use, with the higher the value the more efficient the unit: "The quotient of the cubic foot (or liter) capacity of the clothes container divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption, the energy required for removal of the remaining moisture in the wash load, and the combined low-power mode energy consumption." The Integrated Water Factor (IWF) indicates the total water consumption of the unit, with the lower the value the less water required: "The quotient of the total weighted per-cycle water consumption for all 67 wash cycles in gallons divided by the cubic foot (or liter) capacity of the clothes washer."[36]

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 14 years.[37]

DEEMED MEASURE COST

The incremental cost assumptions are provided below:[38]

Efficiency Level	Incremental Cost
ENERGY STAR®, CEE Tier 1	$32
ENERGY STAR® Most Efficient, CEE TIER 2	$393
CEE TIER 3	$454

[35] See http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/39.
[36] Definitions provided in ENERGY STAR® v7.1 specification on the ENERGY STAR® website.
[37] Based on DOE Chapter 8 Life-Cycle Cost and Payback Period Analysis.
[38] Based on weighted average of top loading and front loading units (based on available product from the California Energy Commission (CEC) Appliance database (https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx) and cost data from Life-Cycle Cost and Payback Period Excel-based analytical tool. See "2015 Clothes Washer Analysis.xls" for details.

LOADSHAPE

Miscellaneous RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left[\left(Capacity * \frac{1}{IMEFbase} * Ncycles\right) * \left(\%CWbase + (\%DHWbase * \%Electric_{DHW}) + \left(\%Dryerbase * \%Electric_{Dryer}\right)\right)\right] - \left[\left(Capacity * \frac{1}{IMEFeff} * Ncycles\right) * \left(\%CWeff + (\%DHWeff * \%Electric_{DHW}) + \left(\%Dryereff * \%Electric_{Dryer}\right)\right)\right]$$

Where:

Capacity = Clothes washer capacity (cubic feet)

= Actual - If capacity is unknown, assume 3.45 cubic feet [39]

IMEFbase = Integrated Modified Energy Factor of baseline unit

Efficiency Level	IMEFbase		
	Top loading >2.5 Cu ft	Front Loading >2.5 Cu ft	Weighted Average[40]
Federal Standard	1.29	1.84	1.66

IMEFeff = Integrated Modified Energy Factor of efficient unit

= Actual. If unknown, assume average values provided below.

Efficiency Level	IMEFeff		
	Top loading >2.5 Cu ft	Front Loading >2.5 Cu ft	Weighted Average[41]
ENERGY STAR®, CEE Tier 1	2.06	2.38	2.26
ENERGY STAR® Most Efficient, CEE Tier 2	2.76	2.74	2.74
CEE Tier 3	2.92		2.92

Ncycles = Number of Cycles per year

= 271[42]

%CW = Percentage of total energy consumption for Clothes Washer operation (different for baseline and efficient unit – see table below)

[39] Based on the average clothes washer volume of all units that pass the new federal standard on the CEC database of clothes washer products (accessed on 08/28/2014). If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

[40] Weighted average IMEF of Federal Standard rating for Front Loading and Top Loading units. Weighting is based upon the relative top v front loading percentage of available non-ENERGY STAR® product in the CEC database (accessed 08/28/2014). The relative weightings are as follows, see more information in "2015 Clothes Washer Analysis.xlsx":

Efficiency Level	Front	Top
Baseline	67%	33%
ENERGY STAR®, CEE Tier 1	62%	38%
ENERGY STAR® Most Efficient, CEE Tier 2	98%	2%
CEE Tier 3	100%	0%

[41] Weighting is based upon the relative top vs. front loading percentage of available product in the CEC database (accessed 08/28/2014).

[42] Weighted average of 271 clothes washer cycles per year (based on 2009 Residential Energy Consumption Survey (RECS) national sample survey of housing appliances section, Midwest Census Region for state of Missouri): http://www.eia.gov/consumption/residential/data/2009/. See "2015 Clothes Washer Analysis.xls" for details.

If utilities have specific evaluation results providing a more appropriate assumption for single family or multifamily homes in a particular market or geographical area, then that should be used.

%DHW = Percentage of total energy consumption used for water heating (different for baseline and efficient unit – see table below)
%Dryer = Percentage of total energy consumption for dryer operation (different for baseline and efficient unit – see table below)

	Percentage of Total Energy Consumption[43]		
	%CW	%DHW	%Dryer
Federal Standard	8%	31%	61%
ENERGY STAR®, CEE Tier 1	8%	23%	69%
ENERGY STAR® Most Efficient, CEE Tier 2	14%	10%	76%
CEE Tier 3	14%	10%	76%

$\%Electric_{DHW}$ = Percentage of DHW savings assumed to be electric

DHW fuel	$\%Electric_{DHW}$
Electric	100%
Natural Gas	0%
Unknown	43%[44]

$\%Electric_{Dryer}$ = Percentage of dryer savings assumed to be electric

Dryer fuel	$\%Electric_{Dryer}$
Electric	100%
Natural Gas	0%
Unknown	90%[45]

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:[46]
Front Loaders:

	ΔkWH			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	149.3	52.6	96.4	-0.2
ENERGY STAR® Most Efficient, CEE Tier 2	222.1	85.9	132.2	-4.0
CEE Tier 3	243.1	104.8	137.2	-1.1

Top Loaders:

	ΔkWH			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	149.3	97.0	77.0	24.8
ENERGY STAR® Most Efficient, CEE Tier 2	222.1	132.6	117.1	27.5
CEE Tier 3	243.1	374.4	230.5	42.0

[43] The percentage of total energy consumption that is used for the machine, heating the hot water, or by the dryer is different depending on the efficiency of the unit. Values are based on a weighted average of top loading and front-loading units based on data from DOE Life-Cycle Cost and Payback Analysis. See "2015 Clothes Washer Analysis.xls" for details.
[44] Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.
[45] Default assumption for unknown is based on percentage of homes with clothes washers that use an electric dryer from EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.
[46] Note that the baseline savings for all cases (front, top and weighted average) is based on the weighted average baseline IMEF (as opposed to assuming front baseline for front-efficient unit and top baseline for top- efficient unit). The reasoning is that the support of the program of more efficient units (which are predominately front loading) will result in some participants switching from planned purchase of a top loader to a front loader.

Weighted Average:

	ΔkWH			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	149.3	70.6	88.0	9.4
ENERGY STAR® Most Efficient, CEE Tier 2	222.1	80.9	137.5	-3.7
CEE Tier 3	243.1	98.4	143.2	-1.5

If the DHW and dryer fuel is unknown, the prescriptive kWH savings based on defaults provided above should be:

	ΔkWH		
Efficiency Level	**Front Loaders**	**Top Loaders**	**Weighted Average**
ENERGY STAR®, CEE Tier 1	112.8	89.6	99.0
ENERGY STAR® Most Efficient, CEE Tier 2	161.5	136.6	134.3
CEE Tier 3	424.6	154.8	151.8

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Energy savings as calculated above

CF = Summer peak coincidence factor for measure
= 0.0001148238

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:

Front Loaders:

	ΔkW			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	0.022	0.008	0.015	0.000
ENERGY STAR® Most Efficient, CEE Tier 2	0.033	0.013	0.020	-0.001
CEE Tier 3	0.037	0.016	0.021	0.000

Top Loaders:

	ΔkW			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	0.022	0.015	0.012	0.004
ENERGY STAR® Most Efficient, CEE Tier 2	0.033	0.020	0.018	0.004
CEE Tier 3	0.037	0.056	0.035	0.006

Weighted Average:

	ΔkW			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	0.022	0.011	0.013	0.001
ENERGY STAR® Most Efficient, CEE Tier 2	0.033	0.012	0.021	-0.001
CEE Tier 3	0.037	0.015	0.022	0.000

If the DHW and dryer fuel is unknown, the prescriptive kW savings should be:

	ΔkW		
Efficiency Level	**Front Loaders**	**Top Loaders**	**Weighted Average**
ENERGY STAR®, CEE Tier 1	0.013	0.017	0.015
ENERGY STAR® Most Efficient, CEE Tier 2	0.021	0.024	0.020
CEE Tier 3	0.023	0.064	0.023

NATURAL GAS SAVINGS

$$\Delta Therms = \left[\left[\left(Capacity * \frac{1}{IMEFbase} * Ncycles\right) * \left((\%DHWbase * \%Natural\ Gas_{DHW} * R\_eff) + (\%Dryerbase * \%Gas_{Dryer}\%Gas\ \_Dryer)\right)\right] - \left[\left(Capacity * \frac{1}{IMEFeff} * Ncycles\right) * \left((\%DHWeff * \%Gas_{DHW}\%Natural\ Gas\_DHW * R\_eff) + (\%Dryereff * \%Gas_{Dryer}\%Gas\_Dryer)\right)\right]\right] * Therm\_convert$$

Where:

$\%Gas_{DHW}$ = Percentage of DHW savings assumed to be Natural Gas

DHW fuel	$\%Gas_{DHW}$
Electric	0%
Natural Gas	100%
Unknown	57%[47]

R_eff = Recovery efficiency factor
= 1.26[48]

$\%Gas_{Dryer}$ = Percentage of dryer savings assumed to be Natural Gas

Dryer fuel	$\%Gas_{Dryer}$
Electric	0%
Natural Gas	100%
Unknown	10%[49]

Therm_convert = Conversion factor from kWh to therm
= 0.03412

Other factors as defined above.

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:
Front Loaders:

	ΔTherms			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	0.0	2.2	2.5	4.7
ENERGY STAR® Most Efficient, CEE Tier 2	0.0	3.8	3.6	7.4
CEE Tier 3	0.0	8.1	11.3	19.4

[47] Default assumption for unknown fuel is based EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.
[48] To account for the different efficiency of electric and Natural Gas hot water heaters (gas water heater: recovery efficiencies ranging from 0.74 to 0.85 (0.78 used), and electric water heater with 0.98 recovery efficiency. (http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Waste_Water_Heat_Recovery_Guidelines.pdf). Therefore, a factor of 0.98/0.78 (1.26) is applied.
[49] Default assumption for unknown fuel is based EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.

Top Loaders:

	ΔTherms			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	0.0	4.2	1.8	6.0
ENERGY STAR® Most Efficient, CEE Tier 2	0.0	5.9	3.1	8.9
CEE Tier 3	0.0	5.9	3.6	9.6

Weighted Average:

	ΔTherms			
	Electric DHW Electric Dryer	Gas DHW Electric Dryer	Electric DHW Gas Dryer	Gas DHW Gas Dryer
ENERGY STAR®, CEE Tier 1	0.0	3.4	2.1	5.5
ENERGY STAR® Most Efficient, CEE Tier 2	0.0	6.1	2.9	9.0
CEE Tier 3	0.0	6.2	3.4	9.6

If the DHW and dryer fuel is unknown, the prescriptive therm savings should be:

	ΔTherms		
Efficiency Level	Front Loaders	Top Loaders	Weighted Average
ENERGY STAR®, CEE Tier 1	1.51	2.52	2.11
ENERGY STAR® Most Efficient, CEE Tier 2	2.52	3.60	3.71
CEE Tier 3	5.66	3.70	3.84

WATER IMPACT DESCRIPTIONS AND CALCULATION

$$\Delta Water\ (gallons) = Capacity * (IWFbase - IWFeff) * Ncycles$$

Where:

IWFbase = Integrated Water Factor of baseline clothes washer
= 5.92[50]

IWFeff = Water Factor of efficient clothes washer
= Actual - If unknown assume average values provided below

Using the default assumptions provided above, the prescriptive water savings for each efficiency level are presented below:

	IWF[51]			ΔWater (gallons per year)		
Efficiency Level	Front Loaders	Top Loaders	Weighted Average	Front Loaders	Top Loaders	Weighted Average
Federal Standard	4.7	8.4	5.92	N/A		
ENERGY STAR®, CEE Tier 1	3.7	4.3	3.93	934	3,828	1,857
ENERGY STAR® Most Efficient, CEE Tier 2	3.2	3.5	3.21	1,400	4,575	2,532
CEE Tier 3	3.2		3.20	1,400	7,842	2,538

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[50] Weighted average IWF of Federal Standard rating for front loading and top loading units. Weighting is based upon the relative top vs. front loading percentage of available non-ENERGY STAR® products in the CEC database.

[51] IWF values are the weighted average of the new ENERGY STAR® specifications. Weighting is based upon the relative top vs. front loading percentage of available ENERGY STAR® and ENERGY STAR® Most Efficient products in the CEC database. See "2015 Clothes Washer Analysis.xls" for the calculation.

3.1.5 Dehumidifier

DESCRIPTION
A dehumidifier meeting the minimum qualifying efficiency standard established by the current ENERGY STAR® Version 4.0 (effective 2/1/2016) is purchased and installed in a residential setting in place of a unit that meets the minimum federal standard efficiency.

This measure was developed to be applicable to the following program types: TOS and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT
To qualify for this measure, the new dehumidifier must meet the ENERGY STAR® standards as defined below:

Capacity (pints/day)	ENERGY STAR® Criteria (L/kWh)
<75	≥2.00
75 to ≤185	≥2.80

Qualifying units must be equipped with an adjustable humidistat control or must have a remote humidistat control to operate.

DEFINITION OF BASELINE EQUIPMENT
The baseline for this measure is defined as a new dehumidifier that meets the federal standard efficiency standards. The federal standard for dehumidifiers as of October 2012 is defined below:

Capacity (pints/day)	Federal Standard Criteria (L/kWh)
Up to 35	≥1.35
> 35 to ≤45	≥1.50
> 45 to ≤ 54	≥1.60
> 54 to ≤ 75	≥1.70
> 75 to ≤ 185	≥2.50

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The assumed lifetime of the measure is 12 years.[52]

DEEMED MEASURE COST
The assumed incremental capital cost for this measure is $5.[53]

LOADSHAPE
Cooling RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (((\text{Avg Capacity} * 0.473) / 24) * \text{Hours}) * (1 / (L/kWh\_Base) – 1 / (L/kWh\_Eff))$$

Where:

Avg Capacity = Average capacity of the unit (pints/day)
= Actual, if unknown assume capacity in each capacity range as provided in table below, or if capacity range unknown assume average.

[52] Lifetime determined by EPA research, 2012. ENERGY STAR® Qualified Room Air Cleaner Calculator. (ENERGY STAR® Appliance Calculator.xlsx).
[53] Incremental costs determined by EPA research on available models, July 2016. ENERGY STAR® Qualified Room Air Cleaner Calculator. (ENERGY STAR® Appliance Calculator.xlsx).

0.473 = Constant to convert Pints to Liters
24 = Constant to convert Liters/day to Liters/hour
Hours = Run hours per year
= 1632[54]
L/kWh = Liters of water per kWh consumed, as provided in tables above

Annual kWh results for each capacity class are presented below:

Capacity Range (pints/day)	Capacity Used (pints/day)	Federal Standard Criteria (≥ L/kWh)	ENERGY STAR® Criteria (≥ L/kWh)	Annual kWh: Federal Standard	Annual kWh: ENERGY STAR®	Annual kWh: Savings
≤25	20	1.35	2.0	477	322	155
> 25 to ≤35	30	1.35	2.0	714	482	232
> 35 to ≤45	40	1.5	2.0	857	643	214
> 45 to ≤ 54	50	1.6	2.0	1005	804	201
> 54 to ≤ 75	65	1.7	2.0	1,229	1,045	184
> 75 to ≤ 185	130	2.5	2.8	1,672	1,493	179
Average[55]						204

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$\Delta kW = \Delta kWh * CF$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0009474181

Summer coincident peak demand results for each capacity class are presented below:

Capacity (pints/day) Range	Annual Summer peak kW Savings
≤25	0.095
> 25 to ≤35	0.142
> 35 to ≤45	0.131
> 45 to ≤ 54	0.123
> 54 to ≤ 75	0.113
> 75 to ≤ 185	0.110
Average	0.125

NATURAL GAS SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[54] Based on 24-hour operation over 68 days of the year. ENERGY STAR® Qualified Room Air Cleaner Calculator. (ENERGY STAR® Appliance Calculator.xlsx).
[55] The relative weighting of each product class is based on number of units on the ENERGY STAR® certified list. See “Dehumidifier Calcs.xls."

3.1.6 Dehumidifier Recycling

DESCRIPTION

This measure describes the savings resulting from the retirement of existing residential, inefficient dehumidifier units from service prior to end of their natural life. This measure assumes that a percentage of these units will be replaced with a baseline standard efficiency unit (note that if the unit is actually replaced by a new ENERGY STAR® qualifying unit, the savings increment between baseline and ENERGY STAR® will be recorded in the Efficient Products program).

This measure was developed to be applicable to the following program type: ERET.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

N/A. This measure relates to the retiring of an existing inefficient unit.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is the existing inefficient dehumidifier unit.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The measure life is assumed to be 5 years.

DEEMED MEASURE COST
The incremental cost for this measure is $42.76.

LOADSHAPE
HVAC RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS[56]
Program Deemed Savings estimate:

Gross Electric Savings (kWh/unit)		Gross Demand Savings (kW/home)
139		.0648

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Gross customer annual kWh savings for the measure
CF = 0.0004660805

MEASURE CODE:

[56] Deemed value per 2018 MEMD database for a drop-off program.

3.1.7 Refrigerator

DESCRIPTION

A refrigerator meeting either ENERGY STAR®/CEE Tier 1 specifications or the higher efficiency specifications of CEE Tier 2 or CEE Tier 3 is installed instead of a new unit of baseline efficiency. The measure applies to TOS and early replacement programs.

This measure also includes a section accounting for the interactive effect of reduced waste heat on the heating and cooling loads.

This measure was developed to be applicable to the following program types: TOS, NC, and EREP.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The high-efficiency level is a refrigerator meeting ENERGY STAR® specifications effective September 15th, 2014 (10% above federal standard), a refrigerator meeting CEE Tier 2 specifications (15% above federal standard), or CEE Tier 3 specifications (20% above federal standards).

DEFINITION OF BASELINE EQUIPMENT

Baseline efficiency is a new refrigerator meeting the minimum federal efficiency standard for refrigerators effective September 15th, 2014, for all programs except low-income direct install programs. For low-income programs, the baseline is the existing equipment.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

17 years[57]

DEEMED MEASURE COST

The full cost of a baseline unit is $742.[58]
The incremental cost to the ENERGY STAR® level is $11, to CEE Tier 2 level is $20, and to CEE Tier 3 is $59.[59]

LOADSHAPE

Refrigeration RES

[57] Mean from Figure 8.2.3, DOE, 2011 - 08-23 Technical Support Document for Energy Conservation Standards for Residential Refrigerators, Refrigerator-Freezers, and Freezers. http://www.regulations.gov/contentStreamer?objectId=0900006480f0c7df&disposition=attachment&contentType=pdf
[58] Configurations weighted according to table under Energy Savings. Values inflated 8.9% from 2009 dollars to 2015. Table 8.1.1, DOE, 2011-08-23 Technical Support Document for Energy Conservation Standards for Residential Refrigerators, Refrigerator-Freezers, and Freezers. http://www.regulations.gov/contentStreamer?objectId=0900006480f0c7df&disposition=attachment&contentType=pdf
[59] Configurations weighted according to table under Energy Savings. Values inflated 8.9% from 2009 dollars to 2015. Table 8.2.2, DOE, 2011-08-23 Technical Support Document for Energy Conservation Standards for Residential Refrigerators, Refrigerator-Freezers, and Freezers. http://www.regulations.gov/contentStreamer?objectId=0900006480f0c7df&disposition=attachment&contentType=pdf

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Savings by model may be pulled directly from ENERGY STAR® data. Alternatively, savings by product class may be calculated according to the algorithm below:

$$\Delta kWh_{Unit} = kWh_{\text{base}} - (kWh_{\text{base}} * (1 - \%Savings))$$

Where:

kWh_{base} = Baseline consumption,[60] assuming 22.5 ft³ adjusted volume[61]

= Calculated using algorithms in table below, or using defaults provided based on 22.5 ft³ adjusted volume[62]

%Savings = Specification of energy consumption below Federal Standard:

Tier	%Savings
Energy Star® and CEE Tier 1	10%
Energy Star® Most Efficient and CEE Tier 2	15%
CEE Tier 3	20%

For low-income programs, the following table may be used to calculate baseline usage:

Age	*Bottom Freezer (16 cu ft)*	*Side-by-Side (14 cu ft)*	*Side-by-Side (15 cu ft)*	*Side-by-Side (16 cu ft)*	*Top Freezer (cu ft 14)*	*Top Freezer (15 cu ft)*	*Top Freezer (16 cu ft)*	*Top Freezer (17 cu ft)*	*Top Freezer (18 cu ft)*
2011-2015	483	592	592	592	374	374	374	412	412
2001 (after July-2010	724	747	747	747	556	556	556	613	613
1993-2001(before June)	962	1,139	1,139	1,139	861	861	861	962	962
1990-1992	1,519	1,617	1,617	1,617	1,272	1,272	1,272	1,432	1,432
1980-1989	1,992	2,119	2,119	2,119	1,668	1,668	1,668	1,877	1,877
Before 1980	2,523	2,684	2,684	2,684	2,112	2,112	2,112	2,377	2,377

<u>Additional Waste Heat Impacts</u>

For units in conditioned spaces in the home (if unknown, assume unit is in conditioned space).

$$\Delta kWh_{WasteHeat} = \Delta kWh * (WHFeHeatElectric + WHFeCool)$$

Where:

ΔkWh = kWh savings calculated from either method above

WHFeHeatElectric = Waste Heat Factor for Energy to account for electric heating increase from removing waste heat from refrigerator/freezer (if fossil fuel heating – see calculation of heating penalty in that section).

= - (HF / $\eta Heat_{Electric}$) * %ElecHeat

HF = Heating Factor or percentage of reduced waste heat that must now be heated

= 58% for unit in heated space or unknown [63]

= 0% for unit in unheated space

$\eta Heat_{Electric}$ = Efficiency in COP of Heating equipment

= Actual - If not available, use table below:[64]

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[60] According to Federal Standard effective 9/15/14.
[61] DOE Building Energy Data Book, http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=5.7.5.
[62] DOE Building Energy Data Book, http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=5.7.5.
[63] Based on 212 days where HDD 65>0, divided by 365.25.
[64] These default system efficiencies are based on the applicable minimum Federal Standards. In 2006 and 2015 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

System Type	Age of Equipment	HSPF Esitmate	ηHeat (COP Estimate)
Heat Pump	Before 2006	6.8	2.00
	2006-2014	7.7	2.26
	2015 on	8.2	2.40
Resistance	N/A	N/A	1.00
Unknown	N/A	N/A	1.28[65]

%ElecHeat = Percentage of home with electric heat

Heating Fuel	%ElecHeat
Electric	100%
Fossil Fuel	0%
Unknown	35%[66]

WHFeCool = Waste Heat Factor for Energy to account for cooling savings from removing waste heat from refrigerator/freezer.
= (CoolF / ηCool) * %Cool
CoolF = Cooling Factor or percentage of reduced waste heat that no longer needs to be cooled
= 40% for unit in cooled space or unknown [67]
= 0% for unit in uncooled space
ηCool = Efficiency in COP of Cooling equipment
= Actual - If not available, assume 2.8 COP[68]
%Cool = Percentage of home with cooling

Home	%Cool
Cooling	100%
No Cooling	0%
Unknown	91%[69]

Algorithms for the most common refrigerator configurations, kWh_{base}, $\Delta kWh_{WasteHeat}$ for unknown building characteristics and resulting deemed ΔkWh savings is provided below:

Product Class	Algorithm from Federal Standard	Baseline Usage kWh_{base}	Unit ΔkWh			$\Delta kWh_{WasteHeat}$			Total ΔkWh		
			ENERGY STAR® / CEE Tier 1	CEE Tier 2	CEE Tier 3	ENERGY STAR® / CEE Tier 1	CEE Tier 2	CEE Tier 3	ENERGY STAR® / CEE Tier 1	CEE Tier 2	CEE Tier 3
Top Freezer (PC 3)	8.40AV + 385.4	574	57.4	86.1	114.8	-0.9	-1.4	-1.9	56.5	84.7	112.9
Side-by-Side w/ TTD (PC 7)	8.54AV + 432.8	625	62.5	93.75	125	-1.0	-1.5	-2.1	61.5	92.2	122.9
Bottom Freezer (PC 5)	8.85AV + 317.0	516	51.6	77.4	103.2	-0.8	-1.3	-1.7	50.8	76.1	101.5
Bottom Freezer w/ TTD (PC 5A)	9.25AV + 475.4	684	68.4	102.6	136.8	-1.1	-1.7	-2.2	67.3	100.9	134.6

[65] Calculation assumes 13% heat pump and 87% resistance, which is based upon data from Energy Information Administration, 2009 Residential Energy Consumption Survey, see "HC6.9 Space Heating in Midwest Region.xls." Average efficiency of heat pump is based on the assumption that 50% are units from before 2006 and 50% 2006-2014.
[66] Based on data from Energy Information Administration, 2009 Residential Energy Consumption Survey, see "HC6.9 Space Heating in Midwest Region.xls."
[67] Based on 148 days where CDD 65>0, divided by 365.25.
[68] Starting from standard assumption of SEER 10.5 central AC unit, converted to 9.5 EER using algorithm $(-0.02 * SEER^2) + (1.12 * SEER)$ (from Wassmer, M. (2003); A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. (Masters Thesis, University of Colorado at Boulder). Converted to COP = EER/3.412 = 2.8COP.
[69] Based on 2009 Residential Energy Consumption Survey, see "HC7.9 Air Conditioning in Midwest Region.xls."

If product class is unknown, the following table provides a market weighting that is applied to give a single deemed savings for each efficiency level:

Product Class	Market Weight[70]	Unit ΔkWh			$\Delta kWh_{WasteHeat}$			Total ΔkWh		
		Energy Star®/ CEE Tier 1	CEE Tier 2	CEE Tier 3	Energy Star®/ CEE Tier 1	CEE Tier 2	CEE Tier 3	Energy Star®/ CEE Tier 1	CEE Tier 2	CEE Tier 3
Top Freezer (PC 3)	52%	59.2	88.8	118.4	-1.0	-1.5	-1.9	58.2	87.3	116.5
Side-by-Side w/ TTD (PC 7)	22%									
Bottom Freezer (PC 5)	13%									
Bottom Freezer w/ TTD (PC 5A)	13%									

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = (\Delta kWh_{WasteHeatCooling}) * CF$$

Where:

$\Delta kWh_{WasteHeatCooling}$ = gross customer connected load kWh savings for the measure. Including any cooling system savings.

CF = Summer Peak Coincident Factor

= 0.0001285253[71]

Default values for each product class and unknown building characteristics are provided below:

Product Class	ΔkW		
	Energy Star®/ CEE Tier 1	CEE Tier 2	CEE Tier 3
Top Freezer (PC 3)	0.0086	0.0130	0.0173
Side-by-Side w/ TTD (PC 7)	0.0094	0.0141	0.0188
Bottom Freezer (PC 5)	0.0078	0.0117	0.0155
Bottom Freezer w/ TTD (PC 5A)	0.0103	0.0155	0.0206

If product class is unknown, the following table provides a market weighting that is applied to give a single deemed savings for each efficiency level:

Product Class	Market Weight[72]	ΔkW		
		Energy Star®/ CEE Tier 1	CEE Tier 2	CEE Tier 3
Top Freezer (PC 3)	52%	0.0089	0.0134	0.0178
Side-by-Side w/ TTD (PC 7)	22%			
Bottom Freezer (PC 5)	13%			
Bottom Freezer w/ TTD (PC 5A)	13%			

[70] Personal Communication from Melisa Fiffer, ENERGY STAR® Appliance Program Manager, EPA 10/26/14.
[71] Based on Ameren Missouri 2016 Loadshape for Residential Refrigeration End-Use.
[72] Personal Communication from Melisa Fiffer, ENERGY STAR® Appliance Program Manager, EPA 10/26/1.4.

NATURAL GAS SAVINGS

Heating penalty for reduction in waste heat, only for units from conditioned space in gas heated home (if unknown, assume unit is from conditioned space).

$$\Delta Therms = \Delta kWh_{Unit} * WHFeHeatGas * \ 0.03412$$

Where:

ΔkWh_{Unit} = kWh savings calculated from either method above, not including the $\Delta kWh_{WasteHeat}$

WHFeHeatGas = Waste Heat Factor for Energy to account for gas heating increase from removing waste heat from refrigerator/freezer

= - (HF / $\eta Heat_{Gas}$) * %GasHeat

HF = Heating Factor or percentage of reduced waste heat that must now be heated

= 58% for unit in heated space or unknown[73]

= 0% for unit in unheated space

$\eta Heat_{Gas}$ = Efficiency of heating system

=74%[74]

%GasHeat = Percentage of homes with gas heat

Heating Fuel	%GasHeat
Electric	0%
Gas	100%
Unknown	65%[75]

0.03412 = Converts kWh to therms

Default values for each product class and unknown building characteristics are provided below:

Product Class	ΔTherms		
	Energy Star®/ CEE Tier 1	CEE Tier 2	CEE Tier 3
Top Freezer (PC 3)	-1.19	-1.78	-2.37
Side-by-Side w/ TTD (PC 7)	-1.29	-1.94	-2.58
Bottom Freezer (PC 5)	-1.07	-1.60	-2.13
Bottom Freezer w/ TTD (PC 5A)	-1.41	-2.12	-2.83

If product class is unknown, the following table provides a market weighting that is applied to give a single deemed savings for each efficiency level:

Product Class	Market Weight[76]	ΔTherms		
		Energy Star®/ CEE Tier 1	CEE Tier 2	CEE Tier 3
Top Freezer (PC 3)	52%	-1.22	-1.84	-2.45
Side-by-Side w/ TTD (PC 7)	22%			
Bottom Freezer (PC 5)	13%			
Bottom Freezer w/ TTD (PC 5A)	13%			

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[73] Based on 212 days where HDD 65>0, divided by 365.25.

[74] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 52% of Missouri homes - based on Energy Information Administration, 2009 Residential Energy Consumption Survey). Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.60*0.92) + (0.40*0.8)) * (1-0.15) = 0.74.

[75] Based on data from Energy Information Administration, 2009 Residential Energy Consumption Survey, see "HC6.9 Space Heating in Midwest Region.xls."

[76] Personal Communication from Melisa Fiffer, ENERGY STAR® Appliance Program Manager, EPA 10/26/14.

3.1.8 Room Air Conditioner Recycling

DESCRIPTION

This measure describes the savings resulting from the retirement of existing residential, inefficient room air conditioner units from service prior to their natural end of life. This measure assumes that a percentage of these units will be replaced with a baseline standard efficiency unit (note that if it is actually replaced by a new ENERGY STAR® qualifying unit, the savings increment between baseline and ENERGY STAR® will be recorded in the Efficient Products program).

This measure was developed to be applicable to the following program type: ERET.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

N/A. This measure relates to the retiring of an existing inefficient unit.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is the existing inefficient room air conditioning unit.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The assumed remaining useful life of the existing room air conditioning unit being retired is 4 years.[77]

DEEMED MEASURE COST

The actual implementation cost for recycling the existing unit should be used.

LOADSHAPE

Cooling RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kWhexist - (\%replaced * kWhnewbase)$$
$$= \frac{Hours * BtuH}{EERexist * 1000} - (\%replaced * \frac{Hours * BtuH}{EERNewBase * 1000})$$

Where:

Hours = Full Load Hours of room air conditioning unit

Weather Basis (City based upon)	Hours[78]
St Louis, MO	860 for primary use and 556 for secondary use

BtuH = Average size of rebated unit. Use actual if available - if not, assume 8500[79]

EERexist = Efficiency of recycled unit

[77] One third of assumed measure life for room air conditioners.

[78] Ameren Missouri PY 2013 Coolsavers evaluation. http://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/117_RLW_CF%20Res%20RAC.pdf) to FLH for Central Cooling for the same locations (provided by AHRI: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) is 31%. This factor was applied to published CDD65 climate normals data to provide an assumption for FLH for Room AC.

[79] Based on maximum capacity average from the RLW Report; "Final Report Coincidence Factor Study Residential Room Air Conditioners, June 23, 2008."

= Actual if recorded - If not, assume 9.0[80]

%replaced = Percentage of units that are replaced

Scenario	%replaced
Customer states unit will not be replaced	0%
Customer states unit will be replaced	100%
Unknown	76%[81]

EERbase = Efficiency of baseline unit

= 10.9[82]

Results using defaults provided above:

Weather Basis (City based upon)	ΔkWh		
	Unit not replaced	Unit replaced	Unknown
St Louis, MO	525.4	91.6	195.7

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer Peak Coincidence Factor for measure

= 0.0009474181[83]

Results using defaults provided above:

Weather Basis (City based upon)	DkW		
	Unit not replaced	Unit replaced	Unknown
St Louis, MO	0.4978	0.0868	0.1854

Natural Gas Savings

N/A

Water Impact Descriptions and Calculation

N/A

Deemed O&M Cost Adjustment Calculation

N/A

Measure Code

[80] The federal minimum for the most common type of unit (8000 – 13999 Btuh with side vents) from 1990-2000 was 9.0 EER, from 2000-2014 it was 9.8 EER, and is currently (2015) 10.9 CEER. Retirement programs will see a large array of ages being retired, and the true EER of many will have been significantly degraded. We have selected 9.0 as a reasonable estimate of the average retired unit. This is supported by material on the ENERGY STAR® website, which, if reverse-engineered, indicates that an EER of 9.16 is used for savings calculations for a 10-year old room air conditioner. Another statement indicates that units that are at least 10 years old use 20% more energy than a new ES unit, which equates to: 10.9EER/1.2 = 9.1 EER; http://www.energystar.gov/ia/products/recycle/documents/RoomAirConditionerTurn-InAndRecyclingPrograms.pdf.

[81] Based on Nexus Market Research Inc., RLW Analytics, December 2005; "Impact, Process, and Market Study of the Connecticut Appliance Retirement Program: Overall Report." Report states that 63% were replaced with ENERGY STAR® units and 13% with non-ENERGY STAR®. However, this formula assumes all are non-ENERGY STAR® since the increment of savings between baseline units and ENERGY STAR® would be recorded by the Efficient Products program when the new unit is purchased.

[82] Minimum federal standard for capacity range and most popular class (without reverse cycle, with louvered sides, and 8,000 to 13,999 Btu/h). http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/41.

[83] Based on Ameren Missouri 2016 loadshape for residential cooling end-use.

3.2 Electronics

3.2.1 Advanced Tier 1 Power Strips

DESCRIPTION

This measure applies to Tier 1 Advanced Power Strips (APS), which are multi-plug power strips with the ability to automatically disconnect specific connected loads depending upon the power draw of a master control load, also plugged into the strip. Power is disconnected from the switched (controlled) outlets when the master control load power draw is reduced below a certain adjustable threshold, thus turning off the appliances plugged into the switched outlets. By disconnecting, the standby load of the controlled devices, the overall load of a centralized group of equipment (i.e. entertainment centers and home office) can be reduced. Uncontrolled outlets are also provided that are not affected by the control device and are always providing power to any device plugged into it. This measure characterization provides savings for use of an APS in a home entertainment system, home office, or unknown setting.

This measure was developed to be applicable to the following program types: TOS, NC, DI, and KITS.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is the use of a 4-8 plug Tier 1 master-controlled APS.

DEFINITION OF BASELINE EQUIPMENT

For TOS and NC applications, the baseline is a standard power strip that does not control connected loads.
For DI and KITS, the baseline is the existing equipment used in the home.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The assumed lifetime of the Tier 1 APS is 10 years.[84]

DEEMED MEASURE COST

For TOS and NC, the incremental cost of an APS over a standard power strip with surge protection is assumed to be $20.[85]
For DI and KITS, the actual full installation cost of an APS (including equipment and labor) should be used.

LOADSHAPE

Miscellaneous RES

[84] "Advanced Power Strip Research Report," NYSERDA, August 2011.
[85] Incremental cost based on "Advanced Power Strip Research Report." Typical cost of an advanced power strip is $35, and average cost of a standard power strip is $15.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (kWh_{office} * Weighting_{Office} + kWh_{Ent} * Weighting_{Ent}) * ISR$$

Where:

kWh_{office} = Estimated energy savings from using an APS in a home office
= 31.0 kWh[86]

$Weighting_{Office}$ = Relative penetration of use in home office

Installation Location	$Weighting_{Office}$
Home Office	100%
Home Entertainment System	0%
Unknown[87]	TOS, NC, DI: 36% KITS: 48%

kWh_{Ent} = Estimated energy savings from using an APS in a home entertainment system
= 75.1 kWh[88]

$Weighting_{Ent}$ = Relative penetration of use with home entertainment systems

Installation Location	$Weighting_{Ent}$
Home Office	0%
Home Entertainment System	100%
Unknown[89]	TOS, NC, DI: 64% KITS: 52%

ISR = In service rate, dependent on program type

Program Type	ISR
TOS, NC, DI	100%
KITS	78%[90]

Based on the default values above, default savings are provided in the table below:

Installation Location	Program Type	ΔkWh
Home Office	TOS, NC, DI	31.0
	KITS	24.2
Home Entertainment System	TOS, NC, DI	75.1
	KITS	58.6
Unknown	TOS, NC, DI	59.2
	KITS	42.1

[86] "Advanced Power Strip Research Report." Note that estimates are not based on pre/post metering but on analysis based on frequency and consumption of likely products in active, standby, and off modes. This measure should be reviewed frequently to ensure that assumptions continue to be appropriate.
[87] Relative weightings of home office and entertainment systems is based on "Ameren Missouri Efficient Product Impact and Process Evaluation: Program Year 2015," Cadmus, May 13, 2016. If the programs have their own evaluations of weightings, they should be used.
[88] "Advanced Power Strip Research Report."
[89] Relative weightings of home office and entertainment systems is based on "Ameren Missouri Efficient Product Impact and Process Evaluation: Program Year 2015," Cadmus, May 13, 2016. If the programs have their own evaluations of weightings, they should be used.
[90] "Ameren Missouri Efficient Product Impact and Process Evaluation: Program Year 2015."

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, as calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001148238[91]

NATURAL GAS SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[91] Based on Ameren Missouri 2016 loadshape for residential miscellaneous end-use. This is deemed appropriate, because savings occur during hours when the controlled standby loads are turned off by the APS. This is estimated to be approximately 7,129, which representing the average of hours for controlled TV and computer from "Advanced Power Strip Research Report."

3.2.2 Tier 2 Advanced Power Strip – Residential Audio Visual

DESCRIPTION

This measure applies to the installation of a Tier 2 Advanced Power Strip for household audio visual environments (Tier 2 AV APS). Tier 2 AV APS are multi-plug power strips that remove power from audio visual equipment through intelligent control and monitoring strategies. Using advanced control strategies such as true RMS (Root Mean Square) power sensing, and/or external sensors,[92] both active power loads and standby power loads of controlled devices are managed by Tier 2 AV APS devices. Monitoring and controlling both active and standby power loads of controlled devices will reduce the overall load of a centralized group of electrical equipment (i.e. the home entertainment center). This intelligent sensing and control process has been demonstrated to deliver increased energy savings and demand reduction compared with Tier 1 Advanced Power Strips.

The Tier 2 AV APS market is a relatively new and developing one. With several new Tier 2 AV APS products coming to market, it is important that energy savings be clearly demonstrated through independent field trials. Field trial should effectively address the inherent variability in AV system usage patterns. Until there is enough independent evidence to demonstrate deemed savings for each of the various control strategies, it is recommended that products with independent field trial results be placed into performance bands and savings claimed accordingly.

This measure was developed to be applicable to the following program type: DI. If applied to other program types, the installation characteristics, including the number of AV devices under control and an appropriate in-service rate, should be verified through evaluation.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is the use of a Tier 2 AV APS in a residential AV (home entertainment) environment that includes control of at least 2 AV devices, one being the television.[93]

DEFINITION OF BASELINE EQUIPMENT

The assumed baseline equipment is the existing equipment used in the home (e.g., a standard power strip or wall socket) that does not control loads of connected AV equipment.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The assumed lifetime of the Tier 2 AV APS is assumed to be 10 years.[94]

DEEMED MEASURE COST

The actual full installation cost of the Tier 2 AV APS (including equipment and labor) should be used.

LOADSHAPE

Miscellaneous RES

[92] Tier 2 AV APS identify when people are not engaged with their AV equipment and then remove power (e.g., a TV and its peripheral devices that are unintentionally left on when a person leaves the house or falls asleep while watching television).

[93] Given this requirement, an AV environment consisting of a TV and DVD player or a TV and home theater would be eligible for a Tier 2 AV APS installation.

[94] "Advanced Power Strip Research Report," NYSERDA, August 2011.

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = ERP * BaselineEnergy_{AV}$$

Where:

ERP = Energy reduction percentage of qualifying Tier 2 AV APS product Class; see table below:[95]

Product Class	Field Trial ERP Range	ERP Used
A	55 – 60%	55%
B	50 – 54%	50%
C	45 – 49%	45%
D	40 – 44%	40%
E	35 – 39%	35%
F	30 – 34%	30%
G	25 – 29%	25%
H	20 – 24%	20%

$BaselineEnergy_{AV}$ = 432 kWh[96]

Based on the default values above, default savings are provided in the table below:

Product Class	ΔkWh
A	238
B	216
C	194
D	173
E	151
F	130
G	108
H	86

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0001148238[97]

NATURAL GAS SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

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[95] Based on field test data for various APS products.

[96] "Energy Savings of Tier 2 Advanced Power Strips in Residential AV Systems," AESC, Inc., February 2016. Note this load represents the average *controlled* AV devices only and will likely be lower than total AV usage.

[97] Based on Ameren Missouri 2016 loadshape for residential miscellaneous end-use. This is deemed appropriate, as savings occur during hours which the controlled standby loads are turned off by the APS, estimated to be approximately 7,129 representing the average of hours for controlled TV and computer from "Advanced Power Strip Research Report."

3.3 Hot Water

3.3.1 Low Flow Faucet Aerator

This measure relates to the installation of a low flow faucet aerator in a household kitchen or bath faucet fixture.

This measure may be used for units provided through efficiency kit's. However, the in-service rate for such measures should be derived through evaluation results specifically for this implementation methodology.

This measure was developed to be applicable to the following program types: TOS, NC, RF, DI, and KITS.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the installed equipment must be a low flow faucet aerator for bathrooms rated at 1.5 gallons per minute (GPM) or less or for kitchens rated at 2.2 GPM or less. Savings are calculated on an average savings per faucet fixture basis.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is assumed to be a standard bathroom faucet aerator rated at 2.25 GPM or greater, or a standard kitchen faucet aerator rated at 2.75 GPM or greater. Average measured flow rates are used in the algorithm and are lower, reflecting the penetration of previously installed low flow fixtures (and therefore the freerider rate for this measure should be 0), use of the faucet at less than full flow, debris buildup, and lower water system pressure than fixtures are rated at.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years.[98]

DEEMED MEASURE COST

The incremental cost for this measure is $11.33[99] or program actual.
For faucet aerators provided in efficiency kits, the actual program delivery costs should be utilized. Absent of program data, use $3.00[100]

LOADSHAPE

Water Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Note these savings are *per* faucet retrofitted[101] (unless faucet type is unknown, then it is per household).

ΔkWh = %ElectricDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * 365.25 *DF / FPH) * EPG_electric * ISR

Where:

%ElectricDHW = proportion of water heating supplied by electric resistance heating

DHW fuel	%ElectricDHW
Electric	100%
Natural Gas	0%
Unknown	43%[102]

GPM_base = Average flow rate, in gallons per minute, of the baseline faucet "as-used." This includes the effect of existing low flow fixtures and therefore the freerider rate for this measure should be 0.

---

[98] Measure lifetime is derived from the California DEER Effective Useful Life Table – 2014 Table Update.
http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx

[99] Direct-install price per showerhead assumes cost of showerhead (market research average of $3 and assess and install cost of $8.33) and also assumes 20min at $25 per hour, which is in line with the typical prevailing wage of a General Laborer, as per the Annual Wage Order No. 23 published by the Missouri Department of Labor.

[100] Illinois TRM.

[101] This algorithm calculates the amount of energy saved per aerator by determining the fraction of water consumption savings for the upgraded fixture.

[102] Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.

= 1.39[103] or custom based on metering studies[104] or if measured during DI:
= Measured full throttle flow * 0.83 throttling factor[105]

GPM_low = Average flow rate, in gallons per minute, of the low-flow faucet aerator "as-used"
= 0.94[106] or custom based on metering studies[107] or if measured during DI:
= Rated full throttle flow * 0.95 throttling factor[108]

L_base = Average baseline daily length faucet use per capita for faucet of interest in minutes
= if available custom based on metering studies, if not use:

Faucet Type	L_base (min/person/day)
Kitchen	4.5[109]
Bathroom	1.6[110]
If location unknown (total for household): Single-Family	7.8[111]
If location unknown (total for household): Multi-Family	6.7[112]

L_low = Average retrofit daily length faucet use per capita for faucet of interest in minutes
= if available custom based on metering studies, if not use:

Faucet Type	L_low (min/person/day)
Kitchen	4.5[113]
Bathroom	1.6[114]
If location unknown (total for household): Single-Family	7.8[115]
If location unknown (total for household): Multi-Family	6.7[116]

Household = Average number of people per household

Household Unit Type	Household
Single-Family	2.67[117]
School Kits	4.3[118]
Multi-Family - Deemed	2.07[119]
Custom	Actual Occupancy or Number of Bedrooms[120]

[103] Deoreo, B., and P. Mayer, "Residential End Uses of Water Study Update." Forthcoming. ©2015 Water Research Foundation. Reprinted with permission.
[104] Measurement should be based on actual average flow consumed over a period of time rather than a one-time spot measurement for maximum flow. Studies have shown maximum flow rates do not correspond well to average flow rate due to occupant behavior, which does not always use maximum flow.
[105] 2008, Schultdt, Marc, and Debra Tachibana, "Energy related Water Fixture Measurements: Securing the Baseline for Northwest Single Family Homes," 2008 ACEEE Summer Study on Energy Efficiency in Buildings, pp. 1-265. www.seattle.gov/light/Conserve/Reports/paper_10.pdf
[106] Average retrofit flow rate for kitchen and bathroom faucet aerators from sources 2, 4, 5, and 7 (see source table at end of characterization).This accounts for all throttling and differences from rated flow rates. Assumes all kitchen aerators at 2.2 gpm or less and all bathroom aerators at 1.5 gpm or less. The most comprehensive available studies did not disaggregate kitchen use from bathroom use, but instead looked at total flow and length of use for all faucets. This makes it difficult to reliably separate kitchen water use from bathroom water use. It is possible that programs installing low flow aerators lower than the 2.2 gpm for kitchens and 1.5 gpm for bathrooms will see a lower overall average retrofit flow rate.
[107] Measurement should be based on actual average flow consumed over a period of time rather than a one-time spot measurement for maximum flow. Studies have shown maximum flow rates do not correspond well to average flow rate due to occupant behavior, which does not always use maximum flow.
[108] 2008, Schultdt, Marc, and Debra Tachibana, "Energy related Water Fixture Measurements: Securing the Baseline for Northwest Single Family Homes," 2008 ACEEE Summer Study on Energy Efficiency in Buildings, pp. 1-265. www.seattle.gov/light/Conserve/Reports/paper_10.pdf
[109] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum, dated June 2013, directed to Michigan Evaluation Working Group. This study of 135 single and multifamily homes in Michigan metered energy parameters for efficient showerhead and faucet aerators.
[110] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, directed to Michigan Evaluation Working Group. This study of 135 single and multifamily homes in Michigan metered energy parameters for efficient showerhead and faucet aerators.
[111] One kitchen faucet plus 2.04 bathroom faucets. Based on findings from a 2012 Ameren Missouri potential study for single family homes.
[112] One kitchen faucet plus 1.4 bathroom faucets. Based on findings from Ameren Missouri PY13 data for multifamily homes.
[113] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, directed to Michigan Evaluation Working Group.
[114] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, directed to Michigan Evaluation Working Group.
[115] One kitchen faucet plus 2.04 bathroom faucets. Based on findings from a 2012 Ameren Missouri potential study for single family homes.
[116] One kitchen faucet plus 1.4 bathroom faucets. Based on findings from an Ameren Missouri PY13 data for multifamily homes.
[117] Ameren Missouri Efficient Products Impact and Process Evaluation: Planning Year 2015, provided by Cadmus.
[118] Ameren Missouri Energy Efficient Kits Program Impact and Process Evaluation: Program Year 2016.
[119] Ameren Missouri Efficient Products Impact and Process Evaluation: Planning Year 2015, provided by Cadmus.
[120] Bedrooms are suitable proxies for household occupancy and may be preferable to actual occupancy due to turnover rates in residency and non-adult population impacts.

365.25 = Days in a year, on average.
DF = Drain Factor

Faucet Type	Drain Factor[121]
Kitchen	75%
Bath	90%
Unknown	79.5%

FPH = Faucets Per Household

Faucet Type	FPH
Kitchen Faucets Per Home (KFPH)	1
Bathroom Faucets Per Home (BFPH): Single-Family	2.04[122]
Bathroom Faucets Per Home (BFPH): School Kits	2.4[123]
Bathroom Faucets Per Home (BFPH): Multi-Family	1.4[124]
If location unknown (total for household): Single-Family	3.04
If location unknown (total for household): Multi-Family	2.4

EPG_electric = Energy per gallon of water used by faucet supplied by electric water heater
= (8.33 * 1.0 * (WaterTemp - SupplyTemp)) / (RE_electric * 3412)
8.33 = Specific weight of water (lbs/gallon)
1.0 = Heat Capacity of water (btu/lb-°F)
WaterTemp = Assumed temperature of mixed water
= 86F for Bath, 93F for Kitchen 91F for Unknown[125]
SupplyTemp = Assumed temperature of water entering house
= 60.83F[126]
RE_electric = Recovery efficiency of electric water heater
= 98%[127]
3412 = Converts Btu to kWh (btu/kWh)

ISR = In service rate of faucet aerators dependant on install method as listed in table below

Selection	ISR
Direct Install	0.977[128]
Efficiency Kit—Single Family	0.52[129]
Efficiency Kit—Multi Family	1.0[130]

121 Because faucet usages are at times dictated by volume (e.g., filling a cooking pot), only usage of the sort that would go straight down the drain will provide savings. VEIC is unaware of any metering study that has determined this specific factor and so recommends these values to be 75% for the kitchen and 90% for the bathroom. If the aerator location is unknown, an average of 79.5% should be used, which is based on the assumption that 70% of household water runs through the kitchen faucet and 30% through the bathroom (0.7*0.75)+(0.3*0.9)=0.795.
122 Based on findings from a 2012 Ameren Missouri potential study for single family homes.
123 Ameren Missouri Energy Efficient Kits Program Impact and Process Evaluation: Program Year 2016.
124 Based on findings from an Ameren Missouri PY13 data for multifamily homes.
125 Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum, dated June 2013, directed to Michigan Evaluation Working Group. If the aerator location is unknown, an average of 91% should be used which is based on the assumption that 70% of household water runs through the kitchen faucet and 30% through the bathroom (0.7*93)+(0.3*86)=0.91.
126 Based on the DOE's Building America Standard DHW Event Schedule calculator. Average annual water main temperatures were determined for each defined weather zone in Missouri. The overall average of 60.83 is taken to represent the statewide average input water temperature.
127 Electric water heaters have recovery efficiency of 98%: http://www.ahridirectory.org/ahridirectory/pages/home.aspx.
128 Ameren Missouri Home Energy Analysis Program Impact and Process Evaluation: Program Year 2015.
129 Ameren Missouri Efficient Products Impact and Process Evaluation: Program Year 2015.
130 Ameren Missouri Efficient Products Impact and Process Evaluation: Program Year 2015.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh * CF

Where:

ΔkWh = as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0000887318[131]

NATURAL GAS SAVINGS

ΔTherms = %GasDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * 365.25 *DF / FPH) * EPG_gas * ISR

Where:

%GasDHW = proportion of water heating supplied by Natural Gas heating

DHW fuel	%GasHW
Electric	0%
Natural Gas	100%
Unknown	48%[132]

EPG_gas = Energy per gallon of Hot water supplied by gas

= (8.33 * 1.0 * (WaterTemp - SupplyTemp)) / (RE_gas * 100,000)

RE_gas = Recovery efficiency of gas water heater

= 78% For SF homes[133]

= 67% For MF homes[134]

100,000 = Converts Btus to therms (btu/therm)

Other variables as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

Δgallons = ((GPM_base * L_base - GPM_low * L_low) * Household * 365.25 *DF / FPH) * ISR

Variables as defined above.

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[131] Based on Ameren Missouri 2016 loadshape for residential water heating end-use.

[132] Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.

[133] DOE final rule discusses recovery efficiency with an average around 0.76 for gas- fired storage water heaters and 0.78 for standard efficiency gas fired tankless water heaters up to 0.95 for the highest efficiency gas fired condensing tankless water heaters. These numbers represent the range of new units however, not the range of existing units in stock. Review of AHRI Directory suggests range of recovery efficiency ratings for new gas DHW units of 70-87%. Average of existing units is estimated at 78%.

[134] Water heating in multifamily buildings is often provided by a larger central boiler. This suggests that the average recovery efficiency is somewhere between a typical central boiler efficiency of 0.59 and the 0.75 for single family homes. An average efficiency of 0.67 is used for this analysis as a default for multifamily buildings.

3.3.2 Low Flow Showerhead

DESCRIPTION

This measure relates to the installation of a low flow showerhead in a single or multifamily household.

This measure may be used for units provided through efficiency kit's. However, the in-service rate for such measures should be derived through evaluation results specifically for this implementation methodology.

This measure was developed to be applicable to the following program types: TOS, RF, NC, DI, and KITS.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the installed equipment must be a low flow showerhead, typically rated at 2.0 gallons per minute (GPM) or less. Savings are calculated on a per showerhead fixture basis.

DEFINITION OF BASELINE EQUIPMENT

For DI programs, the baseline condition is assumed to be a standard showerhead rated at 2.5 GPM[135] or greater.
For RF and TOS programs, the baseline condition is assumed to be a representative average of existing showerhead flow rates of participating customers including a range of low flow showerheads, standard-flow showerheads, and high-flow showerheads.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years.[136]

DEEMED MEASURE COST

The incremental cost for TOS, NC, or KITS is $7[137] or program actual.
For low flow showerheads provided in RF or DI programs, the actual program delivery costs should be utilized; if unknown assume $15.33.[138]

LOADSHAPE

Water Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Note these savings are per showerhead fixture

ΔkWh = %ElectricDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * SPCD * 365.25 / SPH) * EPG_electric * ISR

Where:

%ElectricDHW = proportion of water heating supplied by electric resistance heating

DHW fuel	%ElectricDHW
Electric	100%
Natural Gas	0%
Unknown	43%[139]

[135] Maximum showerhead flow rate at 80 PSI is 2.5 GPM in accordance with federal standard 10 CFR Part 430.32(p). See docket filed at https://www.regulations.gov/document?D=EERE-2011-BT-TP-0061-0039
[136] Table C-6, "Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures," GDS Associates, June 2007. Evaluations indicate that consumer dissatisfaction may lead to reductions in persistence, particularly in Multifamily, http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure_life_GDS%5B1%5D.pdf.
[137] Based on online pricing market research 2/6/2017.
[138] Direct-install price per showerhead assumes cost of showerhead (market research average of $7) and also assumes assess and install cost of $8.33 (20min at $25 per hour, which is in line with the typical prevailing wage of a General Laborer, as per the Annual Wage Order No. 23 published by the Missouri Department of Labor).
[139] Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.

GPM_base = Flow rate of the baseline showerhead

Program	GPM_base
Direct-install	2.35[140]
Retrofit, Efficiency Kits, NC or TOS	2.35[141]

GPM_low = As-used flow rate of the lowflow showerhead, which may, as a result of measurements of program evaulations deviate from rated flows, see table below:

Rated Flow
2.0 GPM
1.75 GPM
1.5 GPM
Custom or Actual[142]

L_base = Shower length in minutes with baseline showerhead
= 7.8 min[143]

L_low = Shower length in minutes with low-flow showerhead
= 7.8 min[144]

Household = Average number of people per household

Household Unit Type[145]	Household
Single-Family	2.67[146]
School Kits	4.3
Multi-Family	2.07[147]
Custom	Actual Occupancy or Number of Bedrooms[148]

SPCD = Showers Per Capita Per Day
= 0.6[149]

365.25 = Days per year, on average.

SPH = Showerheads Per Household so that per-showerhead savings fractions can be determined

Household Type	SPH
Single-Family	2.05[150]
School Kits	2.1[151]
Multi-Family	1.4[152]
Custom	Actual

[140] Based on Ameren Missouri PY14 program data for direct-install measures. A delta of 0.85 GPM is assumed, derived from confirmed retrofitted aerator flow rates of 1.5 GPM and assuming existing showerheads were consuming 2.35 GPM, based on average of DOE-reported values for homes with domestic water pressures of 60psi and 80psi. http://energy.gov/energysaver/articles/reduce-hot-water-use-energy-savings.

[141] Representative value from sources 1, 2, 4, 5, 6, and 7 (See Source Table at end of measure section) adjusted slightly upward to account for program participation, which is expected to target customers with existing higher flow devices rather than those with existing low flow devices.

[142] Note that actual values may be either: a) program-specific minimum flow rate, or b) program-specific evaluation-based value of actual effective flow-rate due to increased duration or temperatures. The latter increases in likelihood as the rated flow drops and may become significant at or below rated flows of 1.5 GPM. The impact can be viewed as the inverse of the throttling described in the footnote for baseline flowrate.

[143] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum, dated June 2013, directed to Michigan Evaluation Working Group. This study of 135 single and multifamily homes in Michigan metered energy parameters for efficient showerhead and faucet aerators.

[144] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, directed to Michigan Evaluation Working Group. This study of 135 single and multifamily homes in Michigan metered energy parameters for efficient showerhead and faucet aerators.

[145] If household type is unknown, as may be the case for TOS measures, then single family deemed value should be used.

[146] Ameren Missouri Efficient Products Impact and Process Evaluation: Planning Year 2015, provided by Cadmus.

[147] Ameren Missouri Efficient Products Impact and Process Evaluation: Planning Year 2015, provided by Cadmus.

[148] Bedrooms are suitable proxies for household occupancy and may be preferable to actual occupancy due to turnover rates in residency and non-adult population impacts.

[149] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum, dated June 2013, directed to Michigan Evaluation Working Group.

[150] Ameren Missouri Efficient Products Impact and Process Evaluation: Planning Year 2015, provided by Cadmus.

[151] Ameren Missouri Energy Efficient Kits Program Impact and Process Evaluation: Program Year 2016.

[152] Ameren Missouri Efficient Products Impact and Process Evaluation: Planning Year 2015, provided by Cadmus.

EPG_electric = Energy per gallon of hot water supplied by electric
= (8.33 * 1.0 * (ShowerTemp - SupplyTemp)) / (RE_electric * 3412)
= (8.33 * 1.0 * (101 – 60.83)) / (0.98 * 3412)
= 0.100 kWh/gal

8.33 = Specific weight of water (lbs/gallon)

1.0 = Heat capacity of water (btu/lb-°)

ShowerTemp = Assumed temperature of water
= 101.0 F[153]

SupplyTemp = Assumed temperature of water entering house
= 60.83 F[154]

RE_electric = Recovery efficiency of electric water heater
= 98%[155]

3412 = Converts Btu to kWh (btu/kWh)

ISR = In service rate of showerhead
= Dependant on program delivery method as listed in table below:

Selection	ISR
Direct Install	0.98[156]
Efficiency Kit—Single Family	0.47[157]
Efficiency Kit—Multifamily	0.86[158]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh * CF

Where:

ΔkWh = as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0000887318[159]

NATURAL GAS SAVINGS

ΔTherms = %GasDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * SPCD * 365.25 / SPH) * EPG_gas * ISR

Where:

%GasDHW = proportion of water heating supplied by natural gas heating

DHW fuel	%GasDHW
Electric	0%
Natural Gas	100%
Unknown	48%[160]

EPG_gas = Energy per gallon of Hot water supplied by gas
= (8.33 * 1.0 * (ShowerTemp - SupplyTemp)) / (RE_gas * 100,000)
= 0.00429 therm/gal for SF homes
= 0.00499 therm/gal for MF homes

RE_gas = Recovery efficiency of gas water heater

[153] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated, June 2013, directed to Michigan Evaluation Working Group.
[154] Based on the DOE's Building America Standard DHW Event Schedule calculator. Average annual water main temperatures were determined for each defined weather zone in Missouri. The overall average of 60.83 is taken to represent the statewide average input water temperature.
[155] Electric water heaters have recovery efficiency of 98%: http://www.ahridirectory.org/ahridirectory/pages/home.aspx.
[156] Ameren Missouri Home Energy Analysis Program Impact and Process Evaluation: Program Year 2015.
[157] Ameren Missouri Efficient Products Impact and Process Evaluation: Program Year 2015.
[158] Ameren Missouri Efficient Products Impact and Process Evaluation: Program Year 2015.
[159] Based on Ameren Missouri 2016 loadshape for residential water heating end-use.
[160] Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Illinois. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.

= 78% For SF homes[161]
= 67% For MF homes[162]
100,000 = Converts Btus to therms (btu/Therm)
Other variables as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

Δgallons = ((GPM_base * L_base - GPM_low * L_low) * Household * SPCD * 365.25 / SPH) * ISR
Variables as defined above

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[161] DOE final rule discusses recovery efficiency with an average around 0.76 for gas-fired storage water heaters and 0.78 for standard efficiency gas fired tankless water heaters up to 0.95 for the highest efficiency gas-fired condensing tankless water heaters. However, these numbers represent the range of new units, not the range of existing units in stock. Review of AHRI Directory suggests range of recovery efficiency ratings for new gas DHW units of 70-87%. Average of existing units is estimated at 78%.

[162] Water heating in multifamily buildings is often provided by a larger central boiler. This suggests that the average recovery efficiency is somewhere between a typical central boiler efficiency of 0.59 and the 0.75 for single family homes. An average efficiency of 0.67 is used for this analysis as a default for multifamily buildings.

3.3.3 Water Heater Wrap

DESCRIPTION
This measure applies to a tank wrap or insulation "blanket" that is wrapped around the outside of an electric or gas domestic hot water (DHW) tank to reduce stand-by losses.

This measure was developed to be applicable to the following program types: DI, and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT
The efficient condition is an electric or gas DHW tank with wrap installed that has an R-value that meets program requirements.

DEFINITION OF BASELINE EQUIPMENT
The baseline condition is an uninsulated electric or gas DHW tank.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The measure life is assumed to be 12 years.[163]

DEEMED MEASURE COST
The measure cost is the actual cost of material and installation. If actual costs are unknown, assume $58[164] for material and installation.

LOADSHAPE
Water Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS
Custom calculation below for electric DHW tanks, otherwise use default values from table that follows:

$$\Delta kWh = ((A_{Base}/R_{Base} - A_{EE}/R_{EE}) * \Delta T * Hours)/(\eta DHW_{Elec} * 3{,}412)$$

Where:

A_{Base} = Surface area (ft^2) of storage tank prior to adding tank wrap[165]
= Actual or if unknown, use default based on tank capacity (gal) from table below

R_{Base} = Thermal resistance coefficient (hr-°F-ft^2/BTU) of uninsulated tank
= Actual or if unknown, assume 14[166]

A_{EE} = Surface area (ft^2) of storage tank after addition of tank wrap[167]
= Actual or, if unknown, use default based on tank capacity (gal) from table below

R_{EE} = Thermal resistance coefficient ((hr-°F-ft2/BTU) of tank after addition of tank wrap (R-value of uninsulated tank + R-value of tank wrap)
= Actual or if unknown, assume 24

ΔT = Average temperature difference (°F) between tank water and outside air
= Actual or if unknown, assume 60°F[168]

[163] 2014 Database for Energy-Efficiency Resources (DEER), Version 2014, "Cost Values and Summary Documentation," California Public Utilities Commission, January 2014. Average of values for electric DHW (13 years) and gas DHW (11 years).
[164] Average cost of R-10 tank wrap installation from the National Renewable Energy Laboratory's National Residential Efficiency Measures Database. http://www.nrel.gov/ap/retrofits/measures.cfm?gId=6&ctId=270.
[165] Area includes tank sides and top to account for typical wrap coverage.
[166] Baseline R-value based on information from Chapter 6 of *The Virginia Energy Savers Handbook*, Third Edition: The best heaters have 2 to 3 inches of urethane foam, providing R-values as high as R-20. Other less expensive models have fiberglass tank insulation with R-values ranging between R-7 and R-10.
[167] Area includes tank sides and top to account for typical wrap coverage.
[168] Assumes 125°F hot water tank temperature and average basement temperature of 65°F.

Hours = Hours per year
= 8,766
ηDHW_{Elec} = Recovery efficiency of electric hot water heater
= Actual or if unknown, assume 0.98[169]
3,412 = Conversion factor from Btu to kWh

The following table contains default savings for various tank capacities.

Capacity (gal)	A_{Base} (ft^2)[170]	A_{EE} (ft^2)[171]	ΔkWh	ΔkW
30	19.16	20.94	78.0	0.00890
40	23.18	25.31	94.6	0.01079
50	24.99	27.06	103.4	0.01180
80	31.84	34.14	134.0	0.01528

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW \quad = \Delta kWh * CF$$

Where:
ΔkWh = Electric energy savings, as calculated above.
CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0000887318[172]
The table above contains default kW savings for various tank capacities.

NATURAL GAS SAVINGS
Custom calculation below for gas DHW tanks, otherwise use default values from table that follows:

$$\Delta Therms = ((A_{Base}/R_{Base} - A_{EE}/R_{EE}) * \Delta T * Hours)/(\eta DHW_{Gas} * 100{,}000)$$

Where:
ηDHW_{Gas} = Recovery efficiency of gas hot water heater
= 0.78[173]
100,000 = Conversion factor from Btu to therms
Other variables as defined above

The following table contains default savings for various tank capacities.

Capacity (gal)	A_{Base} (ft^2)[174]	A_{EE} (ft^2)[175]	ΔTherms	ΔPeakTherms
30	19.16	20.94	3.3	0.0092
40	23.18	25.31	4.1	0.0111
50	24.99	27.06	4.4	0.0121
80	31.84	34.14	5.7	0.0157

WATER IMPACT DESCRIPTIONS AND CALCULATION
N/A

DEEMED O&M COST ADJUSTMENT CALCULATION
N/A

MEASURE CODE:

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[169] Electric water heater recovery efficiency from AHRI database: http://www.ahridirectory.org/ahridirectory/pages/home.aspx.
[170] Surface area assumptions from the June 2016 Pennsylvania TRM. Area values were calculated from average dimensions of several commercially available units, with radius values measured to the center of the insulation. Area includes tank sides and top to account for typical wrap coverage.
[171] Surface area assumptions from the June 2016 Pennsylvania TRM. A_{EE} was calculated by assuming that the water heater wrap is a 2" thick fiberglass material.
[172] 2016 Ameren Missouri Coincident Peak Demand Factor for Residential Water Heating. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."
[173] Review of AHRI directory suggests range of recovery efficiency ratings for new gas DHW units of 70-87%. Average of existing units is estimated at 78%.
[174] Area values were calculated from average dimensions of several commercially available units, with radius values measured to the center of the insulation. Area includes tank sides and top to account for typical wrap coverage. Recommend updating with Missouri-specific data when available.
[175] A_{EE} was calculated by assuming that the water heater wrap is a 2" thick fiberglass material. Recommend updating with Missouri-specific data when available.

3.3.4 Heat Pump Water Heater

DESCRIPTION

This measure applies to the installation of a heat pump water heater (HPWH) in place of a standard electric water heater in a home. Savings are presented dependent on the heating system installed in the home due to the impact of the heat pump water heater on the heating and cooling loads.

This measure was developed to be applicable to the following program types: TOS, and NC.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the installed equipment must be an ENERGY STAR® heat pump water heater with a storage volume ≤ 55 gallons.[176]

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is assumed to be a new, electric storage water heater meeting federal minimum efficiency standards[177] for units ≤55 gallons: 0.96 – (0.0003 * rated volume in gallons).

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 13 years.[178]

DEEMED MEASURE COST

Actual costs should be used where available. The default value for incremental capital costs is $588.[179]

LOADSHAPE

Water Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{(1/EF_{BASE} - 1/EF_{EE}) * GPD * Household * 365.25 * \gamma Water * (T_{Out} - T_{In}) * 1.0)}{3{,}412}\right) + kWh\_cool - kWh\_heat$$

Where:

EF_{BASE} = EF of standard electric water heater according to federal standards
= 0.96 – (0.0003 * rated volume in gallons)
= If rated volume is unknown, assume 0.945 for a 50-gallon water heater

EF_{EE} = EF of heat pump water heater
= Actual

GPD = Gallons per day of hot water use per person
= 17.6[180]

Household = Average number of people per household

[176] Since the federal standard effectively requires a heat pump water heater for units over 55 gallons, this measure is limited to units ≤ 55 gallons.
[177] Minimum federal standard as of 4/16/2015:
http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf.
http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf.
[178] 2010 Residential Heating Products Final Rule Technical Support Document, U.S. DOE, Table 8.7.2.
[179] Ameren Missouri MEEIA 2016-18 TRM – January 1, 2018.
[180] GPD based on 45.5 gallons of hot water per day per household and 2.59 people per household, from “Residential End Uses of Water Study 2013 Update,” by Deoreo, B., and P. Mayer, for the Water Research Foundation, 2014.

Household Unit Type[181]	Household
Single-Family - Deemed	2.67[182]
Multi-Family - Deemed	2.07[183]
Custom	Actual Occupancy or Number of Bedrooms[184]

365.25 = Days per year

γWater = Specific weight of water
= 8.33 pounds per gallon

T_{OUT} = Tank temperature
= Actual, if unknown assume 125°F

T_{IN} = Incoming water temperature from well or municipal system
= 57.898°F[185]

1.0 = Heat capacity of water (1 Btu/lb*°F)

3,412 = Conversion factor from Btu to kWh

kWh_cool = Cooling savings from conversion of heat in home to water heat[186]

$$= \left[\frac{\left(\left(1 - \frac{1}{EF_{EE}} \right) * GPD * Household * 365.25 * \gamma Water * (T_{OUT} - T_{IN}) * 1.0 \right) * LF * 40\% * LM}{COP_{COOL} * 3{,}412} \right] * \%Cool$$

Where:

LF = Location Factor
= 1.0 for HPWH installation in a conditioned space
= 0.0 for installation in an unconditioned space

40% = Portion of reduced waste heat that results in cooling savings[187]

COP_{COOL} = COP of central air conditioner
= Actual, or if unknown, assume 2.8 COP[188]

LM = Latent multiplier to account for latent cooling demand [189]

Weather Basis (City based upon)	LM
St Louis, MO	3.0

%Cool = Percentage of homes with central cooling

Home	%Cool
Cooling	100%
No Cooling	0%
Unknown	91%[190]

[181] If household type is unknown, as may be the case for TOS measures, then single family deemed value shall be used.
[182] Ameren Missouri Efficient Products Impact and Process Evaluation: Planning Year 2015, prepared by Cadmus.
[183] Ameren Missouri Efficient Products Impact and Process Evaluation: Planning Year 2015, prepared by Cadmus.
[184] Bedrooms are suitable proxies for household occupancy and may be preferable to actual occupancy due to turnover rates in residency and non-adult population impacts.
[185] Using 40" deep soil temp as a proxy at Powell Gardens SCAN site. Average by month of available data from 3/28/02–10/11/14: 12-month average is 57.898. http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=2061.
[186] This algorithm calculates the heat removed from the air by subtracting the heat pump water heater electric consumption from the total water heating energy delivered. This is then adjusted to account for location of the heat pump unit and the coincidence of the waste heat with cooling requirements, the efficiency of the central cooling, and latent cooling demands.
[187] Based on 148 days where CDD 65>0, divided by 365.25. CDD days determined with a base temp of 65°F.
[188] Starting from standard assumption of SEER 10.5 central AC unit, converted to 9.5 EER using algorithm (-0.02 * SEER^2) + (1.12 * SEER) (from Wassmer, M. (2003), “A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations,” (Masters Thesis, University of Colorado at Boulder). Converted to COP = EER/3.412 = 2.8COP.
[189] The Latent Multiplier is used to convert the sensible cooling savings calculated to a value representing sensible and latent cooling loads. The values are derived from the methodology outlined in “Infiltration Factor Calculation Methodology” by Bruce Harley, Senior Manager, Applied Building Science, CLEAResult 11/18/2015, and are based upon an 8760 analysis of sensible and total heat loads using hourly climate data.
[190] Based on 2009 Residential Energy Consumption Survey, see “HC7.9 Air Conditioning in Midwest Region.xls.”

kWh_heat = Heating cost from conversion of heat in home to water heat (dependent on heating fuel)

$$= \left(\frac{\left(\left(1 - \frac{1}{EF_{EE}}\right) * GPD * Household * 365.25 * \gamma Water * (T_{OUT} - T_{IN}) * 1.0 \right) * LF * 58\%}{COP_{HEAT} * 3{,}412} \right) * \%ElectricHeat$$

Where:

58% = Portion of reduced waste heat that results in increased heating load[191]

COP_{HEAT} = COP of electric heating system

= Actual, or if unknown, assume:[192]

System Type	Age of Equipment	Heating Seasonal Performance Factor (HSPF) Estimate	COP (Effective COP Estimate) (HSPF/3.412)* 0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.92
	2015 and after	8.2	2.04
Resistance	N/A	N/A	1

%ElectricHeat = Percentage of home with electric heat

Heating fuel	%ElectricHeat
Electric	100%
Natural Gas	0%
Unknown	35%[193]

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWh * CF$$

Where:

kWh = Electric energy savings, as calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0000887318[194]

NATURAL GAS SAVINGS

$$\Delta Therms = -\left(\frac{\left(\left(1 - \frac{1}{EF_{EE}}\right) * GPD * Household * 365.25 * \gamma Water * (T_{OUT} - T_{IN}) * 1.0 \right) * LF * 43\%}{\eta Heat * 100{,}000} \right) * \%GasHeat$$

Where:

ΔTherms = Heating cost from conversion of heat in home to water heat for homes with Natural Gas heat[195]

100,000 = Conversion factor from Btu to therms

ηHeat = Efficiency of heating system

[191] Based on 212 days where HDD 65>0, divided by 365.25.

[192] These default system efficiencies are based on the applicable minimum federal standards. In 2006, the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.

[193] Average (default) value of 35% electric space heating from 2009 Residential Energy Consumption Survey for Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

[194] Based on Ameren Missouri 2016 loadshape for residential water heating end-use.

[195] This is the additional energy consumption required to replace the heat removed from the home during the heating season by the heat pump water heater. The variable kWh_heating (electric resistance) is that additional heating energy for a home with electric resistance heat (COP 1.0). This formula converts the additional heating kWh for an electric resistance home to the MMBtu required in a natural gas heated home, applying the relative efficiencies.

= 71%[196]

%GasHeat = Percentage of homes with gas heat

Heating Fuel	%GasHeat
Electric	0%
Gas	100%
Unknown	65%[197]

Other factors as defined above

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[196] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey)). See reference "HC6.9 Space Heating in Midwest Region.xls." In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years and so units purchased 15 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

[197] Based on data from Energy Information Administration, 2009 Residential Energy Consumption Survey, see "HC6.9 Space Heating in Midwest Region.xls."

3.3.5 Hot Water Pipe Insulation

DESCRIPTION

This measure applies to the addition of insulation to uninsulated domestic hot water (DHW) pipes. The measure assumes the pipe wrap is installed on the first length of both the hot and cold pipe up to the first elbow. This is the most cost-effective section to insulate since the water pipes act as an extension of the hot water tank up to the first elbow, which acts as a heat trap. Insulating this section helps to reduce standby losses.

This measure was developed to be applicable to the following program types: DI, and RF

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient condition is a domestic hot or cold water pipe with pipe wrap installed that has an R value that meets program requirements.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is an uninsulated, domestic hot or cold water pipe.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years.[198]

DEEMED MEASURE COST

The measure cost is the actual cost of material and installation. If the actual cost is unknown, assume a default cost of \$7.10 [199] per linear foot, including material and installation. For a kit program, assume a default cost of \$2.87.[200]

LOADSHAPE

Water heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation below for electric systems, otherwise assume 24.7 kWh per 6 linear feet of ¾ in, R-4 insulation or 35.4 kWh per 6 linear feet of 1 in, R-6 insulation:

$$\Delta kWh = ((C_{Base}/R_{Base} - C_{EE}/R_{EE}) * L * \Delta T * Hours)/(\eta DHW_{Elec} * 3{,}412)$$

Where:

C_{Base} = Circumference (ft) of uninsulated pipe
= Diameter (in) * π/12
= Actual or if unknown, assume 0.196 ft for a pipe with a 0.75 inch diameter

R_{Base} = Thermal resistance coefficient (hr-°F-ft^2)/Btu) of uninsulated pipe
= 1.0[201]

C_{EE} = Circumference (ft) of insulated pipe
= Diameter (in) * π/12
= Actual or if unknown, assume 0.524 ft for a 0.46 in diameter pipe insulated with 3/4 in, R-4 wrap ((0.75 + 1/2 + 1/2) * π/12)

R_{EE} = Thermal resistance coefficient (hr-°F-ft^2)/Btu) of insulated pipe
= 1.0 + R value of insulation
= Actual or if unknown, assume 5.0 for R-4 wrap or 7.0 for R-6 wrap

L = Length of pipe from water heating source covered by pipe wrap (ft)

---

[198] 2014 Database for Energy-Efficiency Resources (DEER), Version 2014, "Cost Values and Summary Documentation," California Public Utilities Commission, January 2014. Average of values for electric DHW (13 years) and gas DHW (11 years).

[199] Average cost of R-5 pipe wrap installation from the National Renewable Energy Laboratory's National Residential Efficiency Measures Database. http://www.nrel.gov/ap/retrofits/measures.cfm?gId=6&ctId=323

[200] Cost based on RS Means 2018 data

[201] "Measures and Assumptions for Demand Side Management (DSM) Planning; Appendix C Substantiation Sheets," Navigant, April 2009.

= Actual or if unknown, assume 6 ft

ΔT = Average temperature difference (°F) between supplied water and outside air

= Actual or if unknown, assume 60°F[202]

Hours = Hours per year

= 8,766

ηDHW_{Elec} = Recovery efficiency of electric hot water heater

= Actual or if unknown, assume 0.98[203]

3,412 = Conversion factor from Btu to kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

ΔkWh = Electric energy savings, as calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0000887318

NATURAL GAS SAVINGS

Custom calculation below for gas DHW systems, otherwise assume 1.1 therms per 6 linear feet of ¾ in, R-4 insulation or 1.5 therms per 6 linear feet of 1 in, R-6 insulation:

$$\Delta Therms = ((C_{Base}/R_{Base} - C_{EE}/R_{EE}) * L * \Delta T * Hours)/(\eta DHW_{Gas} * 100{,}000)$$

Where:

ηDHW_{Gas} = Recovery efficiency of gas hot water heater

= 0.78[204]

100,000 = Conversion factor from Btu to therms

Other variables as defined above

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[202] Assumes 125°F water leaving the hot water tank and average basement temperature of 65°F.

[203] Electric water heater recovery efficiency from AHRI database: http://www.ahridirectory.org/ahridirectory/pages/home.aspx.

[204] Review of AHRI directory suggests range of recovery efficiency ratings for new gas DHW units of 70-87%. Average of existing units is estimated at 78%.

3.3.6 Thermostatic Restrictor Shower Valve

DESCRIPTION

The measure is the installation of a thermostatic restrictor shower valve in a single or multifamily household. This is a valve attached to a residential showerhead which restricts hot water flow through the showerhead once the water reaches a set point (generally 95F or lower).

This measure was developed to be applicable to the following program types: RF, NC, and DI.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the installed equipment must be a thermostatic restrictor shower valve installed on a residential showerhead.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is the residential showerhead without the restrictor valve installed.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years. [205]

DEEMED MEASURE COST

The incremental cost of the measure should be the actual program cost (including labor if applicable) or $30[206] plus $20 labor[207] if not available.

LOADSHAPE

Water Heating RES

COINCIDENCE FACTOR

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0000887318

[205] Assumptions based on NY TRM, Pacific Gas and Electric Company Work Paper PGECODHW113 and measure life of lowflow showerhead.
[206] Based on actual cost of the SS-1002CP-SB Ladybug Water-Saving Shower-Head adapter from Evolve showerheads.
[207] Estimate for contractor installation time.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

ΔkWh = %ElectricDHW * ((GPM_base_S * L_showerdevice) * Household * SPCD * 365.25 / SPH) * EPG_electric * ISR

Where:

%ElectricDHW = proportion of water heating supplied by electric resistance heating

DHW fuel	%ElectricDHW
Electric	100%
Natural Gas	0%
Unknown	16%[208]

GPM_base_S = Flow rate of the base case showerhead, or actual if available

Program	GPM
Direct-install, device only	1.5[209]
New Construction or direct install of device and low flow showerhead	Rated or actual flow of program-installed showerhead
Retrofit or TOS	2.35[210]

L_showerdevice = Hot water waste time avoided due to thermostatic restrictor valve

= 0.89 minutes[211]

Household = Average number of people per household

Household Unit Type[212]	Household
Single-Family - Deemed	2.67[213]
Multi-Family - Deemed	2.07[214]
Custom	Actual Occupancy or Number of Bedrooms[215]

SPCD = Showers Per Capita Per Day

= 0.66[216]

365.25 = Days per year, on average.

SPH = Showerheads Per Household so that per-showerhead savings fractions can be determined

Household Type	SPH
Single-Family	2.05[217]
Multi-Family	1.4[218]
Custom	Actual

[208] Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Illinois. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.

[209] Illinois Statewide Technical Reference Manual for Energy Efficiency Version 5.0. pp. 184. 2016. http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_5/Final/IL-TRM_Version_5.0_dated_February-11-2016_Final_Compiled_Volumes_1-4.pdf. Assumes low flow showerhead is included in direct installation.

[210] Representative value from sources 1, 2, 4, 5, 6 and 7 (See Source Table at end of measure section) adjusted slightly upward to account for program participation which is expected to target customers with existing higher flow devices rather than those with existing low flow devices.

[211] Average of the following sources: ShowerStart LLC survey; "Identifying, Quantifying and Reducing Behavioral Waste in the Shower: Exploring the Savings Potential of ShowerStart" City of San Diego Water Department survey; "Water Conservation Program: ShowerStart Pilot Project White Paper," and PG&E Work Paper PGECODHW113.

[212] If household type is unknown, as may be the case for TOS measures, then single family deemed value should be used.

[213] Missouri TRM 2017 - Low Flow Showerheads 3.3.2.

[214] Missouri TRM 2017 - Low Flow Showerheads 3.3.2.

[215] Bedrooms are suitable proxies for household occupancy and may be preferable to actual occupancy due to turnover rates in residency and non-adult population impacts.

[216] DeOreo, William, P. Mayer, L. Martien, M. Hayden, A. Funk, M. Kramer-Duffield, and R. Davis (2011). "California Single Family Water Use Efficiency Study."

[217] Missouri TRM 2017 - Low Flow Showerheads 3.3.2.

[218] Missouri TRM 2017 - Low Flow Showerheads 3.3.2.

EPG_electric = Energy per gallon of hot water supplied by electric
= (8.33 * 1.0 * (ShowerTemp - SupplyTemp)) / (RE_electric * 3412)
= (8.33 * 1.0 * (105 – 61.3)) / (0.98 * 3412)
= 0.109 kWh/gal
8.33 = Specific weight of water (lbs/gallon)
1.0 = Heat capacity of water (btu/lb-°)
ShowerTemp = Assumed temperature of water
= 105F[219]
SupplyTemp = Assumed temperature of water entering house
= 61.3F[220]
RE_electric = Recovery efficiency of electric water heater
= 98%[221]
3412 = Converts Btu to kWh (btu/kWh)
ISR = In service rate of showerhead
= Dependent on program delivery method as listed in table below

Selection	ISR
Direct Install - Single Family	0.91
Direct Install – Multi Family	0.91[222]
Efficiency Kits	To be determined through evaluation

EXAMPLE

For example, a direct installed valve in a single-family home with electric DHW:
ΔkWh = 1.0 * (2.67 * 0.89 * 1.5 * 0.66 * 365.25 / 2.05) * 0.108 * 0.91
= 42 kWh

Summer Coincident Peak Demand Savings
ΔkW = ΔkWh/Hours * CF

Where:
ΔkWh = calculated value above
Hours = Annual electric DHW recovery hours for wasted showerhead use prevented by device
= ((GPM_base_S * L_showerdevice) * Household * SPCD * 365.25) * 0.712[223] / GPH
GPH = Gallons per hour recovery of electric water heater calculated for 65.9F temp rise (120-54.1), 98% recovery efficiency, and typical 4.5kW electric resistance storage tank.
= 27.51
= 34.4 for SF direct install; 28.3 for MF direct install
= 30.3 for SF Retrofit and TOS; 24.8 for MF Retrofit and TOS
Water Heating RES

EXAMPLE

For example, a direct installed thermostatic restrictor device in a single family home with electric DHW where the number of showers is not known.
ΔkW = 85.3/34.4 * 0.0022
= 0.0055 kW

219 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 5.0. 2016. pp 103. Available Online: http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_5/Final/IL-TRM_Version_5.0_dated_February-11-2016_Final_Compiled_Volumes_1-4.pdf.
220 Ameren Missouri 2012 Technical Resource Manual. Appendix A. pp. 43. https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483.
221 Electric water heaters have recovery efficiency of 98%: http://www.ahridirectory.org/ahridirectory/pages/home.aspx.
222 Based on Ameren Missouri Community Savers Evaluation.
223 71.2% is the proportion of hot 120F water mixed with 54.1F supply water to give 101F shower water.

Natural Gas Savings

ΔTherms = %FossilDHW * ((GPM_base_S * L_showerdevice)* Household * SPCD * 365.25 / SPH) * EPG_gas * ISR

Where:

%FossilDHW = proportion of water heating supplied by Natural Gas heating

DHW fuel	%Fossil_DHW
Electric	0%
Natural Gas	100%
Unknown	84%[224]

EPG_gas = Energy per gallon of Hot water supplied by gas
= (8.33 * 1.0 * (ShowerTemp - SupplyTemp)) / (RE_gas * 100,000)
= 0.00501 therm/gal for SF homes
= 0.00583 therm/gal for MF homes

RE_gas = Recovery efficiency of gas water heater
= 78% For SF homes[225]
= 67% For MF homes[226]

100,000 = Converts Btus to therms (btu/therm)

Other variables as defined above.

> **EXAMPLE**
>
> For example, a direct installed thermostatic restrictor device in a gas fired DHW single family home where the number of showers is not known:
>
> ΔTherms = 1.0 * ((2.67 * 0.89) * 2.56 * 0.6 * 365.25 / 1.79) * 0.00501 * 0.98
> = 3.7 therms

Water Impact Descriptions and Calculation

Δgallons = ((GPM_base_S * L_showerdevice) * Household * SPCD * 365.25 / SPH) * ISR

Variables as defined above

> **EXAMPLE**
>
> For example, a direct installed thermostatic restrictor device in a single family home where the number of showers is not known:
>
> Δgallons = ((2.67 * 0.89) * 2.56 * 0.6 * 365.25 / 1.79) * 0.98
> = 730 gallons

Deemed O&M Cost Adjustment Calculation

N/A

[224] Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of Illinois. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.

[225] DOE final rule discusses recovery efficiency with an average around 0.76 for gas-fired storage water heaters and 0.78 for standard efficiency gas fired tankless water heaters up to 0.95 for the highest efficiency gas fired condensing tankless water heaters. These numbers represent the range of new units however, not the range of existing units in stock. Review of AHRI Directory suggests range of recovery efficiency ratings for new gas DHW units of 70-87%. Average of existing units is estimated at 78%.

[226] Water heating in multifamily buildings is often provided by a larger central boiler. This suggests that the average recovery efficiency is somewhere between a typical central boiler efficiency of 0.59 and the 0.75 for single family homes. An average efficiency of 0.67 is used for this analysis as a default for multifamily buildings.

Sources

Source ID	Reference
1	2011, DeOreo, William. California Single Family Water Use Efficiency Study. April 20, 2011.
2	2000, Mayer, Peter, William DeOreo, and David Lewis. Seattle Home Water Conservation Study. December 2000.
3	1999, Mayer, Peter, William DeOreo. Residential End Uses of Water. Published by AWWA Research Foundation and American Water Works Association. 1999.
4	2003, Mayer, Peter, William DeOreo. Residential Indoor Water Conservation Study. Aquacraft, Inc. Water Engineering and Management. Prepared for East Bay Municipal Utility District and the US EPA. July 2003.
5	2011, DeOreo, William. Analysis of Water Use in New Single Family Homes. By Aquacraft. For Salt Lake City Corporation and US EPA. July 20, 2011.
6	2011, Aquacraft. Albuquerque Single Family Water Use Efficiency and Retrofit Study. For Albuquerque Bernalillo County Water Utility Authority. December 1, 2011.
7	2008, Schultdt, Marc, and Debra Tachibana. Energy related Water Fixture Measurements: Securing the Baseline for Northwest Single Family Homes. 2008 ACEEE Summer Study on Energy Efficiency in Buildings.
8	2011, Lutz, Jim. "Water and Energy Wasted During Residential Shower Events: Findings from a Pilot Field Study of Hot Water Distribution Systems," Energy Analysis Department Lawrence Berkeley National Laboratory, September 2011.
9	2008, Water Conservation Program: ShowerStart Pilot Project White Paper, City of San Diego, CA.
10	2012, Pacific Gas and Electric Company, Work Paper PGECODHW113, Low Flow Showerhead and Thermostatic Shower Restriction Valve, Revision # 4, August 2012.
11	2008, "Simply & Cost Effectively Reducing Shower Based Warm-Up Waste: Increasing Convenience & Conservation by Attaching ShowerStart to Existing Showerheads," ShowerStart LLC.
12	2014, New York State Record of Revision to the TRM, Case 07-M-0548, June 19, 2014.

Measure Code:

3.4 HVAC

3.4.1 Advanced Thermostat

DESCRIPTION

This measure characterizes the household energy savings from the installation of a new thermostat(s) for reduced heating and cooling consumption through a configurable schedule of temperature setpoints (like a programmable thermostat) *and* automatic variations to that schedule to better match HVAC system runtimes to meet occupant comfort needs. These schedules may be defaults, established through user interaction, and be changed manually at the device or remotely through a web or mobile app. Automatic variations to that schedule could be driven by local sensors and software algorithms and/or through connectivity to an internet software service. Data triggers to automatic schedule changes might include, for example: occupancy/activity detection, arrival & departure of conditioned spaces, optimization based on historical or population-specific trends, or weather data and forecasts.[227] This class of products and services are relatively new, diverse, and rapidly changing. Generally, the savings expected for this measure aren't yet established at the level of individual features, but rather at the system level and how it performs overall. Like programmable thermostats, it is not suitable to assume that heating and cooling savings follow a similar pattern of usage and savings opportunity, so this measure treats these savings independently. This is a very active area of ongoing study to better map features to savings value and establish standards of performance measurement based on field data so that a standard of efficiency can be developed.[228] That work is not yet complete but does inform the treatment of some aspects of this characterization and recommendations. Energy savings are applicable at the household level; all thermostats controlling household heat should be programmable and installation of multiple advanced thermostats per home does not accrue additional savings.

This measure was developed to be applicable to the following program types: TOS, NC, RF, and DI.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

This measure involves replacement of a manual-only or programmable thermostat with one that has the default-enabled capability or the automatic capability to establish a schedule of temperature setpoints according to driving device inputs above and beyond basic time and temperature data of conventional programmable thermostats. As summarized in the description, this category of products and services is broad and rapidly advancing with regard to thermostat capability, usability, and sophistication. At a minimum, a qualifying thermostat must be capable of two-way communication[229] and exceed the typical performance of manual and conventional programmable thermostats through the automatic or default capabilities described above.

DEFINITION OF BASELINE EQUIPMENT

The baseline is either the actual thermostat type (manual or programmable), if known,[230] or an assumed mix of both types based upon information available from evaluations or surveys that represent the population of program participants. This mix may vary by program, but as a default, 44% programmable and 56% manual thermostats may be assumed.[231]

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life for advanced thermostats is assumed to be similar to that of a programmable thermostat -- 10 years[232] -- based upon equipment life only.[233]

---

[227] For example, the capabilities of products and added services that use ultrasound, infrared, or geofencing sensor systems, automatically develop individual models of a home's thermal properties through user interaction. The thermostats optimize system operation based on equipment type and performance traits, such as using n weather forecasts, to demonstrate the type of automatic schedule change functionality that apply to this measure characterization.

[228] The ENERGY STAR® program discontinued its support for basic programmable thermostats effective 12/31/09, and is presently developing a new specification for "Residential Climate Controls."

[229] This measure recognizes that field data may be available, through the thermostat's two-way communication capability, to more accurately establish efficiency criteria and make savings calculations. It is recommended that program implementations incorporate this data into their planning and operation activities to improve understanding of the measure to manage risks and enhance savings results.

[230] If the actual thermostat is programmable and is found to be used in override mode or otherwise is effectively being operated like a manual thermostat, then the baseline may be considered to be a manual thermostat.

[231] Value for blend of baseline thermostats comes from an Illinois potential study conducted by ComEd in 2013; Opinion Dynamics Corporation, "ComEd Residential Saturation/End Use, Market Penetration & Behavioral Study," Appendix 3: Detailed Mail Survey Results, April 2013, p. 34.

[232] Table 1, HVAC Controls, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007.

[233] Future evaluation is strongly encouraged to inform the persistence of savings to further refine measure life assumption. As this characterization depends heavily upon a number of savings studies that lasted a single year or less, the longer-term impacts should be assessed.

DEEMED MEASURE COST

For DI and other programs for which installation services are provided, the actual material, labor, and other costs should be used. For retail, Bring Your Own Thermostat (BYOT) programs,[234] or other program types, actual costs are still preferable.[235] If actual costs are unknown, then the average incremental cost for the new installation measure is assumed to be $175.[236]

LOADSHAPE

Cooling RES

Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh^{237} = \Delta kWh_{heating} + \Delta kWh_{cooling}$$

$$\Delta kWh_{heating} = \%ElectricHeat * HeatingConsumption_{Electric} * HF * HeatingReduction * Eff\_ISR + (\Delta Therms * Fe * 29.3)$$

$$\Delta kWh_{cool} = \%AC * ((EFLHcool * CapacityCool * 1/SEER)/1000) * CoolingReduction * Eff\_ISR$$

Where:

%ElectricHeat = Percentage of heating savings assumed to be electric

Heating fuel	%ElectricHeat
Electric	100%
Natural Gas	0%
Unknown	35%[238]

$HeatingConsumption_{Electric}$ = Estimate of annual household heating consumption for electrically heated single-family homes.[239]

Weather Basis (City based upon)	Elec_Heating_ Consumption (kWh)		
	Electric Resistance	Electric Heat Pump	Unknown Electric[240]
St Louis, MO	14,144	8,320	13,416

HF = Household factor, to adjust heating consumption for non-single-family households.

Household Type	HF
Single-Family	100%
Multi-Family	65%[241]
Actual	Custom[242]

[234] In contrast to program designs that utilize program-affiliated contractors or other trade ally partners that support customer participation through thermostat distribution, installation, and other services, BYOT programs enroll customers after the time of purchase through online rebate and program integration sign-ups.

[235] Actual costs include any one-time software integration, annual software maintenance, and/or individual device energy feature fees.

[236] Market prices vary considerably in this category, generally increasing with thermostat capability and sophistication. The core suite of functions required by this measure's eligibility criteria can be found on units readily available in the market. Prices are in the range of $200 and $250, excluding the availability of any wholesale or volume discounts. The assumed incremental cost is based on the middle of this range ($225) minus a cost of $50 for the baseline equipment blend of manual and programmable thermostats. Add-on energy service costs, which may include one-time setup and/or annual per device costs, are not included in this assumption.

[237] Electrical savings are a function of both heating and cooling energy usage reductions. For heating, this is a function of the percent of electric heat (heat pumps) and fan savings in the case of a natural gas furnace.

[238] Average (default) value of 35% electric space heating from 2009 Residential Energy Consumption Survey for Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

[239] Values in table are based on converting an average household heating load (834 therms) for Chicago based on Illinois furnace metering study ('Table E-1, Energy Efficiency/Demand Response Nicor Gas Plan Year 1: Research Report: Furnace Metering Study, Draft, Navigant, August 1 2013) to an electric heat load (divide by 0.03413) to electric resistance and ASHP heat load (resistance load reduced by 15% to account for distribution losses that occur in furnace heating but not in electric resistance while ASHP heat is assumed to suffer from similar distribution losses) and then to electric consumption assuming efficiencies of 100% for resistance and 200% for HP (see 'Thermostat_FLH and Heat Load Calcs.xls'). The other weather basis values are calculated using climate normals HDD data with a base temp ratio of 60°F.

[240] Assumption that 12.5% of electrically heated homes in Missouri have heat pumps, based on 2009 Residential Energy Consumption Survey for Missouri.

[241] Multifamily household heating consumption relative to single family households is affected by overall household square footage and exposure to the exterior. This 65% reduction factor is applied to multifamily homes with electric resistance, based on professional judgment that average household size, and heat loads of multifamily households are smaller than single family homes

[242] Program-specific household factors may be utilized on the basis of sufficiently validated program evaluations.

HeatingReduction = Assumed percentage reduction in total household heating energy consumption due to advanced thermostat

Existing Thermostat Type	Heating_Reduction[243]
Manual	8.8%
Programmable	5.6%
Unknown (Blended)	7.4%

Eff_ISR = Effective In-Service Rate, the percentage of thermostats installed and configured effectively for 2-way communication
= If programs are evaluated during program deployment then custom ISR assumptions should be applied. If in service rate is captured within the savings percentage, ISR should be 100%. If using default savings, use 100%.[244]

ΔTherms = Therm savings if natural gas heating system
= See calculation in natural gas section below

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption
= 3.14%[245]

29.3 = kWh per therm

%AC = Fraction of customers with thermostat-controlled air-conditioning

Thermostat control of air conditioning?	%AC
Yes	100%
No	0%
Unknown	Actual population data, or 91%[246]

$EFLH_{cool}$ = Equivalent full load hours of air conditioning:[247]

Weather Basis (City based upon)	$EFLH_{cool}$ (Hours)
St Louis, MO	869

CapacityCool = Capacity of air cooling system (Btu/hr) (Note: One ton is equal to 12,000 Btu/hr.)
= Actual installed - If actual size unknown, assume 36,000 Btu/h

SEER = the cooling equipment's Seasonal Energy Efficiency Ratio rating (kBtu/kWh)
= Use actual SEER rating where it is possible to measure or reasonably estimate. If unknown assume 13.[248]

1/1000 = kBtu per Btu

CoolingReduction = Assumed percentage reduction in total household cooling energy consumption due to installation of advanced thermostat
= If programs are evaluated during program deployment then custom savings assumptions should be applied. Otherwise use:
= 8.0%[249]

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[243] These values represent adjusted baseline savings values for different existing thermostats, as presented in Navigant's IL TRM Workpaper on Impact Analysis from Preliminary Gas savings findings (page 28). The unknown assumption is calculated by multiplying the savings for manual and programmable thermostats by their respective share of baseline. Further evaluation and regular review of this key assumption is encouraged.

[244] As a function of the method for determining savings impact of these devices, in-service rate effects are already incorporated into the savings value for heating reduction above.

[245] F_e is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBTU/yr) and Eae (kWh/yr). An average of a 300- record sample (non-random) out of 1495 was 3.14%. This is appropriately ~50% greater than the ENERGY STAR® version 3 criteria for 2% F_e. See "Programmable Thermostats Furnace Fan Analysis.xlsx" for reference.

[246] 91% of homes have central cooling in Missouri (based on 2009 Residential Energy Consumption Survey, see "RECS 2009 Air Conditioning_hc7.9.xls").

[247] Based on full load hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) and reduced by 28.5% based on the evaluation results in Ameren Missouri territory, which suggests an appropriate EFLH of 869.The other weather basis values are calculated using the relative climate normals cooling degree day ratios (at 65F set point).

[248] Based on minimum federal standard: http://www1.eere.energy.gov/buildings/appliance_standards/residential/residential_cac_hp.html.

[249] This assumption is based upon the review of many evaluations from other regions in the United States. Cooling savings are more variable than heating due to significantly more variability in control methods and potential population and product capability.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:

$kWh_{cooling}$ = Electric energy savings for cooling, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0009474181[250]

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = \%FossilHeat * HeatingConusmption_{Gas} * HF * HeatingReduction * Eff\_ISR$$

Where:

%FossilHeat = Percentage of heating savings assumed to be Natural Gas

Heating fuel	%FossilHeat
Electric	0%
Natural Gas	100%
Unknown	65%[251]

$HeatingConsumption_{Gas}$
= Estimate of annual household heating consumption for gas heated single-family homes.[252]

Weather Basis (City based upon)	Gas_Heating_ Consumption (Therms)
St Louis, MO	680

Other variables as provided above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[250] 2016 Ameren Missouri Coincident Peak Demand Factor for Residential Cooling. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

[251] Average (default) value of 65% gas space heating from 2009 Residential Energy Consumption Survey for Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

[252] Values in table are based on average household heating load (834 therms) for Chicago based on Illinois furnace metering study ('Table E-1, Energy Efficiency/Demand Response Nicor Gas Plan Year 1: Research Report: Furnace Metering Study, Draft, Navigant, August 1 2013) and adjusted for Missouri climate region values using the relative climate- normal HDD data with a base temp ratio of 60°F. This load value is then divided by standard assumption of existing unit efficiency of 83.5% (estimate based on 29% of furnaces purchased in Missouri were condensing in 2000 (based on data from GAMA, provided to Department of Energy) (see 'Thermostat_FLH and Heat Load Calcs.xls'). The resulting values are generally supported by data provided by Laclede Gas, which showed an average pre-furnace replacement consumption of 1009 therms for St Louis, and a post-replacement consumption of 909. Assuming a typical hot water consumption at 225 therms (using defaults from http://energy.gov/eere/femp/energy-cost-calculator-electric-and-gas-water-heaters-0#output), this indicates a heating load of 684-784 therms.

3.4.2 Air Source Heat Pump Including Dual Fuel Heat Pumps

DESCRIPTION
An air source heat pump provides heating or cooling by moving heat between indoor and outdoor air. A dual fuel heat pump pairs an air source heat pump with a gas furnace. The air source heat pump provides heating in mild weather, and as temperature drop the heat pump shuts off and the furnace provides heating.

This measure characterizes:

a) TOS:
   a. The installation of a new residential sized (<= 65,000 Btu/hr) air source heat pump that is more efficient than required by federal standards. This could relate to the replacement of an existing unit at the end of its useful life, or the installation of a new system in a new home.

b) EREP:
   The early removal of functioning electric heating and cooling systems from service, prior to its natural end of life, and replacement with a new high efficiency air source heat pump unit. To qualify as Early Replacement, the existing unit must be operational when replaced. If the SEER of the existing unit is known and the Baseline SEER is the actual SEER value of the unit replaced and if unknown use assumptions in the variable list below ($SEER_{exist}$ and $HSPF_{exist}$). If the operational status of the existing unit is unknown, use TOS assumptions.

This measure was developed to be applicable to the following program types: TOS, NC, and EREP.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT
A new residential-sized (<= 65,000 Btu/hr) air source heat pump with specifications to be determined by the program.

DEFINITION OF BASELINE EQUIPMENT
A new residential-sized (<= 65,000 Btu/hr) air source heat pump meeting federal standards.

The baseline for the TOS measure is based on the current federal standard efficiency level as of January 1, 2015; 14 SEER and 8.2HSPF, when replacing an existing air source heat pump; and 13 SEER and 3.41 HSPF when replacing a central air conditioner and electric resistance heating.

The baseline for the early replacement measure is the efficiency of the existing equipment for the assumed remaining useful life of the unit and the new baseline as defined above for the remainder of the measure life.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The expected measure life is assumed to be 18 years.[253]
Remaining life of existing ASHP/CAC equipment is assumed to be 6 years[254] and 18 years for electric resistance.

DEEMED MEASURE COST
Dual Fuel Heat Pump:

Efficiency (EER)	Cost (including labor) per measure
DFHP - SEER 19 MF heat pump base	2936.6
DFHP - SEER 20 MF heat pump base	3176.6
DFHP - SEER 21 MF heat pump base	3626.6

Air Source Heat Pump:

TOS: The incremental capital cost for this measure is dependent on the efficiency and capacity of the new unit. Note these costs are per ton of unit capacity:

[253] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007, http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf.
[254] Assumed to be one third of effective useful life.

Efficiency (SEER)	Incremental Cost per Ton of Capacity ($/ton)	Source
SEER 15	$303.00	IL TRM V6.0
SEER 16	$392.70	RS Means 2018 data
SEER 17	$580.00	RS Means 2018 data
SEER 18	$713.33	RS Means 2018 data
SEER 19	$813.33	RS Means 2018 Data
SEER 20	$1,160.00	RS Means 2018 Data
SEER 21	$1,160.00	SEER 20 value used

EREP: The full install cost for this measure is the actual cost of removing the existing unit and installing the new one. If this is unknown, assume the following (note these costs are per ton of unit capacity):

Efficiency (SEER)	Full Retrofit Cost (including labor) per Ton of Capacity ($/ton)	Source
SEER 15	$844.69	IL TRM V6.0
SEER 16	$934.39	RS Means 2018 data
SEER 17	$1,121.69	RS Means 2018 data
SEER 18	$1,255.02	RS Means 2018 data
SEER 19	$1,355.02	RS Means 2018 Data
SEER 20	$1,701.69	RS Means 2018 Data
SEER 21	$1,701.69	SEER 20 value used

Assumed deferred cost (after 6 years) of replacing existing equipment with new baseline unit is assumed to be $1,518 per ton of capacity. This cost should be discounted to present value using the utilities' real discount rate.

LOADSHAPE
Cooling RES
Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

TOS:

$\Delta kWh = ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{base} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{base} - 1/HSPF_{ee})) / 1000)$

EREP:[255]

ΔkWH for remaining life of existing unit (1st 6 years for replacing an ASHP, 18 years for replacing electric resistance):

$= ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{exist} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{exist} - 1/HSPF_{ee})) / 1000)$

ΔkWH for remaining measure life (next 12 years if replacing an ASHP):

$= ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{base} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{base} - 1/HSPF_{ee})) / 1000)$

Where:

$EFLH_{cool}$ = Equivalent full load hours of air conditioning[256]:

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[255] The two equations are provided to show how savings are determined during the initial phase of the measure (existing to efficient) and the remaining phase (new baseline to efficient). In practice, the screening tools used may either require a first year savings (using the first equation) and then a "number of years to adjustment" and "savings adjustment" input, which would be the either the new base to efficient savings or the (existing to efficient savings.

[256] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) and reduced by 28.5% based on the evaluation results in Ameren Missouri' service territory, suggesting an appropriate EFLH of 869.The other weather basis values are calculated using the relative climate normals cooling degree day ratios (at 65F set point).

Weather Basis (City based upon)	$EFLH_{cool}$ (Hours)
St Louis, MO	869

$Capacity_{cool}$ = Cooling Capacity of Air Source Heat Pump (Btu/hr)
= Actual (1 ton = 12,000Btu/hr)

$SEER_{exist}$ = Seasonal Energy Efficiency Ratio of existing cooling system (kBtu/kWh)
= Use actual SEER rating where it is possible to measure or reasonably estimate.

Existing Cooling System	$SEER_{exist}$[257]
Air Source Heat Pump	7.2
Central AC	6.8
No central cooling[258]	Let '1/$SEER_{exist}$' = 0

$SEER_{base}$ = Seasonal Energy Efficiency Ratio of baseline Air Source Heat Pump (kBtu/kWh)
= 14[259]

$SEER_{ee}$ = Seasonal Energy Efficiency Ratio of efficient Air Source Heat Pump (kBtu/kWh)
= Actual

$EFLH_{heat}$ = Equivalent full load hours of heating:[260]

Weather Basis (City based upon)	$EFLH_{heat}$ (Hours)
St Louis, MO	2009 for ASHP and 1119 for DFHP

$Capacity_{heat}$ = Heating Capacity of Air Source Heat Pump (Btu/hr)
= Actual (1 ton = 12,000Btu/hr)

$HSPF_{exist}$ =Heating System Performance Factor of existing heating system (kBtu/kWh)
= Use actual HSPF rating where it is possible to measure or reasonably estimate. If not available use:

Existing Heating System	$HSPF_{exist}$
Air Source Heat Pump	5.44[261]
Electric Resistance	3.41[262]

$HSPF_{base}$ =Heating System Performance Factor of baseline Air Source Heat Pump (kBtu/kWh)
= 8.2[263]

$HSFP_{ee}$ =Heating System Performance Factor of efficient Air Source Heat Pump (kBtu/kWh)
= Actual

SUMMER COINCIDENT PEAK DEMAND SAVINGS

Time of sale:

$\Delta kW = \Delta kWh_{cooling} * CF$

CF = 0.0009474181

[257] ASHP existing efficiency assumes degradation and is sourced from the Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015. CAC assumed to follow the same trend in degradation as the ASHP: 9.12 SEER nameplate to 7.2 operations SEER represents degradation to 78.9% of nameplate. 78.9% of 8.6 SEER CAC nameplate gives an operational SEER of 6.8.

[258] If there is no central cooling in place but the incentive encourages installation of a new ASHP with cooling, the added cooling load should be subtracted from any heating benefit.

[259] Based on minimum federal standard effective 1/1/2015: http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf.

[260] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls). The other weather basis values are calculated using the relative climate normals HDD data with a base temp ratio of 60°F.

[261] This is estimated based on finding the average HSPF/SEER ratio from the AHRI directory data (using the least efficient models – SEER 12 and SEER 13) – 0.596, and applying to the average nameplate SEER rating of all early replacement qualifying equipment in Ameren PY3-PY4. This estimation methodology appears to provide a result within 10% of actual HSPF.

[262] Electric resistance has a COP of 1.0 which equals 1/0.293 = 3.41 HSPF.

[263] Based on minimum federal standard effective 1/1/2015: http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf.

NATURAL GAS SAVINGS
N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION
N/A

DEEMED O&M COST ADJUSTMENT CALCULATION
N/A

MEASURE CODE:

3.4.3 Duct Sealing and Duct Repair

DESCRIPTION

This measure describes evaluating the savings associated with performing duct sealing to the distribution system of homes with central cooling and/or a ducted heating system. While sealing ducts in conditioned space can help with control and comfort, energy savings are largely limited to sealing ducts in unconditioned space where the heat loss is to outside the thermal envelope. Therefore, for this measure to be applicable at least 30% of ducts should be within unconditioned space (e.g., attic with floor insulation, vented crawlspace, unheated garages; basements should be considered conditioned space).

Three methodologies for estimating the savings associate from sealing the ducts are provided.

1. **Modified Blower Door Subtraction** – this technique is described in detail on p. 44 of the Energy Conservatory Blower Door Manual; http://dev.energyconservatory.com/wp-content/uploads/2014/07/Blower-Door-model-3-and-4.pdf.
   It involves performing a whole house depressurization test and repeating the test with the ducts excluded.
2. **Duct Blaster Testing** - as described in RESNET Test 803.7: http://www.resnet.us/standards/DRAFT_Chapter_8_July_22.pdf.
   This involves using a blower door to pressurize the house to 25 Pascals and pressurizing the duct system using a duct blaster to reach equilibrium with the inside. The air required to reach equilibrium provides a duct leakage estimate.
3. **Deemed Savings per Linear Foot** – this method provides a deemed conservative estimate of savings and should only be used where performance testing described above is not possible.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient condition is sealed duct work throughout the unconditioned space in the home.

DEFINITION OF BASELINE EQUIPMENT

The existing baseline condition is leaky duct work with at least 30% of the ducts within the unconditioned space in the home.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The assumed lifetime of this measure is 20 years.[264]

DEEMED MEASURE COST

The actual duct sealing measure cost should be used.

LOADSHAPE

HVAC RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Methodology 1: Modified Blower Door Subtraction

a. Determine Duct Leakage rate before and after performing duct sealing:

$$Duct\ Leakage\ (CFM50_{DL}) = (CFM50_{Whole\ House} - CFM50_{Envelope\ Only}) * SCF$$

Where:

$CFM50_{Whole\ House}$ = Standard Blower Door test result finding Cubic Feet per Minute at 50 Pascal pressure differentials

$CFM50_{Envelope\ Only}$ = Blower Door test result finding Cubic Feet per Minute at 50 Pascal pressure differentials with all supply and return registers sealed

[264] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.

SCF = Subtraction Correction Factor to account for underestimation of duct leakage due to connections between the duct system and the home. Determined by measuring pressure with respect to the building in the sealed duct system, with the building pressurized to 50 Pascals with respect to the outside. Use the following look up table provided by energy conservatory to determine the appropriate subtraction correction factor:

House to Duct Pressure	Subtraction Correction Factor
50	1.00
49	1.09
48	1.14
47	1.19
46	1.24
45	1.29
44	1.34
43	1.39
42	1.44
41	1.49
40	1.54
39	1.60
38	1.65
37	1.71
36	1.78
35	1.84
34	1.91
33	1.98
32	2.06
31	2.14

House to Duct Pressure	Subtraction Correction Factor
30	2.23
29	2.32
28	2.42
27	2.52
26	2.64
25	2.76
24	2.89
23	3.03
22	3.18
21	3.35
20	3.54
19	3.74
18	3.97
17	4.23
16	4.51
15	4.83
14	5.20
13	5.63
12	6.12
11	6.71

b. Calculate duct leakage reduction, convert to $CFM25_{DL,}$[265] and factor in Supply and Return Loss Factors:

$$Duct\ Leakage\ Reduction\ (\Delta CFM25_{\mathrm{DL}}) = (Pre\ CFM50_{DL} - Post\ CFM50_{DL}) * 0.64 * (SLF + RLF)$$

Where:

0.64 = Converts $CFM50_{DL}$ to $CFM25_{DL}$[266]

SLF = Supply Loss Factor[267]
= % leaks sealed located in Supply ducts * 1
Default = 0.5[268]

RLF = Return Loss Factor[269]
= % leaks sealed located in Return ducts * 0.5
Default = 0.25[270]

---

[265] 25 Pascals is the standard assumption for typical pressures experienced in the duct system under normal operating conditions.
[266] To convert CFM50 to CFM25, multiply by 0.64 (inverse of the "Can't Reach Fifty" factor for CFM25; see Energy Conservatory Blower Door Manual).
[267] Assumes that for each percent of supply air loss there is one percent annual energy penalty. This assumes supply leaks are direct losses to the outside and are not recaptured back to the house. This could be adjusted downward to reflect regain of usable energy to the house from duct leaks. For example, during the winter some of the energy lost from supply leaks in a crawlspace will probably be regained back to the house (sometimes 1/2 or more may be regained). More information provided in "Appendix E Estimating HVAC System Loss From Duct Airtightness Measurements" from Energy Conservatory Blower Door Manual.
[268] Assumes 50% of leaks are in supply ducts.
[269] Assumes that for each percent of return air loss there is a half percent annual energy penalty. Note that this assumes that return leaks contribute less to energy losses than do supply leaks. This value could be adjusted upward if there was reason to suspect that the return leaks contribute significantly more energy loss than "average" (e.g., pulling return air from a super-heated attic), or can be adjusted downward to represent significantly less energy loss (e.g., pulling return air from a moderate temperature crawl space). More information provided in "Appendix E Estimating HVAC System Loss From Duct Airtightness Measurements" from Energy Conservatory Blower Door Manual.
[270] Assumes 50% of leaks are in return ducts.

c. Calculate electric savings

$$\Delta kWh = \Delta kWhCooling + \Delta kWhHeating$$

$$\Delta kWhCooling = \frac{\frac{\Delta CFM25_{DL}}{(CapacityCool/12000 * 400)} * EFLHcool * CapacityCool}{1000 * SEER}$$

$$\Delta kWhHeating_{Electric} = \frac{\frac{\Delta CFM25_{DL}}{(CapacityHeat/12000 * 400)} * EFLHheat * CapacityHeat}{COP * 3412}$$

$$\Delta kWhHeating_{Gas} = (\Delta Therms * Fe * 29.3)$$

Where:

$\Delta CFM25_{DL}$ = Duct leakage reduction in CFM2 as calculated above

CapacityCool = Capacity of Air Cooling system (Btu/hr)
= Actual

12,000 = Converts Btu/H capacity to tons

400 = Conversion of Capacity to CFM (400CFM / ton) [271]

EFLHcool = Equivalent Full Load Cooling Hours:[272]

Weather Basis (City based upon)	EFLHcool (Hours)
St Louis, MO	869

1000 = Converts Btu to kBtu

SEER = Efficiency in SEER of Air Conditioning equipment
= Actual - If not available, use:[273]

Equipment Type	Age of Equipment	SEER Estimate
Central AC	Before 2006	10
	After 2006	13
Heat Pump	Before 2006	10
	2006-2014	13
	2015 on	14

CapacityHeat = Heating output capacity (Btu/hr) of electric heat
= Actual

EFLHheat = Equivalent Full Load Heating Hours:[274]

Weather Basis (City based upon)	EFLHheat (Hours)
St Louis, MO	2009

COP = Efficiency in COP of Heating equipment
= Actual - If not available, use:[275]

[271] This conversion is an industry rule of thumb. E.g., see http://www.hvacsalesandsupply.com/Linked%20Documents/Tech%20Tips/61-Why%20400%20CFM%20per%20ton.pdf.

[272] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) and reduced by 28.5% based on the evaluation results in Ameren territory suggesting an appropriate EFLH of 869.The other weather basis values are calculated using the relative climate normals cooling degree day ratios (at 65F set point).

[273] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for central AC was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

[274] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls). The other climate region values are calculated using the relative climate normals HDD data with a base temp ratio of 60°F.

[275] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.

System Type	Age of Equipment	HSPF Estimate	COP (Effective COP Estimate) (HSPF/3.412)*0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.92
	2015 on	8.2	2.04
Resistance	N/A	N/A	1

3412 = Converts Btu to kWh

ΔTherms = Therm savings as calculated in Natural Gas Savings

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption
= 3.14%[276]

29.3 = kWh per therm

Methodology 2: Duct Blaster Testing

$$\Delta kWh = \Delta kWhCooling + \Delta kWhHeating$$

$$\Delta kWhCooling = \frac{\frac{Pre\_CFM25 - Post\_CFM25}{CapacityCool/12000 * 400} * EFLHcool * CapacityCool}{1000 * SEER}$$

$$\Delta kWhHeating_{Electric} = \frac{\frac{Pre\_CFM25 - Post\_CFM25}{CapacityCool/12000 * 400} * EFLHheat * CapacityHeat}{COP * 3412}$$

$$\Delta kWhHeating_{Gas} = (\Delta Therms * Fe * 29.3)$$

Where:

Pre_CFM25 = Duct leakage in CFM25 as measured by duct blaster test before sealing

Post_CFM25 = Duct leakage in CFM25 as measured by duct blaster test after sealing

All other variables as provided above

Methodology 3: Deemed Savings[277]

$$\Delta kWh = \Delta kWhcooling + \Delta kWhHeating$$

$$\Delta kWhcooling = CoolSavingsPerUnit * Duct_{Length}$$

$$\Delta kWhHeating_{Electric} = HeatSavingsPerUnit * Duct_{Length}$$

$$\Delta kWhHeating_{Gas} = (\Delta Therms * Fe * 29.3)$$

Where:

CoolSavingsPerUnit = Annual cooling savings per linear foot of duct

Building Type	HVAC System	CoolSavingsPerUnit (kWh/ft)
Multifamily	Cool Central	0.70
Single-family	Cool Central	0.81
Multifamily	Heat Pump—Cooling	0.70
Single-family	Heat Pump—Cooling	0.81

$Duct_{Length}$ = Linear foot of duct
= Actual

HeatSavingsPerUnit = Annual heating savings per linear foot of duct

Building Type	HVAC System	HeatSavingsPerUnit (kWh/ft)
Manufactured	Heat Pump—Heating	5.06
Multifamily	Heat Pump - Heating	3.41
Single-family	Heat Pump— Heating	4.11

[276] F_e is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300 record sample (non-random) out of 1495 was 3.14%. This is, appropriately, ~50% greater than the ENERGY STAR® version 3 criteria for 2% F_e.

[277] Savings per unit are based upon analysis performed by Cadmus for the 2011 Iowa Joint Assessment of Potential. It was based on 10% savings in system efficiency. This would represent savings from homes with significant duct work outside of the thermal envelope. With no performance testing or verification, a deemed savings value should be very conservative and therefore the values provided in this section represent half of the savings – or 5% improvement. These values are provided as a conservative deemed estimate for Missouri, while encouraging the use of performance testing and verification for determination of more accurate savings estimates.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW \quad = \Delta kWh_{cooling} * CF$$

Where:

$kWh_{cooling}$ = Electric energy savings for cooling, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0009474181[278]

NATURAL GAS SAVINGS

For homes with Natural Gas Heating:

Methodology 1: Modified Blower Door Subtraction

$$\Delta Therm = \frac{\frac{\Delta CFM25_{DL}}{CapacityHeat * 0.0136} * EFLHheat * CapacityHeat * \frac{\eta Equipment}{\eta System}}{100{,}000}$$

Where:

$\Delta CFM25_{DL}$ = Duct leakage reduction in CFM25

= As calculated in Methodology 1 under electric savings

CapacityHeat = Heating input capacity (Btu/hr)

= Actual

0.0125 = Conversion of Capacity to CFM (0.0125CFM / Btu/hr)[279]

ηEquipment = Heating Equipment Efficiency

= Actual[280] - If not available, use 83.5%[281]

ηSystem = Pre duct sealing Heating System Efficiency (Equipment Efficiency * Pre Distribution Efficiency)[282]

= Actual - If not available use 71.0%[283]

100,000 = Converts Btu to therms

Methodology 2: Duct Blaster Testing

$$\Delta Therms = \frac{\frac{Pre\_CFM25 - Post\_CFM25}{CapacityHeat * 0.0136} * EFLHgasheat * CapacityHeat * \frac{\eta Equipment}{\eta System}}{100{,}000}$$

Where:

All variables as provided above

Methodology 3: Deemed Savings[284]

$$\Delta Therms = HeatSavingsPerUnit * Duct_{Length}$$

[278] 2016 Ameren Missouri Coincident Peak Demand Factor for Residential Cooling. See reference "Ameren Missouri 2016 Appendix E - End Use Shapes and Coincident Factors.pdf."

[279] Based on natural draft furnaces requiring 100 CFM per 10,000 Btu, induced draft furnaces requiring 130CFM per 10,000Btu, and condensing furnaces requiring 150 CFM per 10,000 Btu (rule of thumb from http://contractingbusiness.com/enewsletters/cb_imp_43580/). Data provided by GAMA during the federal rulemaking process for furnace efficiency standards, suggested that in 2000, 29% of furnaces purchased in Missouri were condensing units. Therefore, a weighted average required airflow rate is calculated assuming a 50:50 split of natural v induced draft non-condensing furnaces, as 125 per 10,000Btu or 0.0125/Btu.

[280] The actual Heating Equipment Efficiency can be obtained either by recording the AFUE of the unit, or performing a steady state efficiency test. If there is more than one heating system, the weighted (by consumption) average efficiency should be used.

If the heating system or distribution is being upgraded within a package of measures together with the insulation upgrade, the new average heating system efficiency should be used.

[281] In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment; see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 16 years ago provide a reasonable proxy for the current mix of furnaces in the state. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: (0.29*0.92) + (0.71*0.8) = 0.835.

[282] The distribution efficiency can be estimated via a visual inspection and by referring to a look-up table such as that provided by the Building Performance Institute - (http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf) - or by performing duct blaster testing.

[283] Estimated as follows: 0.835 * (1-0.15) = 0.710.

[284] Savings per unit are based upon analysis performed by Cadmus for the 2011 Joint Assessment of Potential. It was based on 10% savings in system efficiency. This would represent savings from homes with significant duct work outside of the thermal envelope. With no performance testing or verification, a deemed savings value should be very conservative and therefore the values provided in this section represent half of the savings – or 5% improvement. These values are provided as a conservative deemed estimate for Missouri, while encouraging the use of performance testing and verification for determination of more accurate savings estimates.

Where:

HeatSavingsPerUnit = Annual heating savings per linear foot of duct

Building Type	HVAC System	HeatSavingsPerUnit (Therms/ft)
Multifamily	Heat Central Furnace	0.19
Single-family	Heat Central Furnace	0.21

$Duct_{Length}$ = Linear foot of duct
= Actual

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

3.4.4 Ductless Air Source Heat Pump

DESCRIPTION

This measure is designed to calculate electric savings from retrofitting existing electric HVAC systems with ductless mini-split heat pumps (DMSHPs). DMSHPs save energy in heating mode because they provide heat more efficiently than electric resistance heat and central ASHP systems. Additionally, DMSHPs use less fan energy to move heat and don't incur heat loss through a duct distribution system. Often DMSHPs are installed in addition to (do not replace) existing heating equipment because at extreme cold conditions many DMSHPs cannot provide enough heating capacity, although cold-climate heat pumps can continue to perform at sub-zero temperatures.

For cooling, the proposed savings calculations are aligned with those of typical replacement systems. DMSHPs save energy in cooling mode because they provide cooling capacity more efficiently than other types of unitary cooling equipment. A DMSHP installed in a home with a central ASHP system will save energy by offsetting some of the cooling energy of the ASHP. In order for this measure to apply, the control strategy for the heat pump is assumed to be chosen to maximize savings per installer recommendation.[285]

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the new equipment must be a high-efficiency, variable-capacity (typically "inverter-driven" DC motor) ductless heat pump system that exceeds the program minimum efficiency requirements.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, baseline equipment must include a permanent electric resistance heating source or a ducted air-source heat pump. For multifamily buildings, each residence must have existing individual heating equipment. Multifamily residences with central heating do not qualify for this characterization. Existing cooling equipment is assumed to be standard efficiency. Note that in order to claim cooling savings, there must be an existing air conditioning system.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 18 years.[286]

[285] The whole purpose of installing ductless heat pumps is to conserve energy, so the installer can be assumed to be capable of recommending an appropriate control strategy. For most applications, the heating setpoint for the ductless heat pump should be at least 2F higher than any remaining existing system and the cooling setpoint should be at least 2F cooler than the existing system (this should apply to all periods of a programmable schedule, if applicable). This helps ensure that the ductless heat pump will be used to meet as much of the load as possible before the existing system operates to meet the remaining load. Ideally, the new ductless heat pump controls should be set to the current comfort settings, while the existing system setpoints should be adjusted down (heating) and up (cooling) to capture savings.

[286] Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007.

DEEMED MEASURE COST

The incremental cost for this measure is provided below:

Measure	Incremental Cost ($/ 1.5 ton)	Source
Ductless AC - ER1 SF	$2,108	Ameren Missouri MEEIA 2016-18 TRM effective January 1, 2018
Ductless AC - Replace on fail SF	$1,545	RS Means 2018 data
Ductless ASHP - Replace on fail SF NC	$888	Ameren Missouri MEEIA 2016-18 TRM effective January 1, 2018
Ductless ASHP - Replace on fail SF ROF	$888.	Ameren Missouri MEEIA 2016-18 TRM effective January 1, 2018
Ductless ASHP Replace Electric Resistance ER1 SF	$2,108	Ameren Missouri MEEIA 2016-18 TRM effective January 1, 2018
Ductless ASHP Replace Electric Resistance ROF	$1,051	Ameren Missouri MEEIA 2016-18 TRM effective January 1, 2018
Ductless ASHP ER1 SF	$1,982	Ameren Missouri MEEIA 2016-18 TRM effective January 1, 2018
Ductless AC - ER1 MF	$1,413	RS Means 2018 data
Ductless AC - Replace on fail MF	$978.50	RS Means 2018 data
Ductless ASHP - Replace on fail MF NC	$705	RS Means 2018 data
Ductless ASHP - Replace on fail MF ROF	$705	RS Means 2018 data
Ductless ASHP Replace Electric Resistance ER1 MF	$1,590	RS Means 2018 data
Ductless ASHP Replace Electric Resistance ROF MF	$705	RS Means 2018 data
Ductless ASHP ER1 MF	$1,440	RS Means 2018 data

LOADSHAPE

Cooling RES

Heating RES

Algorithms

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Electric savings

$$\Delta kWh = \Delta kWh_{heat} + \Delta kWh_{cool}$$

$$\Delta kWh_{heat} = (Capacity_{heat} * EFLH_{heat} * (1/HSPF_{exist} - 1/HSPF_{ee})) / 1000$$

$$\Delta kWh_{cool} = (Capacity_{cool} * EFLH_{cool} * (1/SEER_{exist} - 1/SEER_{ee})) / 1000$$

Where:

$Capacity_{heat}$ = Heating capacity of the ductless heat pump unit in Btu/hr
= Actual

$EFLH_{heat}$ = Equivalent Full Load Hours for heating. See table below:

Weather Basis (City based upon)	$EFLH_{heat}$[287]
St Louis	1,496

[287] Ameren Missouri Heating and Cooling Evaluation - Program Year 2016.

$HSPF_{exist}$ = HSPF rating of existing equipment (kbtu/kwh)

Existing Equipment Type	$HSPF_{exist}$
Electric resistance heating	3.412[288]
Air Source Heat Pump	5.44[289]

$HSPF_{ee}$ = HSPF rating of new equipment (kbtu/kwh)
= Actual installed
$Capacity_{cool}$ = the cooling capacity of the ductless heat pump unit in Btu/hr.[290]
= Actual installed
$SEER_{ee}$ = SEER rating of new equipment (kbtu/kwh)
= Actual installed[291]
$SEER_{exist}$ = SEER rating of existing equipment (kbtu/kwh)

= Use actual value. If unknown, see table below

Existing Cooling System	$SEER_{exist}$[292]
Air Source Heat Pump	7.2
Central AC	6.8
Room AC	6.3[293]
No existing cooling[294]	Let '1/SEER_exist' = 0

$EFLH_{cool}$ = Equivalent Full Load Hours for cooling. See table below[295] Weather Basis	$EFLH_{cool}$
St Louis	869

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:
CF = 0.0009474181

NATURAL GAS SAVINGS

N/A

[288] Electric resistance has a COP of 1.0 which equals 1/0.293 = 3.41 HSPF.
[289] This is estimated based on finding the average HSPF/SEER ratio from the AHRI directory data (using the least efficient models – SEER 12 and SEER 13) – 0.596, and applying to the average nameplate SEER rating of all Early Replacement qualifying equipment in Ameren PY3-PY4. This estimation methodology appears to provide a result within 10% of actual HSPF.
[290] 1 Ton = 12 kBtu/hr.
[291] Note that if only an EER rating is available, use the following conversion equation; EER_base = (-0.02 * SEER_base²) + (1.12 * SEER). From Wassmer, M. (2003). A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. (Masters Thesis, University of Colorado at Boulder).
[292] ASHP existing efficiency assumes degradation and is sourced from the Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015. CAC assumed to follow the same trend in degradation as the ASHP: 9.12 SEER nameplate to 7.2 operations SEER represents degradation to 78.9% of nameplate. 78.9% of 8.6 SEER CAC nameplate gives an operational SEER of 6.8, 78.9% of 8.0 SEER RAC nameplate gives an operational SEER of 6.3.
[293] Estimated by converting the EER assumption using the conversion equation; EER_base = (-0.02 * SEER_base²) + (1.12 * SEER). From Wassmer, M. (2003), "A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations," (Masters Thesis, University of Colorado at Boulder). Adjusted to account for degradation per above footnote.
[294] If there is no existing cooling in place but the incentive encourages installation of a new DMSHP with cooling, the added cooling load should be subtracted from any heating benefit.

WATER IMPACT DESCRIPTIONS AND CALCULATION
N/A

DEEMED O&M COST ADJUSTMENT CALCULATION
N/A

MEASURE CODE:

3.4.5 Standard Programmable Thermostat

DESCRIPTION
This measure characterizes the household energy savings from the installation of a new standard programmable thermostat for reduced heating and cooling energy consumption through temperature set-back during unoccupied or reduced demand times.

Energy savings are applicable at the household level; all thermostats controlling household heat should be programmable and installation of multiple programmable thermostats per home does not accrue additional savings.

If the home has a heat pump, a programmable thermostat specifically designed for heat pumps should be used to minimize the use of backup electric resistance heat systems.

This measure was developed to be applicable to the following program types: RF, and DI.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT
The criteria for this measure are established by replacement of a manual-only temperature control with one that has the capability to adjust temperature setpoints according to a schedule without manual intervention.

DEFINITION OF BASELINE EQUIPMENT
For new thermostats the baseline is a non-programmable thermostat requiring manual intervention to change temperature set point.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The expected equipment life of a programmable thermostat is assumed to be 10 years.[296]

DEEMED MEASURE COST
Actual material and labor costs should be used if the implementation method allows. If unknown (e.g., through a retail program), the capital cost for the new installation is assumed to be $70.[297]

LOADSHAPE
Cooling RES

Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS
For central air conditioners and air source heat pumps:

$$\Delta kWhcool = EFLHcool * Capacitycooling * \left(\frac{1}{SEER}\right) * SBdegrees * SF * EF/1000$$

For air source heat pumps there are additional heating savings:

$$\Delta kWhheat = EFLHheat * Capacityheating * \left(\frac{1}{HSPF}\right) * SBdegrees * SF * EF/1000$$

Where:

$EFLHcool$ = Full load cooling hours

[296] Table 1, HVAC Controls, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007. Future evaluation is strongly encouraged to inform the persistence of savings to further refine measure life assumption. As this characterization depends heavily upon a large scale but only 2-year study of the energy impacts of programmable thermostats, the longer-term impacts should be assessed.
[297] Market prices vary significantly in this category, generally increasing with thermostat capability and sophistication. The basic functions required by this measure's eligibility criteria are available on units readily available in the market for $30. Labor is assumed to be one hour at $40 per hour.

EFLHcool_stat = Full load cooling hours with setback schedule

CapacityCooling = Cooling capacity of system in BTU/hr (1 ton = 12,000 BTU/hr)

SEERCAC = SEER efficiency of central air conditioner

SEERASHP = SEER efficiency of air source heat pump

HSPFASHP = Heating Season Performance Factor of system

FLHheat = Full load heating hours

FLHheat = Full load heating hours with setback schedule

CapacityHeating = Heating capacity of system in BTU/hr (1 ton = 12,000 BTU/hr)

SBdegrees = weighted sum of setback degrees to comfort temperature

SF = Savings factors from ENERGY STAR® calculator
EF = Efficiency ratio from Cadmus metering study

Parameter	*Value*	*Source*
FLH_{cool}	1,215 (St. Louis region)	ENERGY STAR air-source heat pump calculator[1]
$Capacity_{Cooling}$	Per unit serviced	PY2016 program data
$SEER_{CAC}$	10	IL-TRM (Based on minimum federal standards between 1992 and 2006.)[2]
$SEER_{ASHP}$	10	IL-TRM (Based on minimum federal standards between 1992 and 2006.)[2]
$HSPF_{ASHP}$	6.8	IL-TRM (Based on minimum federal standards between 1992 and 2006.)[2]
FLH_{heat}	2,009 (St. Louis region)	ENERGY STAR air-source heat pump calculator
$Capacity_{Heating}$	Per unit serviced	PY2016 program data
SBdegrees	-8[F] heat,4 to 7 cool	ENERGY STAR Setpoints
SF	3%/degree heat, 6%/degree cool	ENERGY STAR Calculator
EF	13% heat, 18% cool	Cadmus metering study[3]

1. https://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/ASHP_Sav_Calc.xls
2. Illinois Statewide Technical Reference Manual v. 5.0 http://www.ilsag.info/il_trm_version_5.html
3. Ameren Missouri Low Income and Process Evaluation: program Year 2014. p. 31

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:
CF = 0.0009474181
N/A due to no savings from cooling during the summer peak period.

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = \%FossilHeat * HeatingConusmption_{Gas} * HF * Heating_{Reduction} * Eff_{ISR} * PF$$

Where:

%FossilHeat = Percentage of heating savings assumed to be Natural Gas

Heating fuel	%FossilHeat
Electric	0%
Natural Gas	100%
Unknown	65%[298]

$HeatingConsumption_{Gas}$ = Estimate of annual household heating consumption for gas heated single-family homes.[299]

Weather Basis (City based upon)	Gas_Heating_ Consumption (Therms)
St Louis, MO	680

Other variables as provided above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[298] Average (default) value of 65% gas space heating from 2009 Residential Energy Consumption Survey for Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

[299] Values in table are based on average household heating load (834 therms) for Chicago based on Illinois furnace metering study (‘Table E-1, Energy Efficiency/Demand Response Nicor Gas Plan Year 1: Research Report: Furnace Metering Study, Draft, Navigant, August 1 2013) and adjusted for Missouri weather basis values using the relative climate normals HDD data with a base temp ratio of 60°F. This load value is then divided by standard assumption of existing unit efficiency of 83.5% (estimate based on 29% of furnaces purchased in Missouri were condensing in 2000 (based on data from GAMA, provided to Department of Energy) (see ‘Thermostat_FLH and Heat Load Calcs.xls’). The resulting values are generally supported by data provided by Laclede Gas, which showed an average pre-furnace replacement consumption of 1009 therms for St Louis, and a post-replacement consumption of 909. Assuming a typical hot water consumption at 225 therms (using defaults from http://energy.gov/eere/femp/energy-cost-calculator-electric-and-gas-water-heaters-0#output), this indicates a heating load of 684-784 therms.

3.4.6 HVAC Tune-Up (Central Air Conditioning or Air Source Heat Pump)

DESCRIPTION

This measure involves the measurement of refrigerant charge levels and airflow over the central air conditioning or heat pump unit coil, correction of any problems found and post-treatment re-measurement.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

A tuned and commissioned residential central air conditioning unit or air source heat pump.

DEFINITION OF BASELINE EQUIPMENT

An existing residential central air conditioning unit or air source heat pump that has required tuning to restore optimal performance.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life is assumed to be 2 years.[300]

DEEMED MEASURE COST

As a RF measure, actual costs should be used. If unavailable, the measure cost should be assumed to be $175.[301] The table below identifies more specific costs for varying services (lower three.

Tune- up Service for HP or AC	Incremental Cost ($)	
General Tune-Up (no charge or coil clean)	$70.00	
Tune-up / refrigerant charge	$81.00	$175.00
Tune-up / Indoor Coil (Evaporator) Cleaning	$63.00	
Tune-up / Outdoor Coil (Condenser) Cleaning	$31.00	

LOADSHAPE

Cooling RES
Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$\Delta kWh_{Central\ AC} = ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{test\text{-}in} - 1/SEER_{test\text{-}out})) / 1000)$

$\Delta kWh_{ASHP} = ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{test\text{-}in} - 1/SEER_{test\text{-}out})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{test\text{-}in} - 1/HSFP_{test\text{-}out})) / 1000)$

Where:

$EFLH_{cool}$ = Equivalent full load hours of air conditioning
= dependent on location:[302]

Weather Basis (City based upon)	$EFLH_{cool}$ (Hours)
St Louis, MO	869

$Capacity_{cool}$ = Cooling Capacity of Air Source Heat Pump (Btu/hr)
= Actual (1 ton = 12,000Btu/hr)

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[300] Sourced from DEER Database Technology and Measure Cost Data.

[301] Based on personal communication with HVAC efficiency program consultant Buck Taylor of Roltay Inc., 6/21/10, who estimated the cost of tune up at $125 to $225, depending on the market and the implementation details.

[302] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) and reduced by 28.5% based on the evaluation results in Ameren territory suggesting an appropriate EFLH of 869.The other weather basis values are calculated using the relative climate normals cooling degree day ratios (at 65F set point).

$SEER_{test-in}$ = Seasonal Energy Efficiency Ratio of existing cooling system before tuning (kBtu/kWh)
= In most instances, test-in EER will be determined and noted prior to tuning. SEER rating can be estimated by using the following relationship:[303]
$EER = (-0.02 * SEER^2) + (1.12 * SEER)$
When unknown,[304] assume SEER = 11.9

$SEER_{test-out}$ = Seasonal Energy Efficiency Ratio of existing cooling system after tuning (kBtu/kWh)
= In most instances, test-out EER will be determined and noted after tuning. SEER rating can be estimated by using the following relationship:[305]

$EER = (-0.02 * SEER^2) + (1.12 * SEER)$

When SEER test-in and test-out values are unknown, tune-ups are assumed to improve efficiency as follows:

Measure	% Improvement
Refrigerant charge adjustment	28.4%
Condenser Cleaning Only	7.9%
Indoor coil cleaning	3.8%
General tune-up	5.6%

$EFLH_{heat}$ = Equivalent full load hours of heating:[306]

Weather Basis (City based upon)	$EFLH_{heat}$ (Hours)
St Louis, MO	2009

$Capacity_{heat}$ = Heating Capacity of Air Source Heat Pump (Btu/hr)
= Actual (1 ton = 12,000Btu/hr)

$HSPF_{test-in}$ Pump before tuning (kBtu/kWh)
= Use actual HSPF rating where it is possible to measure or reasonably estimate. If not available, assume[307] HSPF = 6.3.

$HSPF_{test-out}$ =Heating System Performance Factor of existing Air Source Heat Pump after tuning (kBtu/kWh)
= Use actual HSPF rating where it is possible to measure or reasonably estimate. If not available, assume[308] HSPF = 6.9

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:

CF = 0.0009474181

Natural Gas Savings

N/A

Water Impact Descriptions and Calculation

N/A

Deemed O&M Cost Adjustment Calculation

N/A

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303 Based on Wassmer, M. (2003)," A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations," (Masters Thesis, University of Colorado at Boulder). Note this is appropriate for single speed units only.

304 Using aforementioned relationship and test-in efficiency of 10.5 EER, as listed in "Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015."

305 Based on Wassmer, M. (2003), "A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations," (Masters Thesis, University of Colorado at Boulder). Note: this is appropriate for single speed units only.

306 Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls). The other weather basis values are calculated using the Climate Normals Heating Degree Day ratios (at 60F set point).

307 Based on evaluation results outlined in "Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015."

308 Assumes the efficiency improvement is the same in heating mode as was realized in cooling mode. Based on the improvement reported in "Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015."

MEASURE CODE:

3.4.7 Blower Motor

DESCRIPTION

A new furnace with a brushless permanent magnet (BPM) blower motor is installed instead of a new furnace with a lower efficiency motor. This measure characterizes only the electric savings associated with the fan and could be coupled with gas savings associated with a more efficient furnace. Savings decrease sharply with static pressure so duct improvements, and clean, low pressure drop filters can maximize savings. Savings improve when the blower is used for cooling as well and when it is used for continuous ventilation, but only if the non-BPM motor would have been used for continuous ventilation too. If the resident runs the BPM blower continuously because it is a more efficient motor and would not run a non-BPM motor that way, savings are near zero and possibly negative. This characterization uses a 2009 Focus on Energy study of BPM blower motor savings in Wisconsin, which accounted for the effects of this behavioral impact.

This measure was developed to be applicable to the following program types: TOS, NC, and EREP.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

A furnace with a brushless permanent magnet (BPM) blower motor, also known by the trademark ECM, BLDC, and other names.

DEFINITION OF BASELINE EQUIPMENT

A furnace with a non-BPM blower motor.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 20 years.[309]

DEEMED MEASURE COST

The capital cost for this measure is assumed to be:

Incremental Cost ($)	
$97[310]	Time of Sale
$475[311]	Early Replacement

LOADSHAPE

HVAC RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh_{Heating\ Mode} = (1 - \%\ with\ New\ ASHP) \times \left(400\frac{kWh}{year} \times \frac{Heating\ EFLH}{Wisconsin\ Heating\ EFLH}\right)$$

$$\Delta kWh_{Cooling\ Mode} = (1 - \%\ with\ New\ Central\ Cooling) \times \left(70\frac{kWh}{year} \times \frac{Cooling\ EFLH}{Wisconsin\ CoolingEFLH}\right)$$

$$\Delta kWh_{Auto\ Circulation} = 25\frac{kWh}{year} \times \frac{CoolingEFLH}{Wisconsin\ CoolingEFLH} + 2960\frac{kWh}{year} \times 10\% - 30\frac{kWh}{year}$$

$$\Delta kWh_{Continous\ Circulation} = 25\frac{kWh}{year} \times \frac{CoolingEFLH}{Wisconsin\ CoolingEFLH} + 2960\frac{kWh}{year} - 30\frac{kWh}{year}$$

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309 Consistent with assumed life of a new gas furnace. Table 8.3.3 The technical support documents for federal residential appliance standards: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/fb_fr_tsd/chapter_8.pdf.

310 Adapted from Tables 8.2.3 and 8.2.13 in http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/hvac_ch_08_lcc_2011-06-24.pdf.

311 Minnesota TRM, https://www.energy.gov/sites/prod/files/2014/02/f7/case_study_variablespeed_furnacemotor.pdf.

Where:

Parameter	Value
Wisconsin Cooling Savings kWh/year	70.00
Cooling Savings All Systems	25.00
Wisconsin Cooling EFLH	542.50
Wisconsin Heating Savings kWh/year	400.00
Wisconsin Heating EFLH	2,545.25
Wisconsin Circulation Savings kWh/year	2,960.00
% of Circulation Used	10%
Standby losses	30
Saint Louis Heating EFLH	2,009.00
Saint Louis Cooling EFLH	1,215.00
% with New Central Cooling	0.97
% with New ASHP	0.16

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$\Delta kW = \Delta kWh * CF$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0004660805

NATURAL GAS SAVINGS

Δtherms[312] = - Heating Savings * 0.03412/ AFUE

Where:

0.03412 = Converts kWh to therms

AFUE = Efficiency of the Furnace
= Actual. If unknown assume 95%[313] if in new furnace or 64.4 AFUE%[314] if in existing furnace

Using defaults:

For new Furnace = - (430 * 0.03412) / 0.95
= - 15.4 therms

For existing Furnace = - (430 * 0.03412) / 0.644
= - 22.8 therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[312] The blower fan is in the heating duct so all, or very nearly all, of its waste heat is delivered to the conditioned space. Negative value since this measure will increase the heating load due to reduced waste heat.
[313] Minimum efficiency rating from ENERGY STAR® Furnace Specification v4.0, effective February 1, 2013.
[314] Average nameplate efficiencies of all early replacement qualifying equipment in Ameren IL PY3-PY4.

3.4.8 Central Air Conditioner

DESCRIPTION

This measure characterizes:

a) TOS:

The installation of a new residential sized (<= 65,000 Btu/hr) central air conditioning ducted split system meeting ENERGY STAR® efficiency standards presented below. This could relate to the replacement of an existing unit at the end of its useful life, or the installation of a new system in a new home.

b) EREP:

Early Replacement determination will be defined by program requirements. All other conditions will be considered TOS.

The baseline SEER of the existing central air conditioning unit replaced:

- If the SEER of the existing unit is known and, the baseline SEER is the actual SEER value of the unit replaced. If the SEER of the existing unit is unknown, use assumptions in variable list below (SEER_exist).

This measure was developed to be applicable to the following program types: TOS, NC, and EREP.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a ducted split central air conditioning unit meeting the minimum ENERGY STAR® efficiency level standards; 15 SEER and 12 EER.

DEFINITION OF BASELINE EQUIPMENT

The baseline for the TOS measure is based on the current federal standard efficiency level: 13 SEER and 11 EER.

The baseline for the early replacement measure is the efficiency of the existing equipment for the assumed remaining useful life of the unit and the new baseline as defined above[315] for the remainder of the measure life.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 18 years.[316]

Remaining life of existing equipment is assumed to be 6 years.[317]

DEEMED MEASURE COST

TOS: The incremental capital cost for this measure is dependent on efficiency. Assumed incremental costs are provided below:

Efficiency Level	ROF Cost per Ton	Early Replacement Cost per Ton	Source
SEER 14	$0.00	$212.38	IL TRM 6.0
SEER 15	$108	$320.38	IL TRM 6.0
SEER 16	$221	$433.38	IL TRM 6.0
SEER 17	$404	$616.38	Based on RS Means 2018 data.
SEER 18	$620	$832.38	IL TRM 6.0
SEER 19	$715	$927.38	DEER 2008 Database Technology and Measure Cost Data (www.deeresources.com)
SEER 20	$834	$1,046.38	
SEER 21	$908	$1,120.38	
Average	$530	$742.38	

[315] Baseline SEER and EER should be updated when new minimum federal standards become effective.

[316] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf.

The "lifespan" of a central air conditioner is about 15 to 20 years (US DOE: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12440).

[317] Assumed to be one third of effective useful life.

Early replacement: The full install cost for this measure is the actual cost of removing the existing unit and installing the new one. If this is unknown, assume $3,413.[318]
Assumed deferred cost (after 6 years) of replacing existing equipment with new baseline unit is assumed to be $3,140.[319] This cost should be discounted to present value using the utilities' discount rate.

LOADSHAPE
Cooling RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS
Time of sale:

ΔkWH = (FLHcool * Btu/hr * (1/SEERbase - 1/SEERee))/1000

Early replacement:[320]

ΔkWH for remaining life of existing unit (1st 6 years):

=((FLHcool * Capacity * (1/SEERexist - 1/SEERee))/1000);

ΔkWH for remaining measure life (next 12 years):

= ((FLHcool * Capacity * (1/SEERbase - 1/SEERee))/1000)

Where:

FLHcool = Full load cooling hours:[321]

Weather Basis (City based upon)	EFLHcool (Hours)
St Louis, MO	869

Capacity = Size of new equipment in Btu/hr (note 1 ton = 12,000Btu/hr)
= Actual installed, or if actual size unknown 33,600Btu/hr for single-family buildings[322]

SEERbase = Seasonal Energy Efficiency Ratio of baseline unit (kBtu/kWh)
= 13[323]

SEERexist = Seasonal Energy Efficiency Ratio of existing unit (kBtu/kWh)
= Use actual SEER rating where it is possible to measure or reasonably estimate. If unknown assume 10.0.[324]

SEERee = Seasonal Energy Efficiency Ratio of ENERGY STAR® unit (kBtu/kWh)
= Actual installed or 14.5 if unknown

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh* CF

Where:

CF = 0.0009474181

[318] Based on 3 ton initial cost estimate for an ENERGY STAR® unit from ENERGY STAR® central AC calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls).
[319] Based on 3 ton initial cost estimate for a conventional unit from ENERGY STAR® central AC calculator, $2,857, and applying inflation rate of 1.91% (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls). While baselines are likely to shift in the future, there is currently no good indication of what the cost of a new baseline unit will be in 6 years. In the absence of this information, assuming a constant federal baseline cost is within the range of error for this prescriptive measure.
[320] The two equations are provided to show how savings are determined during the initial phase of the measure (existing to efficient) and the remaining phase (new baseline to efficient). In practice, the screening tools used may either require a First Year savings (using the first equation) and then a "number of years to adjustment" and "savings adjustment" input which would be the (new base to efficient savings)/(existing to efficient savings).
[321] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) and reduced by 28.5% based on the evaluation results in Ameren territory suggesting an appropriate EFLH of 869.The other weather basis values are calculated using the relative climate normals cooling degree day ratios (at 65F set point).
[322] Actual unit size required for multifamily building, no size assumption provided because the unit size and resulting savings can vary greatly depending on the number of units.
[323] Based on minimum federal standard; http://www1.eere.energy.gov/buildings/appliance_standards/residential/residential_cac_hp.html.
[324] Estimate based on Department of Energy standard between 1992 and 2006. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then that should be used.

NATURAL GAS SAVINGS
N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION
N/A

DEEMED O&M COST ADJUSTMENT CALCULATION
N/A

MEASURE CODE:

3.4.9 Filter Cleaning or Replacement and Dirty Filter Alarms

DESCRIPTION

An air filter on a central forced air heating system is replaced prior to the end of its useful life with a new filter, resulting in a lower pressure drop across the filter. As filters age, the pressure drop across them increases as filtered medium accumulates. Replacing filters before they reach the point of becoming ineffective can save energy by reducing the pressure drop required by filtration, subsequently reducing the load on the blower motor.

This measure was developed to be applicable to the following program type: RET.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

A new filter offering a lower pressure drop across the filter medium compared to the existing filter.

DEFINITION OF BASELINE EQUIPMENT

A filter that is nearing the end of its effective useful life, defined by having a pressure drop twice that of its original state.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 1 year[325] for a filter replacement and 14 years for a dirty filter alarm.

DEEMED MEASURE COST

Actual material and labor cost should be used if known, since there is a wide range of filter types and costs. If unknown,[326] the cost of a fiberglass filter is assumed to be $7.33 and the cost of a pleated filter is assumed to be $15.66. If unknown, the cost of a dirty filter alarm is assumed to be $5.

LOADSHAPE

HVAC RES

Algorithm

CALCULATION OF SAVINGS

Electric energy savings are calculated by estimating the difference in power requirements to move air through the existing and new filter and multiplying by the anticipated operating hours of the blower during the heating season.

ELECTRIC ENERGY SAVINGS

$$kWh\ Heating\ Savings = kW_{motor} * FLH_{heat} * EI$$

$$kWh\ Cooling\ Savings = kW_{motor} * FLH_{cool} * EI$$

[325] Many manufacturers suggest replacing filters more often than an annual basis, however this measure assumes that a filter will generally last one full heating season before it needs replacement.

[326] Assumes an average price of $1.08 for fiberglass and $9.41 for pleated, plus $6.25 in labor (based on 15 minutes, including portion of travel time, and $25 per hour, which is in line with the typical prevailing wage of a General Laborer, as per Annual Wage Order No. 23 documents published by the Missouri Department of Labor). Average filter costs sourced from "Air Filter Testing, Listing, and Labeling." Docket #12-AAER-2E prepared for the California Energy Commission, July 23, 2013.

Where:

Factor	Term	School Value
KW (motor)	Average motor full load electric demand (kW)	0.5
EFLH (heat)	Equivalent Full Load Hours (EFLH) Heating (hours/year)	1496
EFLH (cool)	Equivalent Full Load Hours (EFLH) Cooling (hours/year)	869
EI	Efficiency Improvement (%)	15%
Utility Adjustment	% Homes in Service Territory	86%
ISR	Installation Rate	47%

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = 0.0004660805

NATURAL GAS SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

3.4.10 Packaged Terminal Air Conditioner (PTAC) and Packaged Terminal Heat Pump (PTHP)

DESCRIPTION

A PTAC is a packaged terminal air conditioner that cools and provides heat through an electric resistance heater (heat strip). A PTHP is a packaged terminal heat pump. A PTHP uses its compressor year-round to heat or cool. In warm weather, it efficiently captures heat from inside a space and pumps it outside for cooling. In cool weather, it captures heat from outdoor air and pumps it into a space, adding heat from electric heat strips as necessary to provide heat.

This measure was developed to be applicable to the following program types: TOS, NC, and EREP.

This measure characterizes:

> TOS: the purchase and installation of a new efficient PTAC or PTHP.
>
> EREP: the early removal of an existing PTAC or PTHP from service, prior to its natural end of life, and replacement with a new efficient PTAC or PTHP unit. Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life. The measure is only valid for non-fuel switching installations – for example replacing a cooling only PTAC with a PTHP can currently not use the TRM.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be PTACs or PTHPs that exceed baseline efficiencies.

DEFINITION OF BASELINE EQUIPMENT

TOS: the baseline condition is defined by the Code of Federal Regulations at 10 CFR 431.97(c), section §431.97.
EREP: the baseline is the existing PTAC or PTHP for the assumed remaining useful life of the unit and the new baseline as defined above for the remainder of the measure life.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.[327]
Remaining life of existing equipment is assumed to be 5 years.[328]

DEEMED MEASURE COST

TOS: The incremental capital cost for this equipment is estimated to be $84/ton.[329]
EREP: The measure cost is the full cost of removing the existing unit and installing a new one. The actual program cost should be used; if unknown, assume $1,047 per ton.[330]
The assumed deferred cost (after 5 years) of replacing existing equipment with new baseline unit is assumed to be $1,039 per ton.[331] This cost should be discounted to present value using the utilities' discount rate.

LOADSHAPE

Cooling RES
Heating RES

[327] Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007.
[328] Standard assumption of one third of effective useful life.
[329] DEER 2008. This assumes that baseline shift from IECC 2012 to IECC 2015 carries the same incremental costs. Values should be verified during evaluation.
[330] Based on DCEO – IL PHA Efficient Living Program data.
[331] Based on subtracting TOS incremental cost from the DCEO data and incorporating inflation rate of 1.91%.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Electric savings for PTACs and PTHPs should be calculated using the following algorithms

Time of sale:

$\Delta kWh = ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{base} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{base} - 1/HSFP_{ee})) / 1000)$

Early replacement:[332]

ΔkWH for remaining life of existing unit:

$= ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{exist} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{exist} - 1/HSFP_{ee})) / 1000)$

ΔkWH for remaining measure life:

$= ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{base} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{base} - 1/HSFP_{ee})) / 1000)$

Where:

$Capacity_{heat}$ = Heating capacity of the unit in Btu/hr

= Actual

$EFLH_{heat}$ = Equivalent Full Load Hours for heating.

= Custom input if program or regional evaluation results are available, otherwise, per the following table:

Weather Basis (City based upon)	$EFLH_{heat}$[333]
St Louis	1,040

$HSPF_{ee}$ = HSPF rating of new equipment (kbtu/kwh)

= Actual installed

$HSPF_{base}$ =Heating System Performance Factor of baseline unit (kBtu/kWh)

Equipment Type	$HSPF_{base}$ (manufacture date prior to 1/2/2017)	$HSPF_{base}$ (manufacture date after to 1/1/2017)
PTAC	7.7	8.0
PTHP	7.7	8.0

$HSPF_{exist}$ = Actual HSPF rating of existing equipment (kbtu/kwh). If unknown, assume:

Existing Equipment Type	$HSPF_{exist}$
Electric resistance heating (PTAC)	3.412[334]
PTHP	5.44[335]

$Capacity_{cool}$ = the cooling capacity of the ductless heat pump unit in Btu/hr.[336]

= Actual installed

$SEER_{ee}$ = SEER rating of new equipment (kbtu/kwh)

= Actual installed[337]

$SEER_{base}$ = Seasonal Energy Efficiency Ratio of baseline unit (kBtu/kWh)

Equipment Type	$SEER_{base}$ (manufacture date prior to 1/2/2017)	$SEER_{base}$ (manufacture date after to 1/1/2017)
PTAC	13.0	14.0
PTHP	13.0	14.0

[332] The two equations are provided to show how savings are determined during the initial phase of the measure (existing to efficient) and the remaining phase (new baseline to efficient). In practice, the screening tools used may either require a first year savings (using the first equation) and then a "number of years to adjustment" and "savings adjustment" input which would be the (new base to efficient savings)/(existing to efficient savings).

[333] Base values reported in *All-Electric Homes PY6 Metering Results: Multifamily HVAC Systems*, Cadmus, October 2015, Ameren. Illinois were adjusted to fit Missouri climate zones by a comparison of relative annual heating and cooling degree hours (base 65). See 3.4.8 EFLH 06022016.xlsx for derivation. FLH values are based on metering of multifamily units that were used as the primary heating source to the whole home, and in buildings that had received weatherization improvements. A DMSHP installed in a single-family home may be used more sporadically, especially if the DMSHP serves only a room, and buildings that have not been weatherized may require longer hours. Additional evaluation is recommended to refine the EFLH assumptions for the general population.

[334] Electric resistance has a COP of 1.0 which equals 1/0.293 = 3.41 HSPF.

[335] This is estimated based on finding the average HSPF/SEER ratio from the AHRI directory data (using the least efficient models – SEER 12 and SEER 13) – 0.596 and applying to the average nameplate SEER rating of all early replacement qualifying equipment in Ameren PY3-PY4. This estimation methodology appears to provide a result within 10% of actual HSPF.

[336] 1 Ton = 12 kBtu/hr.

[337] Note that if only an EER rating is available, use the following conversion equation; $EER\_base = (-0.02 * SEER\_base^2) + (1.12 * SEER)$. From Wassmer, M. (2003), "A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations," (Masters Thesis, University of Colorado at Boulder).

$SEER_{exist}$ = Actual SEER rating of existing equipment (kbtu/kwh). If unknown, assume:

Existing Cooling System	$SEER_{exist}$[338]
PTHP	7.2
PTAC	6.8

$EFLH_{cool}$ = Equivalent Full Load Hours for cooling.

= Custom input if program or regional evaluation results are available, otherwise, per the following table.[339]

Weather Basis (City based upon)	$EFLH_{cool}$
St Louis	617

SUMMER COINCIDENT PEAK DEMAND SAVINGS

Time of sale:

$\Delta kW = \Delta kWhcooling * CF$

$CF = 0.0009474181$

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[338] ASHP existing efficiency assumes degradation and is sourced from the Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015. CAC assumed to follow the same trend in degradation as the ASHP: 9.12 SEER nameplate to 7.2 operations SEER represents degradation to 78.9% of nameplate. 78.9% of 8.6 SEER CAC nameplate gives an operational SEER of 6.8.

[339] Base values reported in *All-Electric Homes PY6 Metering Results: Multifamily HVAC Systems*, Cadmus, October 2015, Ameren Illinois were adjusted to fit Missouri climate zones by a comparison of relative annual heating and cooling degree hours (base 65). See 3.4.8 EFLH 06022016.xlsx for derivation. FLH values are based on metering of multifamily units that were used as the primary heating source to the whole home, and in buildings that had received weatherization improvements. A DMSHP installed in a single-family home may be used more sporadically, especially if the DMSHP serves only a room, and buildings that have not been weatherized may require longer hours. Additional evaluation is recommended to refine the EFLH assumptions for the general population.

3.4.11 Room Air Conditioner

DESCRIPTION

This measure relates to the purchase and installation of a room air conditioning unit that meets the ENERGY STAR® minimum qualifying efficiency specifications, in place of a baseline unit meeting minimum federal standard efficiency ratings presented below:[340]

<table>
<tr><th>Product Class (Btu/H)</th><th>Federal Standard CEERbase, with louvered sides, without reverse cycle[341]</th><th>Federal Standard CEERbase, without louvered sides, without reverse cycle</th><th>ENERGY STAR® CEERee, with louvered sides</th><th>ENERGY STAR® CEERee, without louvered sides</th></tr>
<tr><td>< 8,000</td><td>11.0</td><td>10.0</td><td>11.5</td><td>10.5</td></tr>
<tr><td>8,000 to 10,999</td><td rowspan="2">10.9</td><td>9.6</td><td rowspan="2">11.4</td><td>10.1</td></tr>
<tr><td>11,000 to 13,999</td><td>9.5</td><td>10.0</td></tr>
<tr><td>14,000 to 19,999</td><td>10.7</td><td>9.3</td><td>11.2</td><td>9.7</td></tr>
<tr><td>20,000 to 24,999</td><td>9.4</td><td rowspan="3">9.4</td><td rowspan="2">9.8</td><td rowspan="3">9.8</td></tr>
<tr><td>25,000-27,999</td><td rowspan="2">9.0</td></tr>
<tr><td>>=28,000</td><td>9.5</td></tr>
</table>

Casement	Federal Standard CEERbase	ENERGY STAR® CEERee
Casement-only	9.5	10.0
Casement-slider	10.4	10.8

Reverse Cycle - Product Class (Btu/H)	Federal Standard CEERbase, with louvered sides	Federal Standard CEERbase, without louvered sides[342]	ENERGY STAR® CEERee, with louvered sides[343]	ENERGY STAR® CEERee, without louvered sides
< 14,000	N/A	9.3	N/A	9.7
>= 14,000	N/A	8.7	N/A	9.1
< 20,000	9.8	N/A	10.3	N/A
>= 20,000	9.3	N/A	9.7	N/A

This measure was developed to be applicable to the following program type: TOS.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the new room air conditioning unit must meet the ENERGY STAR® efficiency standards presented above.

DEFINITION OF BASELINE EQUIPMENT

The baseline assumption is a new room air conditioning unit that meets the current minimum federal efficiency standards presented above.

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340 Side louvers that extend from a room air conditioner model in order to position the unit in a window. A model without louvered sides is placed in a built-in wall sleeve and are commonly referred to as "through-the-wall" or "built-in" models.
Casement-only refers to a room air conditioner designed for mounting in a casement window of a specific size.
Casement-slider refers to a room air conditioner with an encased assembly designed for mounting in a sliding or casement window of a specific size. Reverse cycle refers to the heating function found in certain room air conditioner models. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%204.0%20Room%20Air%20Conditioners%20Program%20Requirements.pdf.

341 Federal standard air conditioner baselines. https://ees.lbl.gov/product/room-air-conditioners.

342 Federal standard air conditioner baselines. https://ees.lbl.gov/product/room-air-conditioners.

343 EnergyStar® version 4.0 Room Air Conditioner Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%204.0%20Room%20Air% 20Conditioners%20Program%20Requirements.pdf.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The measure life is assumed to be 9 years.[344]

DEEMED MEASURE COST
The incremental cost for this measure is assumed to be $20 for an ENERGY STAR® unit.[345]

LOADSHAPE
Cooling RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \frac{(FLH_{RoomAC} * Btu/H * \left(\frac{1}{CEERbase} - \frac{1}{CEERee}\right)}{1000}$$

Where:

FLH_{RoomAC} = Full Load Hours of room air conditioning unit:

Weather Basis (City based upon)	Hours
St Louis, MO	860 for primary use and 556 for secondary use

Btu/H = Size of unit
= Actual. If unknown assume 8500 Btu/hr [346]

CEERbase = Efficiency of baseline unit
= As provided in tables above

CEERee = Efficiency of ENERGY STAR® unit
= Actual. If unknown assume minimum qualifying standard as provided in tables above

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer Peak Coincidence Factor for measure
= 0.0009474181[347]

NATURAL GAS SAVINGS
N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION
N/A

DEEMED O&M COST ADJUSTMENT CALCULATION
N/A

MEASURE CODE:

[344] ENERGY STAR® Room Air Conditioner Savings Calculator: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=AC.
[345] Cost from RS Means 2018.
[346] Based on maximum capacity average from the RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners, June 23, 2008.
[347] Based on Ameren Missouri 2016 loadshape for residential cooling end-use.

3.4.12 Ground Source Heat Pump

DESCRIPTION
A heat pump provides heating or cooling by moving heat between indoor and the ground.

This measure characterizes:

TOS:
The installation of a new residential sized ground source heat pump. This could relate to the replacement of an existing unit at the end of its useful life, or the installation of a new system in a new home.

EREP:
The early removal of functioning electric heating and cooling systems from service, prior to its natural end of life, and replacement with a new high efficiency ground source heat pump unit. To qualify as early replacement, the existing unit must be operational when replaced. If the SEER of the existing unit is known and the baseline SEER is the actual SEER value of the unit replaced and if unknown use assumptions in the variable list below ($SEER_{exist}$ and $HSPF_{exist}$). If the operational status of the existing unit is unknown, use TOS assumptions.

This measure was developed to be applicable to the following program types: TOS, NC, and EREP.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT
A new residential sized ground source heat pump with specifications to be determined by program.

DEFINITION OF BASELINE EQUIPMENT
The baseline for the TOS measure is federal standard efficiency level as of: 3.3 COP and 14.1 EER when replacing an existing ground source heat pump, 14 SEER and 8.2HSPF when replacing an existing air source heat pump, and 13 SEER and 3.41 HSPF when replacing a central air conditioner and electric resistance heating.
The baseline for the early replacement measure is the efficiency of the existing equipment for the assumed remaining useful life of the unit and the new baseline as defined above for the remainder of the measure life.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The expected measure life is assumed to be 18 years.
For early replacement, the remaining life of existing equipment is assumed to be 6 years for GSHP, ASHP and CAC and 18 years for electric resistance.

DEEMED MEASURE COST
TOS: The incremental capital cost for this measure is dependent on the efficiency and capacity of the new unit.[348]

Efficiency (EER)	Cost (including labor) per measure
GSHP - EER 23 - replace electric furnace / CAC	$4,717
GSHP EER 23 Replace at Fail GSHP	$3,200

EREP: The full install cost for this measure is the actual cost of removing the existing unit and installing the new one. If this is unknown, assume the following (note these costs are per ton of unit capacity):[349]

Efficiency (EER)	Cost (including labor) per measure
GSHP - EER 23 - replace electric furnace / CAC Early Replacement	$5,250
GSHP EER 23	$4,859

[348] Cost based upon Ameren Missouri MEEIA 2016-18 TRM effective January 1, 2018.
[349] Cost based upon Ameren Missouri MEEIA 2016-18 TRM effective January 1, 2018.

LOADSHAPE

Cooling RES

Heating RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

TOS:

$\Delta kWh = ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{base} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{base} - 1/HSPF_{ee})) / 1000)$

EREP:[350]

ΔkWH for remaining life of existing unit (1st 6 years for replacing an ASHP or GSHP, 18 years for replacing electric resistance):

$= ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{exist} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{exist} - 1/HSPF_{ee})) / 1000)$

ΔkWH for remaining measure life (next 12 years if replacing an ASHP or GSHP):

$= ((EFLH_{cool} * Capacity_{cool} * (1/SEER_{base} - 1/SEER_{ee})) / 1000) + ((EFLH_{heat} * Capacity_{heat} * (1/HSPF_{base} - 1/HSPF_{ee})) / 1000)$

Where:

$EFLH_{cool}$ = Equivalent full load hours of air conditioning:[351]

Weather Basis (City based upon)	$EFLH_{cool}$ (Hours)
St Louis, MO	869

$Capacity_{cool}$ = Cooling capacity of air source heat pump (Btu/hr)

= Actual (1 ton = 12,000Btu/hr)

$SEER_{exist}$ = Seasonal Energy Efficiency Ratio of existing cooling system (kBtu/kWh)

= Use actual SEER rating where it is possible to measure or reasonably estimate.

Existing Cooling System	$SEER_{exist}$[352]
Air Source Heat Pump	7.2
Central AC	6.8
No central cooling[353]	Let ‘$1/SEER_{exist}$’ = 0

$SEER_{base}$ = Seasonal Energy Efficiency Ratio of baseline Air Source Heat Pump (kBtu/kWh)

= 14[354]

$SEER_{ee}$ = Seasonal Energy Efficiency Ratio of efficient Air Source Heat Pump (kBtu/kWh)

= Actual

$EFLH_{heat}$ = Equivalent full load hours of heating

= Dependent on location:[355]

Weather Basis (City based upon)	$EFLH_{heat}$ (Hours)
St Louis, MO	2009

[350] The two equations are provided to show how savings are determined during the initial phase of the measure (existing to efficient) and the remaining phase (new baseline to efficient). In practice, the screening tools used may either require a first year savings (using the first equation) and then a “number of years to adjustment” and “savings adjustment” input which would be the (new base to efficient savings)/(existing to efficient savings).

[351] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) and reduced by 28.5% based on the evaluation results in Ameren territory suggesting an appropriate EFLH of 869.The other climate region values are calculated using the relative climate normals cooling degree day ratios (at 65F set point).

[352] ASHP existing efficiency assumes degradation and is sourced from the Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015. CAC assumed to follow the same trend in degradation as the ASHP: 9.12 SEER nameplate to 7.2 operations SEER represents degradation to 78.9% of nameplate. 78.9% of 8.6 SEER CAC nameplate gives an operational SEER of 6.8.

[353] If there is no central cooling in place but the incentive encourages installation of a new ASHP with cooling, the added cooling load should be subtracted from any heating benefit.

[354] Based on minimum federal standard effective 1/1/2015; http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf.

[355] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls). The other weather basis values are calculated using the relative climate normals HDD data with a base temp ratio of 60°F.

$Capacity_{heat}$ = Heating Capacity of Air Source Heat Pump (Btu/hr)
= Actual (1 ton = 12,000Btu/hr)

$HSPF_{exist}$ =Heating System Performance Factor of existing heating system (kBtu/kWh)
= Use actual HSPF rating where it is possible to measure or reasonably estimate. If not available use:

Existing Heating System	$HSPF_{exist}$
Air Source Heat Pump	5.44[356]
Electric Resistance	3.41[357]

$HSPF_{base}$ =Heating System Performance Factor of baseline Air Source Heat Pump (kBtu/kWh)
= 8.2[358]

$HSFP_{ee}$ =Heating System Performance Factor of efficient Air Source Heat Pump (kBtu/kWh)

SUMMER COINCIDENT PEAK DEMAND SAVINGS

TOS:

$\Delta kW = \Delta kWh_{cooling} * CF$

CF = 0.0009474181

[356] This is estimated based on finding the average HSPF/SEER ratio from the AHRI directory data (using the least efficient models – SEER 12 and SEER 13) – 0.596, and applying to the average nameplate SEER rating of all early replacement qualifying equipment in Ameren PY3-PY4. This estimation methodology appears to provide a result within 10% of actual HSPF.

[357] Electric resistance has a COP of 1.0 which equals 1/0.293 = 3.41 HSPF.

[358] Based on minimum federal standard effective 1/1/2015; http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf.

3.5 Lighting

3.5.1 LED Screw Based Omnidirectional Bulb

DESCRIPTION
This measure provides savings assumptions for LED screw-based omnidirectional (e.g., A-Type) lamps installed in a known location (i.e., residential and in-unit interior or exterior) or, if the implementation strategy does not allow for the installation location to be known (e.g., an upstream retail program or efficiency kit), an unknown residential location. For upstream programs, utilities should develop an assumption of the Residential v Commercial split and apply the relevant assumptions to each portion.

Federal legislation stemming from the Energy Independence and Security Act of 2007 (EISA) requires all general-purpose light bulbs between 40W and 100W to be approximately 30% more energy efficient than standard incandescent bulbs. Production of 100W, standard efficacy incandescent lamps ended in 2012, followed by restrictions on 75W lamps in 2013 and 60W and 40W lamps in 2014. The baseline for this measure has therefore become bulbs (improved incandescent or halogen) that meet the new standard.

A provision in the EISA regulations requires that by January 1, 2020, all lamps meet efficiency criteria of at least 45 lumens per watt, in effect making the baseline equivalent to a current day CFL. Therefore a midlife adjustment is provided.

This measure was developed to be applicable to the following program types: TOS, NC, and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT
In order for this measure to apply, new lamps must be ENERGY STAR® labeled based upon the ENERGY STAR® specification v2.0 which became effective on 1/2/2017 (https://www.energystar.gov/sites/default/files/Luminaires%20V2%200%20Final.pdf).
Qualification could also be based on the Design Light Consortium's qualified product list.[359]

DEFINITION OF BASELINE EQUIPMENT
The baseline condition for this measure is assumed to be an EISA-qualified halogen or incandescent lamp. From 2020, the baseline will change[360] based upon what is available in the market. Therefore a midlife adjustment is provided.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The rated life of omnidirectional LED lamps is assumed to be 20,000 hours.[361] This would imply a lifetime of 27 years for residential interior lighting and 15.2 years for residential exterior lighting. However, all installations are capped at 19 years.[362]

DEEMED MEASURE COST
While LEDs may have a higher upfront cost than a halogen or CFL, the incremental cost for LEDs in an upstream lighting program is assumed to be zero because the net present value of the costs to replace the halogen or CFL multiple times over the life of the LED is greater than the upfront cost of the LED. The incentive in this case is not designed to reduce the incremental cost over the lifetime of the measure. Instead the incentive is designed to reduce the initial upfront cost that may have been a barrier to the customer choosing the efficient lighting option. In the case of direct install programs or lighting included in efficient kits, the actual cost of the measure should be used.

LOADSHAPE
Lighting RES
Lighting BUS

[359] https://www.designlights.org/QPL.
[360] A provision in the EISA regulations requires that by January 1, 2020, all lamps meet efficiency criteria of at least 45 lumens per watt, in essence making the baseline equivalent to a current day CFL.
[361] Version 1.1 of the ENERGY STAR® specification required omnidirectional bulbs have a rated life of 25,000 hours or more. Version 2.0 of the specification now only requires 15,000 hours. While the V2.0 is not effective until 1/2/2017, lamps may today be qualified with this updated rated life specification. In the absence of data suggesting an average – an assumed average rated life of 20,000 hours is used.
[362] Particularly in residential applications, lamps are susceptible to persistence issues such as removal, new fixtures, new occupants, etc. The measure life is capped at 19 years based on TAC agreement 1/19/2017.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$\Delta kWh_{RES} =$
$(Watt_{Base} - Watt_{EE}) * \%RES * ISR * (1 - LKG) * (Hours_{RES} * WHF_{RES}) / 1{,}000$

$\Delta kWh_{NRES} =$
$(Watt_{Base} - Watt_{EE}) * (1 - \%RES) * ISR * (1 - LKG) * (Hours_{NRES} * WHF_{NRES}) / 1{,}000$

Where:

$Watts_{Base}$ = Based on lumens of LED bulb installed.

$Watts_{EE}$ = Actual wattage of LED purchased / installed - If unknown, use default provided below:[363]

Lower Lumen Range	Upper Lumen Range	$Watts_{Base}$	$Watts_{EE}$ LED	Delta Watts
250	309	25	4.0	21
310	749	29	6.7	22.3
750	1,049	43	10.1	32.9
1,050	1,489	53	12.8	40.2
1,490	2,600	72	17.4	54.6
2,601	3,000	150	43.1	106.9
3,001	3,999	200	53.8	146.2
4,000	6,000	300	76.9	223.1

%RES = percentage of bulbs sold to residential customers

LKG = leakage rate (program bulbs installed outside Ameren Missouri's service area)

ISR = In Service Rate, the percentage of units rebated that are actually in service

Program	Discounted In Service Rate (ISR)
Retail (Time of Sale)	95.12%
Direct Install[364]	99%
Efficiency Kit (Single Family)[365]	92%
Efficiency Kit (Multi-Family)[366]	98%

$Hours_{RES}$ = Average hours of use per year
= Custom, or if unknown assume 728[367] for interior or 1314 for exterior, or 776 if location is not known.

$HoursN_{RES}$ = 3,613

$WHFe_{Heat}$ = Waste Heat Factor for energy to account for electric heating increase from reducing waste heat from efficient lighting (if fossil fuel heating, see calculation of heating penalty in that section).
= 1 - ((HF / ηHeat) * %ElecHeat)
If unknown assume 0.88[368]

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363 $Watts_{EE}$ defaults are based upon the average available ENERGY STAR® product, accessed 06/18/2015. For any lumen range where there is no ENERGY STAR® product currently available, $Watts_{EE}$ is based upon the ENERGY STAR® minimum luminous efficacy (55Lm/W for lamps with rated wattages less than 15W and 65 Lm/W for lamps with rated wattages ≥ 15 watts) for the mid-point of the lumen range. See calculation at "cerified-light-bulbs-2015-06-18.xlsx." These assumptions should be reviewed regularly to ensure they represent the available product.

364 Ameren Missouri Home Energy Analysis Program Impact and Process Evaluation: Program Year 2015.

365 Ameren Missouri Efficient Products Impact and Process Evaluation: Program Year 2015.

366 Ameren Missouri Efficient Products Impact and Process Evaluation: Program Year 2015.

368 Calculated using defaults: 1-((0.53/1.57) * 0.35) = 0.88.

Where:

HF = Heating Factor or percentage of light savings that must now be heated

= 53%[369] for interior or unknown location

= 0% for exterior or unheated location

$\eta Heat_{Electric}$ = Efficiency in COP of Heating equipment

= Actual - If not available, use:[370]

System Type	Age of Equipment	HSPF Estimate	ηHeat (COP Estimate)
Heat Pump	Before 2006	6.8	2.00
	2006-2014	7.7	2.26
	2015 and after	8.2	2.40
Resistance	N/A	N/A	1.00
Unknown	N/A	N/A	1.57[371]

%ElecHeat = Percentage of heating savings assumed to be electric

Heating fuel	%ElectricHeat
Electric	100%
Natural Gas	0%
Unknown	35%[372]

$WHFe_{Cool}$ = Waste Heat Factor for energy to account for cooling savings from reducing waste heat from efficient lighting

Bulb Location	$WHFe_{Cool}$
Building with cooling	1.12[373]
Building without cooling or exterior	1.0
Unknown	1.11[374]

Mid-Life Baseline Adjustment

During the lifetime of a standard omnidirectional LED, the baseline incandescent/halogen bulb would need to be replaced multiple times. Since the baseline bulb changes to a CFL equivalent beginning in 2020 (depending upon availability of halogen bulbs in the market), due to the EISA backstop provision (except for <310 and 2600+ lumen lamps) the annual savings claim must be reduced within the life of the measure to account for this baseline shift. This reduced annual savings will need to be incorporated in to cost-effectiveness screening calculations. The baseline adjustment also impacts the O&M schedule.

For example, for 43W equivalent LED lamp installed in 2016, the full savings (as calculated above in the Algorithm) should be claimed for the first four years and a reduced annual savings (calculated energy savings above multiplied by the adjustment factor in the table below) claimed for the remainder of the measure life.

369 This means that heating loads increase by 53% of the lighting savings. This is based on the average result from REMRate modeling of several different building configurations in Iowa (Des Moines, Mason City, and Burlington). These results were judged to be equally applicable to Missouri.

370 These default system efficiencies are based on the applicable minimum federal standards. In 2006 and 2015, the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

371 Calculation assumes 50% heat pump and 50% resistance, which is based upon data from Energy Information Administration, 2009 Residential Energy Consumption Survey, see “HC6.9 Space Heating in Midwest Region.xls.” Average efficiency of heat pump is based on assumption 50% are units from before 2006 and 50% 2006-2014.

372 Average (default) value of 35% electric space heating from 2009 Residential Energy Consumption Survey for Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

373 The value is estimated at 1.12 (calculated as 1 + (0.34 / 2.8)), and it is based on cooling loads decreasing by 34% of the lighting savings (average result from REMRate modeling of several different building configurations in Iowa (Des Moines, Mason City, and Burlington)). The estimate also assumes typical cooling system operating efficiency of 2.8 COP (starting from standard assumption of SEER 10.5 central AC unit, converted to 9.5 EER using algorithm ($-0.02 * SEER^2$) + (1.12 * SEER) (from Wassmer, M. (2003); A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. (Masters Thesis, University of Colorado at Boulder, converted to COP = EER/3.412 = 2.8COP). Results of the Iowa study are assumed to be applicable to Missouri.

374 The value is estimated at 1.11 (calculated as 1 + (0.91*(0.34 / 2.8)), which is based on assumption that 91% of homes have central cooling (based on 2009 Residential Energy Consumption Survey, see “HC7.9 Air Conditioning in Midwest Region.xls”).

Lower Lumen Range	Upper Lumen Range	Mid Lumen Range	WattsEE	WattsBase before EISA 2020	Delta Watts before EISA 2020	WattsBase after EISA 2020[375]	Delta Watts after EISA 2020
250	309	280	4.0	25	21	25	21.0
310	749	530	6.7	29	22.3	9.4	2.7
750	1049	900	10.1	43	32.9	13.4	3.3
1050	1489	1270	12.8	53	40.2	18.9	6.1
1490	2600	2045	17.4	72	54.6	24.8	7.4
2,601	3,000	2,775	43.1	150	106.9	150	106.9
3,001	3,999	3,500	53.8	200	146.2	200	146.2
4,000	6,000	5,000	76.9	300	223.1	300	223.1

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0001492529 for residential bulbs and 0.0001899635 for nonresidential bulbs

NATURAL GAS SAVINGS

Heating Penalty for Natural Gas heated homes:[376]

$$\Delta Therms = -\frac{\frac{Watts_{Base} - Watts_{EE}}{1,000} * ISR * Hours * HF * 0.03412}{\eta \text{Heat}} * \%\text{GasHeat}$$

Where:

HF = Heating Factor or percentage of light savings that must now be heated
= 53%[377] for interior or unknown location
= 0% for exterior or unheated location

0.03412 =Converts kWh to therms

$\eta Heat_{Gas}$ = Efficiency of heating system
= 71%[378]

%GasHeat = Percentage of heating savings assumed to be Natural Gas

Heating fuel	%GasHeat
Electric	0%
Natural Gas	100%
Unknown	65%[379]

MEASURE CODE:

[375] Calculated with EISA requirement of 45lumens/watt.
[376] Negative value because this is an increase in heating consumption due to the efficient lighting.
[377] This means that heating loads increase by 53% of the lighting savings. This is based on the average result from REMRate modeling of several different building configurations in Iowa (Des Moines, Mason City, and Burlington). Results of the Iowa study are judged to be equally applicable to Missouri.
[378] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey)). See reference "HC6.9 Space Heating in Midwest Region.xls." In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 15 years ago provide a reasonable proxy for the current mix of furnaces in the state. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.
[379] Average (default) value of 65% gas space heating from 2009 Residential Energy Consumption Survey for Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

3.5.2 LED Specialty Lamp

DESCRIPTION

This measure provides savings assumptions for LED directional, decorative, and globe lamps when the LED is installed in a known location (i.e., residential and in-unit interior or exterior) or, if the implementation strategy does not allow for the installation location to be known (e.g., an upstream retail program or efficiency kit), an unknown residential location. For upstream programs, utilities should develop an assumption of the Residential v Nonresidential split and apply the relevant assumptions to each portion.

Federal legislation stemming from the Energy Independence and Security Act of 2007 (EISA) requires all general-purpose light bulbs between 40W and 100W to be approximately 30% more energy efficient than standard incandescent bulbs. Production of 100W, standard efficacy incandescent lamps ended in 2012, followed by restrictions on 75W lamps in 2013 and 60W and 40W lamps in 2014. The baseline for this measure has therefore become bulbs (improved incandescent or halogen) that meet the new standard.

A provision in the EISA regulations requires that by January 1, 2020, all lamps meet efficiency criteria of at least 45 lumens per watt, in effect making the baseline equivalent to a current day CFL

This measure was developed to be applicable to the following program types: TOS, NC, and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, new lamps must be ENERGY STAR® labeled based upon the ENERGY STAR® specification v2.0 which became effective on 1/2/2017 https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2_0%20Revised%20AUG-2016.pdf). Qualification could also be based on the Design Light Consortium's qualified product list.[380]

DEFINITION OF BASELINE EQUIPMENT

The baseline condition for this measure is assumed to be an EISA qualified halogen or incandescent. From 2020, the baseline will change based upon what is available in the market.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The ENERGY STAR® rated life requirement for directional bulbs is 25,000 and for decorative bulbs is 15,000 hours[381]. This would imply a lifetime of 34 years for residential interior directional and 21 years for residential interior decorative. However, all installations are capped at 19 years.[382]

DEEMED MEASURE COST

While LEDs may have a higher upfront cost than a halogen or CFL, the incremental cost for LEDs in an upstream lighting program is assumed to be zero because the net present value of the costs to replace the halogen or CFL multiple times over the life of the LED is greater than the upfront cost of the LED. Therefore, the incentive in this case is not designed to reduce the incremental cost over the lifetime of the measure. Instead the incentive is designed to reduce the initial upfront cost that may have been a barrier to the customer choosing the efficient lighting option. In the case of direct install programs or lighting included in efficient kits, the actual cost of the measure should be used.

LOADSHAPE

Lighting RES
Lighting BUS

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$\Delta kWh_{RES} =$

$(Watt_{Base} - Watt_{EE}) * \%RES * ISR * (1 - LKG) * (Hours_{RES} * WHF_{RES}) / 1{,}000$

[380] https://www.designlights.org/QPL.
[381] ENERGY STAR®, v2.0: https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2_0%20Revised%20AUG-2016.pdf.
[382] Particularly in residential applications, lamps are susceptible to persistence issues such as removal, new fixtures, new occupants etc. The measure life is capped at 19, per TAC agreement 1/19/2017.

ΔkWh_{NRES}=
$(Watt_{Base} - Watt_{EE}) * (1 - \%RES) * ISR * (1 - LKG) * (Hours_{NRES} * Days * WHF_{NRES})/1{,}000$

Where:

$Watts_{Base}$ = Based on bulb type and lumens of LED bulb installed. See table below.

$Watts_{EE}$ = Actual wattage of LED purchased / installed - If unknown, use default provided below:[383]

Bulb Type	Lower Lumen Range	Upper Lumen Range	$Watts_{Base}$	$Watts_{EE}$	Delta Watts
Directional	250	349	25	5.6	19.4
	350	399	35	6.3	28.7
	400	599	40	7.5	32.5
	600	749	60	9.7	50.3
	750	999	75	12.7	62.3
	1000	1250	100	16.2	83.8
Decorative	70	89	10	1.8	8.2
	90	149	15	2.7	12.3
	150	299	25	3.2	21.8
	300	499	40	4.7	35.3
	500	699	60	6.9	53.1
Globe	250	349	25	4.1	20.9
	350	499	40	5.9	34.1
	500	574	60	7.6	52.4
	575	649	75	13.6	61.4
	650	1099	100	17.5	82.5
	1100	1300	150	13.0	137.0

%RES = percentage of bulbs sold to residential customers

LKG = leakage rate (program bulbs installed outside Ameren Missouri's service area)

ISR = In Service Rate, the percentage of units rebated that are actually in service

Program	Discounted In Service Rate (ISR)
Retail (Time of Sale)[384]	95.12%
Direct Install[385]	99%
Efficiency Kit (School)	92%
Efficiency Kit (Single Family)[386]	92%
Efficiency Kit (Multi-Family)[387]	98%

$Hours_{RES}$ = Average hours of use per year

[383] $Watts_{EE}$ defaults are based upon the average available ENERGY STAR® product, accessed 06/18/2015. For any lumen range where there is no ENERGY STAR® product currently available, $Watts_{EE}$ is based upon the ENERGY STAR® minimum luminous efficacy (directional; 40Lm/W for lamps with rated wattages less than 20Wand 50 Lm/W for lamps with rated wattages ≥ 20 watts. decorative and globe; 45Lm/W for lamps with rated wattages less than 15W, 50lm/W for lamps ≥15 and <25W, 60 Lm/W for lamps with rated wattages ≥ 25 watts.) for the mid-point of the lumen range. See calculation at "cerified-light-bulbs-2015-06-18.xlsx." These assumptions should be reviewed regularly to ensure they represent the available product.

[384] Updated UMP Method (based on initial install value from PY17 inventory).

[385] Ameren Missouri Home Energy Analysis Program Impact and Process Evaluation: Program Year 2015.

[386] Ameren Missouri Efficient Products Impact and Process Evaluation: Program Year 2015.

[387] Ameren Missouri Efficient Products Impact and Process Evaluation: Program Year 2015.

= Custom, or if unknown assume 728[388] for interior or 1,314 for exterior, or 776 if location is not known.

$Hours_{NRES}$ = 3,613

$WHFe_{Heat}$ = Waste Heat Factor for energy to account for electric heating increase from reducing waste heat from efficient lighting (if fossil fuel heating – see calculation of heating penalty in that section).

= 1 - ((HF / ηHeat) * %ElecHeat)

If unknown assume 0.88[389]

Where:

HF = Heating Factor or percentage of light savings that must now be heated

= 53%[390] for interior or unknown location

= 0% for exterior or unheated location

$\eta Heat_{Electric}$ = Efficiency in COP of Heating equipment

= Actual - If not available, use:[391]

System Type	Age of Equipment	HSPF Estimate	ηHeat (COP Estimate)
Heat Pump	Before 2006	6.8	2.00
	2006-2014	7.7	2.26
	2015 and after	8.2	2.40
Resistance	N/A	N/A	1.00
Unknown	N/A	N/A	1.57[392]

%ElecHeat = Percentage of heating savings assumed to be electric

Heating fuel	%ElectricHeat
Electric	100%
Natural Gas	0%
Unknown	35%[393]

$WHFe_{Cool}$ = Waste Heat Factor for energy to account for cooling savings from reducing waste heat from efficient lighting

Bulb Location	$WHFe_{Cool}$
Building with cooling	1.12[394]
Building without cooling or exterior	1.0
Unknown	1.11[395]

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

Bulb Location	CF
Lighting RES (Residential)	0.0001492529
Lighting BUS (Business)	0.0001899635

Other factors as defined above.

389 Calculated using defaults: 1-((0.53/1.57) * 0.35) = 0.88.

390 This means that heating loads increase by 53% of the lighting savings. This is based on the average result from REMRate modeling of several different building configurations in Iowa (Des Moines, Mason City, and Burlington). Results of the Iowa study were judged to be equally applicable to Missouri.

391 These default system efficiencies are based on the applicable minimum federal standards. In 2006 and 2015 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

392 Calculation assumes 50% heat pump and 50% resistance, which is based upon data from Energy Information Administration, 2009 Residential Energy Consumption Survey, see "HC6.9 Space Heating in Midwest Region.xls." Average efficiency of heat pump is based on assumption 50% are units from before 2006 and 50% 2006-2014.

393 Average (default) value of 35% electric space heating from 2009 Residential Energy Consumption Survey for Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

394 The value is estimated at 1.12 (calculated as 1 + (0.34 / 2.8)), is based on cooling loads decreasing by 34% of the lighting savings (average result from REMRate modeling of several different building configurations in Iowa (Des Moines, Mason City, and Burlington)). The estimate also assumes typical cooling system operating efficiency of 2.8 COP (starting from standard assumption of SEER 10.5 central AC unit, converted to 9.5 EER using algorithm (-0.02 * $SEER^2$) + (1.12 * SEER) (from Wassmer, M. (2003); A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. (Masters Thesis, University of Colorado at Boulder) Converted to COP = EER/3.412 = 2.8COP). Results of the Iowa study were assumed to be applicable to Missouri.

395 The value is estimated at 1.11 (calculated as 1 + (0.91*(0.34 / 2.8)). Based on assumption that 91% of homes have central cooling (based on 2009 Residential Energy Consumption Survey, see "HC7.9 Air Conditioning in Midwest Region.xls").

NATURAL GAS SAVINGS

Heating Penalty for Natural Gas heated home:s[396]

$$\Delta Therms = -\frac{\frac{Watts_{Base} - Watts_{EE}}{1,000} * ISR * Hours * HF * 0.03412}{\eta\text{Heat}} * \%\text{GasHeat}$$

Where:

HF = Heating Factor or percentage of light savings that must be heated
= 53%[397] for interior or unknown location
= 0% for exterior or unheated location

0.03412 =Converts kWh to therms

$\eta Heat_{Gas}$ = Efficiency of heating system
=71%[398]

%GasHeat = Percentage of homes with gas heat

Heating fuel	%GasHeat
Electric	0%
Gas	100%
Unknown	65%[399]

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

MEASURE CODE:

[396] Negative value because this is an increase in heating consumption due to the efficient lighting.

[397] This means that heating loads increase by 53% of the lighting savings. This is based on the average result from REMRate modeling of several different building configurations in Des Moines, Mason City, and Burlington, Iowa. Results of the Iowa study were judged to be equally applicable to Missouri.

[398] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey)). See reference "HC6.9 Space Heating in Midwest Region.xls." In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 15 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

[399] Average (default) value of 65% gas space heating from 2009 Residential Energy Consumption Survey for Missouri. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area, then they should be used.

3.6 Motors

3.6.1 High Efficiency Pool Pumps

DESCRIPTION

Conventional residential outdoor pool pumps are single speed, often oversized, and run frequently at constant flow regardless of load. Single speed pool pumps require that the motor be sized for the task that requires the highest speed. As such, energy is wasted performing low speed tasks at high speed. Two- speed and variable speed pool pumps reduce speed when less flow is required, such as when filtering is needed but not cleaning, and have timers that encourage programming for fewer on-hours. Variable speed pool pumps use advanced motor technologies to achieve efficiency ratings of 90% while the average single speed pump will have efficiency ratings between 30% and 70%.[400] This measure is the characterization of the purchasing and installing of an efficient two-speed or variable speed residential pool pump motor in place of a standard single speed motor of equivalent horsepower.

This measure was developed to be applicable to the following program types: TOS, NC, and RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The high efficiency equipment is an ENERGY STAR® two speed or variable speed residential pool pump for in-ground pools.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a single speed residential pool pump.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The estimated useful life for a two speed or variable speed pool pump is 10 years.[401]

DEEMED MEASURE COST

The incremental cost is estimated as $235 for a two-speed motor and $549 for a variable speed motor.[402]

LOADSHAPE

Pool Spa RES

Algorithm

CALCULATION OF ENERGY SAVINGS

Electric Energy Savings

$$Energy\ Savings\ \left(\frac{kWh}{Year}\right) = Days_{oper} * \{\left(\frac{kWh_{ss}}{Day}\right) - \left(\frac{kWh_{ds}}{Day}\right)\}$$

$$\left(\frac{kWh_{ds}}{Day}\right) = \left(\frac{kWh_{hs}}{Day}\right) + \left(\frac{kWh_{ls}}{Day}\right)$$

$$\left(\frac{kWh_{ss}}{Day}\right) = (RT_{ss} * GPM_{ss} * 60)/(EF_{ss} * 1000)$$

$$\left(\frac{kWh_{hs}}{Day}\right) = (RT_{hs} * GPM_{hs} * 60)/(EF_{hs} * 1000)$$

$$\left(\frac{kWh_{ls}}{Day}\right) = (RT_{ls} * GPM_{ls} * 60)/(EF_{ls} * 1000)$$

[400] U.S. DOE, 2012. Measure Guideline: Replacing Single-Speed Pool Pumps with Variable Speed Pumps for Energy Savings. Report No. DOE/GO-102012-3534.

[401] The CEE Efficient Residential Swimming Pool Initiative, p18, indicates that the average motor life for pools in use year round is 5-7 years. For pools in use for under a third of a year, you would expect the lifetime to be higher so 10 years is selected as an assumption. This is consistent with DEER, 2014 and the ENERGY STAR® Pool Pump Calculator assumptions.

[402] ENERGY STAR® Pool Pump Calculator.

Where:

Term	Multi speed	Variable Speed
$Days_{oper}$= Days per Year of Operation	*121.6*	*121.6*
RT_{ss} = runtime in hours/day using single speed (ss) pump	11.4	11.4
RT_{ls} = runtime in hours/day in low speed (ls) using dual speed (ds) pump	9.8	10.0
RT_{hs} = runtime in hours/day in high speed (hs) using dual speed (ds) pump	2.0	2.0
GPM_{ss} = gallons per minute using single speed (ss) pump	64.4	64.4
GPM_{ls} = gallons per minute in low speed (ls) using dual speed (ds) pump	31.0	30.6
GPM_{hs} = gallons per minute in high speed (ls) using dual speed (ds) pump	56.0	50.0
EF_{ss} = energy factor (gallons/watt-hr) using single speed (ss) pump	2.1	2.1
EF_{ls} = energy factor (gallons/watt-hr) in low speed (ls) using dual speed (ds) pump	5.4	7.3
EF_{hs} = energy factor (gallons/watt-hr) in high speed (hs) using dual speed (ds) pump	2.4	3.8

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0002354459

3.7 Building Shell

3.7.1 Air Sealing

DESCRIPTION
Thermal shell air leaks are sealed through strategic use and location of air-tight materials. An estimate of savings is provided in two ways. It is highly recommended that leaks be detected and pre- and post-sealing leakage rates measured with the assistance of a blower-door by qualified/certified inspectors.[403] Where this occurs, an algorithm is provided to estimate the site-specific savings. Where test in/test out has not occurred, a conservative deemed assumption is provided.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT
Air sealing materials and diagnostic testing should meet all eligibility program qualification criteria. The initial and final tested leakage rates should be assessed in such a manner that the identified reductions can be properly discerned, particularly in situations wherein multiple building envelope measures may be implemented simultaneously.

DEFINITION OF BASELINE EQUIPMENT
The existing air leakage should be determined through approved and appropriate test methods using a blower door. The baseline condition of a building upon first inspection significantly affects the opportunity for cost-effective energy savings through air sealing.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The expected measure life is assumed to be 15 years.[404]

DEEMED MEASURE COST
The actual capital cost for this measure should be used.

LOADSHAPE
Building Shell RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS
Test In / Test Out Approach

$$\Delta kWh = \Delta kWh\_cooling + \Delta kWh\_heating$$

Where:

ΔkWh_cooling = If central cooling, reduction in annual cooling requirement due to air sealing

$$= \frac{\left(\frac{CFM50_{Pre} - CFM50_{Post}}{N_{cool}}\right) * 60 * 24 * CDD * DUA * 0.018 * LM}{(1000 * \eta Cool)}$$

$CFM50_{Pre}$ = Infiltration at 50 Pascals as measured by blower door before air sealing
= Actual[405]

$CFM50_{Post}$ = Infiltration at 50 Pascals as measured by blower door after air sealing
= Actual

[403] Refer to the Energy Conservatory Blower Door Manual for more information on testing methodologies.
[404] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007.
[405] Because the pre- and post-sealing blower door test will occur on different days, there is a potential for the wind and temperature conditions on the two days to affect the readings. There are methodologies to account for these effects. For wind – first, if possible, avoid testing in high wind, place blower door on downwind side, take a pre-test baseline house pressure reading, adjust house pressure readings by subtracting the baseline reading, and use the time averaging feature on the digital gauge, etc. Corrections for air density due to temperature swings can be accounted for with air density correction factors. Refer to the Energy Conservatory Blower Door Manual for more information.

N_{cool} = Conversion factor from leakage at 50 Pascal to leakage at natural conditions
=Dependent on number of stories:[406]

Weather Basis (City based upon)	N_cool (by # of stories)			
	1	1.5	2	3
St Louis, MO	34.9	30.9	28.3	25.1

60 * 24 = Converts cubic feet per minute to cubic feet per day

CDD = Cooling Degree Days:[407]

Weather Basis (City based upon)	CDD 65
St Louis, MO	1646

DUA = Discretionary Use Adjustment (reflects the fact that people do not always operate their AC when conditions may call for it)
= 0.75[408]

0.018 = Specific heat capacity of air (Btu/ft^3*°F)

1000 = Converts Btu to kBtu

ηCool = Efficiency (SEER) of air conditioning equipment (kBtu/kWh)
= Actual (where it is possible to measure or reasonably estimate) - if unknown, assume the following:[409]

Age of Equipment	SEER Estimate
Before 2006	10
2006 - 2014	13
Central AC After 1/1/2015	13
Heat Pump After 1/1/2015	14

LM = Latent multiplier to account for latent cooling demand: [410]

Weather Basis (City based upon)	LM
St Louis, MO	3.0

ΔkWh_heating = If electric heat (resistance or heat pump), reduction in annual electric heating due to air sealing

$$= \frac{\frac{(CFM50_{Pre} - CFM50_{Post})}{N\_heat} * 60 * 24 * HDD * 0.018}{(\eta Heat * 3{,}412)}$$

N_heat = Conversion factor from leakage at 50 Pascal to leakage at natural conditions
= Based on building height:[411]

Weather Basis (City based upon)	N_heat (by # of stories)			
	1	1.5	2	3
St Louis, MO	24.0	21.3	19.5	17.3

HDD = Heating Degree Days

Weather Basis (City based upon)	HDD 65
St Louis, MO	4486

ηHeat = Efficiency of heating system

[406] N-factor is used to convert 50-pascal blower door air flows to natural air flows and is dependent on geographic location and # of stories. These were developed by applying the LBNL infiltration model (see LBNL paper 21040, *Exegisis of Proposed ASHRAE Standard 119: Air Leakage Performance for Detached Single-Family Residential Buildings*; Sherman, 1986; page v-vi, Appendix page 7-9) to the reported wind speeds and outdoor temperatures provided by the NRDC 30-year climate normals. For more information see Bruce Harley, CLEAResult "Infiltration Factor Calculations Methodology.doc" and calculation worksheets.

[407] Based on climate normals data with a base temperature of 65°F.

[408] This factor's source: Energy Center of Wisconsin, May 2008 metering study; "Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research," p31.

[409] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for central AC was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

[410] The LM is used to convert the sensible cooling savings calculated to a value representing sensible and latent cooling loads. The values are derived from the methodology outlined in Infiltration Factor Calculation Methodology by Bruce Harley, Senior Manager, Applied Building Science, CLEAResult 11/18/2015 and is based upon an 8760 analysis of sensible and total heat loads using hourly climate data.

[411] N-factor is used to convert 50-pascal blower door air flows to natural air flows and is dependent on geographic location and # of stories. These were developed by applying the LBNL infiltration model (see LBNL paper 21040, *Exegisis of Proposed ASHRAE Standard 119: Air Leakage Performance for Detached Single-Family Residential Buildings*; Sherman, 1986; page v-vi, Appendix page 7-9) to the reported wind speeds and outdoor temperatures provided by the NRDC 30 year climate normals. For more information see Bruce Harley, CLEAResult "Infiltration Factor Calculations Methodology.doc" and calculation worksheets.

= Actual - if not available refer to default table below:[412]

System Type	Age of Equipment	HSPF Estimate	ηHeat (Effective COP Estimate) (HSPF/3.412)*0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.92
	2015 and after	8.2	2.04
Resistance	N/A	N/A	1

3412 = Converts Btu to kWh

<u>Conservative Deemed Approach</u>

$$\Delta kWh = SavingsPerUnit * SqFt$$

Where:

SavingsPerUnit = Annual savings per square foot, dependent on heating / cooling equipment[413]

Building Type	HVAC System	SavingsPerUnit (kWh/ft)
Manufactured	Central Air Conditioner	0.062
Multifamily	Central Air Conditioner	0.043
Single Family	Central Air Conditioner	0.050
Manufactured	Electric Furnace/Resistance Space Heat	0.413
Multifamily	Electric Furnace/Resistance Space Heat	0.285
Single Family	Electric Furnace/Resistance Space Heat	0.308
Manufactured	Air Source Heat Pump	0.391
Multifamily	Air Source Heat Pump	0.251
Single Family	Air Source Heat Pump	0.308
Manufactured	Air Source Heat Pump - Cooling	0.062
Multifamily	Air Source Heat Pump - Cooling	0.043
Single Family	Air Source Heat Pump - Cooling	0.050
Manufactured	Air Source Heat Pump - Heating	0.329
Multifamily	Air Source Heat Pump - Heating	0.208
Single Family	Air Source Heat Pump - Heating	0.257

SqFt = Building conditioned square footage
= Actual

<u>Additional Fan savings</u>

ΔkWh_heating = If gas *furnace* heat, kWh savings for reduction in fan run time
= ΔTherms * F_e * 29.3

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption
= 3.14%[414]

29.3 = kWh per therm

[412] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.

[413] The values in the table represent estimates of savings from a 15% improvement in air leakage. The values are half those provided by Cadmus for the Iowa Joint Assessment, based on building simulations performed. While 30% savings are certainly achievable, this represents a thorough job in both the attic and basements and could not be verified without testing. The conservative 15% estimate is more appropriate for a deemed estimate. These values should be re-evaluated if EM&V values provide support for a higher deemed estimate.

[414] F_e is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300-record sample (non-random) out of 1495 was 3.14%. This is, appropriately, ~50% greater than the ENERGY STAR® version 3 criteria for 2% F_e. See "Furnace Fan Analysis.xlsx" for reference.

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:

ΔkWh_cooling = As calculated above.

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor

= 0.0009474181[415]

Natural Gas Savings

Test In / Test Out Approach

If natural gas heating:

$$\Delta Therms = \frac{\frac{(CFM50_{Pre} - CFM50_{Post})}{N\_heat} * 60 * 24 * HDD * 0.018}{(\eta Heat * 100{,}000)}$$

Where:

N_heat = Conversion factor from leakage at 50 Pascal to leakage at natural conditions

= Based on building height:[416]

Weather Basis (City based upon)	N_heat (by # of stories)			
	1	1.5	2	3
St Louis, MO	24.0	21.3	19.5	17.3

HDD = Heating Degree Days

Weather Basis (City based upon)	HDD 65
St Louis, MO	4486

ηHeat = Efficiency of heating system

= Equipment efficiency * distribution efficiency

= Actual[417] - if not available, use 71%[418]

Other factors as defined above

Conservative Deemed Approach

$$\Delta kWh = SavingsPerUnit * SqFt$$

Where:

SavingsPerUnit = Annual savings per square foot, dependent on heating / cooling equipment[419]

Building Type	HVAC System	SavingsPerUnit (Therms/ft)
Manufactured	Gas Boiler	0.022
Multifamily	Gas Boiler	0.018
Single Family	Gas Boiler	0.016
Manufactured	Gas Furnace	0.017
Multifamily	Gas Furnace	0.012
Single Family	Gas Furnace	0.013

[415] Based on Ameren Missouri 2016 loadshape for residential cooling end-use.

[416] N-factor is used to convert 50-pascal blower door air flows to natural air flows and is dependent on geographic location and # of stories. These were developed by applying the LBNL infiltration model (see LBNL paper 21040, *Exegisis of Proposed ASHRAE Standard 119: Air Leakage Performance for Detached Single-Family Residential Buildings*; Sherman, 1986; page v-vi, Appendix page 7-9) to the reported wind speeds and outdoor temperatures provided by the NRDC 30-year climate normals. For more information see Bruce Harley, CLEAResult "Infiltration Factor Calculations Methodology.doc" and calculation worksheets.

[417] Ideally, the system efficiency should be obtained either by recording the AFUE of the unit, or performing a steady state efficiency test. The distribution efficiency can be estimated via a visual inspection and by referring to a look up table such as that provided by the Building Performance Institute - (http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf - or by performing duct blaster testing.

[418] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey). In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 16 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

[419] The values in the table represent estimates of savings from a 15% improvement in air leakage. The values are half those provided by Cadmus for the Iowa Joint Assessment, based on building simulations performed. While 30% savings are certainly achievable, this represents a thorough job in both the attic and basements and could not be verified without testing. The conservative 15% estimate is more appropriate for a deemed estimate. These values should be re-evaluated if EM&V values provide support for a higher deemed estimate.

SqFt = Building square footage
= Actual

WATER IMPACT DESCRIPTIONS AND CALCULATION
N/A

DEEMED O&M COST ADJUSTMENT CALCULATION
N/A

MEASURE CODE:

3.7.2 Ceiling Insulation

DESCRIPTION

This measure describes savings from adding insulation to the attic/ceiling. This measure requires a member of the implementation staff evaluating the pre- and post-project R-values and to measure surface areas. The efficiency of the heating and cooling equipment in the home should also be evaluated if possible.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The requirements for participation in the program will be defined by the utilities.

DEFINITION OF BASELINE EQUIPMENT

The existing condition will be evaluated by implementation staff or a participating contractor.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 25 years.[420]

DEEMED MEASURE COST

The actual installed cost for this measure should be used in screening.

LOADSHAPE

Building Shell RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (\Delta kWh\_cooling + \Delta kWh\_heating)$$

Where

ΔkWh_cooling = If central cooling, reduction in annual cooling requirement due to insulation

$$= \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{Attic}}\right) * A_{attic} * (1 - FramingFactor_{Attic}) * CDD * 24 * DUA}{(1000 * \eta Cool)}$$

R_{Attic} = R-value of new attic assembly including all layers between inside air and outside air (ft^2.°F.h/Btu)

R_{Old} = R-value value of existing assembly and any existing insulation (Minimum of R-5 for uninsulated assemblies[421])

A_{Attic} = Total area of insulated ceiling/attic (ft^2)

$FramingFactor_{Attic}$ = Adjustment to account for area of framing = 7%[422]

CDD = Cooling Degree Days:[423]

Weather Basis (City based upon)	CDD 65
St Louis, MO	1646

24 = Converts days to hours

[420] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007

[421] An estimate based on review of Madison Gas and Electric, Exterior Wall Insulation, R-value for no insulation in walls, and NREL's Building Energy Simulation Test for Existing Homes (BESTEST-EX).

[422] ASHRAE, 2001, "Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP)," Table 7.1

[423] Based on climate normals data with a base temp of 65°F.

DUA = Discretionary Use Adjustment (reflects the fact that people do not always operate their AC when conditions may call for it)
= 0.75[424]
1000 = Converts Btu to kBtu
ηCool = Seasonal energy efficiency ratio of cooling system (kBtu/kWh)
= Actual (where it is possible to measure or reasonably estimate) - if unknown, assume the following:[425]

Age of Equipment	ηCool Estimate
Before 2006	10
2006 - 2014	13
Central AC after 1/1/2015	13
Heat Pump after 1/1/2015	14

kWh_heating = If electric heat (resistance or heat pump), reduction in annual electric heating due to insulation

$$= \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{Attic}}\right) * A_{Attic} * (1 - FramingFactor_{Attic}) * HDD * 24 * ADJAttic}{(\eta Heat * 3412)}$$

HDD = Heating Degree Days

Weather Basis (City based upon)	HDD 65
St Louis, MO	4486

ηHeat = Efficiency of heating system
= Actual - if not available, refer to default table below:[426]

System Type	Age of Equipment	HSPF Estimate	ηHeat (Effective COP Estimate) (HSPF/3.412)*0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.9
	2015 and after	8.2	2.0
Resistance	N/A	N/A	1.0

3412 = Converts Btu to kWh
ADJ_{Attic} = Adjustment for attic insulation to account for prescriptive engineering algorithms consistently overclaiming savings.
= 74%[427]
ΔkWh_heating = If gas *furnace* heat, kWh savings for reduction in fan run time
= ΔTherms * F_e * 29.3
Where:
F_e = Furnace fan energy consumption as a percentage of annual fuel consumption
= 3.14%[428]
29.3 = kWh per therm

[424] This factor's source: Energy Center of Wisconsin, May 2008 metering study; "Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research," p31.
[425] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for central AC was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.
[426] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.
[427] Based upon comparing algorithm derived savings estimate and evaluated bill analysis estimate in the following 2012 Massachusetts report: "Home Energy Services Impact Evaluation," August 2012. See "Insulation ADJ calculations.xls" for details or calculation.
[428] F_e is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300 record sample (non-random) out of 1495 was 3.14%. This is, appropriately, ~50% greater than the ENERGY STAR® version 3 criteria for 2% F_e. See "Furnace Fan Analysis.xlsx" for reference.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0009474181[429]

NATURAL GAS SAVINGS

ΔTherms (if Natural Gas heating)

$$= \frac{\left(\frac{1}{R_{old}} - \frac{1}{R_{attic}}\right) * A_{Attic} * (1 - FramingFactor_{Attic}) * HDD * 24 * ADJAttic}{(\eta Heat * 100{,}000)}$$

Where:

HDD = Heating Degree Days

Weather Basis (City based upon)	HDD 65
St Louis, MO	4486

ηHeat = Efficiency of heating system
= Equipment efficiency * distribution efficiency
= Actual.[430] If unknown, assume 71%.[431]

100,000 = Converts Btu to therms

Other factors as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[429] Based on Ameren Missouri 2016 loadshape for residential cooling end-use.
[430] Ideally, the system efficiency should be obtained either by recording the AFUE of the unit, or performing a steady state efficiency test. The distribution efficiency can be estimated via a visual inspection and by referring to a look up table such as that provided by the Building Performance Institute - (http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf) - or by performing duct blaster testing.
[431] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes based on Energy Information Administration, 2009 Residential Energy Consumption Survey). In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 16 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

3.7.3 Duct Insulation

DESCRIPTION

This measure describes evaluating the savings associated with performing duct insulation on the distribution system of homes with central cooling and/or a ducted heating system. While insulating ducts in conditioned space can help with control and comfort, energy savings are largely limited to insulating ducts in unconditioned space where the heat loss is to outside the thermal envelope. Therefore, for this measure to be applicable, at least 30% of ducts should be within unconditioned space (e.g., attic with floor insulation, vented crawlspace, unheated garages. Basements should be considered conditioned space).

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient condition is insulated duct work throughout the unconditioned space in the home.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is existing duct work with at least 30% of the ducts within the unconditioned space in the home.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 20 years.[432]

DEEMED MEASURE COST

The actual duct insulation measure cost should be used.

LOADSHAPE

HVAC RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Electric energy savings is calculated as the sum of energy saved when cooling the home and energy saved when heating the home.

$$\Delta kWh = \Delta kWhCooling + \Delta kWhHeating$$

If central cooling, the electric energy saved in annual cooling due to the added insulation is

$$\Delta kWhCooling = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * Area * EFLHcool * \Delta T_{AVG,cooling}}{(1{,}000 * SEER)}$$

Where:

$R_{existing}$ = Duct heat loss coefficient with existing insulation ((hr-^{0}F-ft^2)/Btu)
= Actual

R_{new} = Duct heat loss coefficient with new insulation (hr-^{0}F-ft^2)/Btu)
= Actual

Area = Area of the duct surface exposed to the unconditioned space that has been insulated (ft^2)

EFLHcool = Equivalent Full Load Cooling Hours:[433]

Weather Basis (City based upon)	EFLHcool (Hours)
St Louis, MO	869

[432] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.

[433] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) and reduced by 28.5% based on the evaluation results in Ameren territory suggesting an appropriate EFLH of 869.The other weather basis values are calculated using the relative climate normals cooling degree day ratios (at 65F set point).

$\Delta T_{AVG,cooling}$ = Average temperature difference (^{0}F) during cooling season between outdoor air temperature and assumed 60^{0}F duct supply air temperature[434]

Weather Basis (City based upon)	$OA_{AVG,cooling}$ [°F][435]	$\Delta T_{AVG,cooling}$ [°F]
St Louis, MO	80.8	20.8

1,000 = Converts Btu to kBtu

SEER = Efficiency in SEER of air conditioning equipment

= Actual - If not available, use:[436]

Equipment Type	Age of Equipment	SEER Estimate
Central AC	Before 2006	10
	After 2006	13
Heat Pump	Before 2006	10
	2006-2014	13
	2015 on	14

If the home is heated with electric heat (resistance or heat pump), the electric energy saved in annual heating due to the added insulation is:

$$\Delta kWhHeating_{Electric} = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * Area * EFLHheat * \Delta T_{AVG,heating}}{(3{,}412 * COP)}$$

Where:

EFLHheat = Equivalent Full Load Heating Hours:[437]

Weather Basis (City based upon)	EFLHheat (Hours)
St Louis, MO	2009

$\Delta T_{AVG,heating}$ = Average temperature difference (^{0}F) during heating season between outdoor air temperature and assumed 115^{0}F duct supply temperature[438]

Weather Basis (City based upon)	$OA_{AVG,heating}$ [°F][439]	$\Delta T_{AVG,heating}$ [°F]
St Louis, MO	43.2	71.8

3,412 = Converts Btu to kWh

COP = Efficiency in COP of heating equipment

= Actual - if not available, use:[440]

System Type	Age of Equipment	HSPF Estimate	COP (Effective COP Estimate) (HSPF/3.412)*0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.92
	2015 on	8.2	2.04

[434] Leaving coil air temperatures are typically about 55^{0}F. Therefore, 60^{0}F is used as an average temperature, recognizing that some heat transfer occurs between the ductwork and the environment it passes through.

[435] National Solar Radiation Data Base -- 1991- 2005 Update: Typical Meteorological Year 3 http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html . Heating season defined as September 17th through April 13th, cooling season defined as May 20 through August 15th. For cooling season, temperatures from 8AM to 8PM were used to establish average temperatures as this is when cooling systems are expected to be loaded.

[436] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for central AC was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

[437] Based on Full Load Hour assumptions (for St Louis and Kansas City) taken from the ENERGY STAR® calculator (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls). The other weather basis values are calculated using the climate normals heating degree day ratios (at 60F set point).

[438] Forced air supply temperatures are typically 130^{0}F. 115^{0}F is used as an average temperature, recognizing that some heat transfer occurs between the ductwork and the environment it passes through.

[439] National Solar Radiation Data Base -- 1991- 2005 Update: Typical Meteorological Year 3 http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html . Heating season defined as September 17 through April 13, cooling season defined as May 20 through August 15. For cooling season, temperatures from 8AM to 8PM were used to establish average temperatures as this is when cooling systems are expected to be loaded.

[440] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.

Resistance	N/A	N/A	1

If the building is heated with a gas furnace, there will be some electric savings in heating the building attributed to extra insulation since the furnace fans will run less.

$$\Delta kWhHeating_{Gas} = (\Delta Therms * Fe * 29.3)$$

Where:

ΔTherms = Therm savings as calculated in Natural Gas Savings

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption
= 3.14%[441]

29.3 = Converts therms to kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWhCooling * CF$$

Where:

ΔkWhCooling = Electric energy savings for cooling, calculated above

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0004660805

NATURAL GAS SAVINGS

If home uses a gas heating system, the savings resulting from the insulation is calculated with the following formula.

$$\Delta \text{Therms} = \frac{\left(\frac{1}{R_{existing}} - \frac{1}{R_{new}}\right) * Area * EFLHheat * \Delta T_{AVG,heating}}{(100{,}000 * \eta\text{Heat})}$$

Where:

All factors as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[441] F_e is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300-record sample (non-random) out of 1495 was 3.14%. This is, appropriately, ~50% greater than the ENERGY STAR® version 3 criteria for 2% F_e.

3.7.4 Floor Insulation

DESCRIPTION

Insulation is added to the floor above a vented crawl space that does not contain pipes or HVAC equipment. If there are pipes, HVAC, or a basement, it is desirable to keep them within the conditioned space by insulating the crawl space walls and ground. Insulating the floor separates the conditioned space above from the space below the floor and is only acceptable when there is nothing underneath that could freeze or would operate less efficiently in an environment resembling the outdoors. Even in the case of an empty, unvented crawl space, it is still considered best practice to seal and insulate the crawl space perimeter rather than the floor. Not only is there generally less area to insulate this way, but there are also moisture control benefits. There is a "Foundation Sidewall Insulation" measure for perimeter sealing and insulation. This measure assumes the insulation is installed above an unvented crawl space and should not be used in other situations.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The requirements for participation in the program will be defined by the utilities.

DEFINITION OF BASELINE EQUIPMENT

The existing condition will be evaluated by implementation staff or a participating contractor and is likely to be no insulation on any surface surrounding a crawl space.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 25 years.[442]

DEEMED MEASURE COST

The actual installed cost for this measure should be used in screening.

LOADSHAPE

Building Shell RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Where available, savings from shell insulation measures should be determined through a custom analysis. When that is not feasible, the following engineering algorithms can be used with the inclusion of an adjustment factor to de-rate the heating savings:

$$\Delta kWh = (\Delta kWh\_cooling + \Delta kWh\_heating)$$

Where:

ΔkWh_cooling = If central cooling, reduction in annual cooling requirement due to insulation

$$= \frac{\left(\frac{1}{R_{Old}} - \frac{1}{(R_{Added} + R_{Old})}\right) * Area * (1 - Framing\ Factor) * CDD * 24 * DUA}{(1000 * \eta Cool)}$$

R_{Old} = R-value value of floor before insulation, assuming 3/4" plywood subfloor and carpet with pad

= Actual -- if unknown, assume 3.96[443]

R_{Added} = R-value of additional spray foam, rigid foam, or cavity insulation.

Area = Total floor area to be insulated

Framing Factor = Adjustment to account for area of framing

= 12%[444]

[442] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007.

[443] Based on 2005 ASHRAE Handbook – Fundamentals: assuming 2x8 joists, 16" OC, ¾" subfloor, ½" carpet with rubber pad, and accounting for a still air film above and below: 1/ [(0.85 cavity share of area / (0.68 + 0.94 + 1.23 + 0.68)) + (0.15 framing share / (0.68 + 7.5" * 1.25 R/in + 0.94 + 1.23 + 0.68))] = 3.96.

[444] ASHRAE, 2001, "Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP)," Table 7.1.

24 = Converts hours to days

CDD = Cooling Degree Days

Weather Basis (City based upon)	Unconditioned Space CDD 75 [445]
St Louis, MO	762

DUA = Discretionary Use Adjustment (reflects the fact that people do not always operate their AC when conditions may call for it).

= 0.75[446]

1000 = Converts Btu to kBtu

ηCool = Seasonal energy efficiency ratio of cooling system (kBtu/kWh)

= Actual (where it is possible to measure or reasonably estimate). If unknown, assume the following:[447]

Age of Equipment	ηCool Estimate
Before 2006	10
2006 - 2014	13
Central AC After 1/1/2015	13
Heat Pump After 1/1/2015	14

ΔkWh_heating = If electric heat (resistance or heat pump), reduction in annual electric heating due to insulation

$$= \frac{\left(\frac{1}{R_{Old}} - \frac{1}{(R_{Added} + R_{Old})}\right) * Area * (1 - Framing\ Factor) * HDD * 24 * ADJ_{Floor}}{(\eta Heat * 3412)}$$

HDD = Heating Degree Days:

Weather Basis Zone (City based upon)	Unconditioned Space HDD 50 [448]
St Louis, MO	1911

ηHeat = Efficiency of heating system

= Actual -- if not available, refer to default table below:[449]

System Type	Age of Equipment	HSPF Estimate	ηHeat (Effective COP Estimate) (HSPF/3.412)*0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.9
	2015 and after	8.2	2.0
Resistance	N/A	N/A	1.0

ADJ_{Floor} = Adjustment for floor insulation to account for prescriptive engineering algorithms overclaiming savings.

= 88%[450]

Other factors as defined above

[445] The base temperature should be the outdoor temperature at which the desired indoor temperature stays constant in balance with heat loss or gain to the outside and internal gains. Since unconditioned basements are allowed to swing in temperature, are ground coupled, and are usually cool, they have a bigger delta between the two (heating and cooling) base temperatures. 75F for cooling and 50F for heating are used based on professional judgment. Five-year average cooling degree days with 75F base temp are provided from DegreeDays.net because the 30 year climate normals from NCDC are not available at base temps above 72F.

[446] Energy Center of Wisconsin, May 2008 metering study; "Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research," p31.

[447] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for central AC was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

[448] The base temperature should be the outdoor temperature at which the desired indoor temperature stays constant in balance with heat loss or gain to the outside and internal gains. Since unconditioned basements are allowed to swing in temperature, are ground coupled, and are usually cool, they have a bigger delta between the two (heating and cooling) base temperatures. 75F for cooling and 50F for heating are used based on professional judgment. National Climatic Data Center, calculated from 1981-2010 climate normals.

[449] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.

[450] Based upon comparing algorithm-derived savings estimate and evaluated bill analysis estimate in the following 2012 Massachusetts report: "Home Energy Services Impact Evaluation," August 2012. See "Insulation ADJ calculations.xls" for details or calculation. Note that basement wall is used as a proxy for crawlspace ceiling.

ΔkWh_heating = If gas *furnace* heat, kWh savings for reduction in fan run time
= ΔTherms * F_e * 29.3

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption
= 3.14%[451]

29.3 = kWh per therm

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0009474181[452]

NATURAL GAS SAVINGS

ΔTherms (if Natural Gas heating)

$$= \frac{\left(\frac{1}{R_{Old}} - \frac{1}{(R_{Added} + R_{Old})}\right) * Area * (1 - Framing\ Factor) * HDD * 24 * ADJ_{Floor}}{(\eta Heat * 100{,}000)}$$

Where

ηHeat = Efficiency of heating system
= Equipment efficiency * distribution efficiency
= Actual[453] - If not available, use 71%[454]

100,000 = Converts Btu to therms
Other factors as defined above.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[451] F_e is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300-record sample (non-random) out of 1495 was 3.14%. This is, appropriately, ~50% greater than the ENERGY STAR® version 3 criteria for 2% F_e. See "Programmable Thermostats Furnace Fan Analysis.xlsx" for reference.

[452] Based on Ameren Missouri 2016 loadshape for residential cooling end-use.

[453] Ideally, the system efficiency should be obtained either by recording the AFUE of the unit, or performing a steady state efficiency test. The distribution efficiency can be estimated via a visual inspection and by referring to a look up table such as that provided by the Building Performance Institute - (http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf - or by performing duct blaster testing.

[454] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey). In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 16 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

3.7.5 Foundation Sidewall Insulation

DESCRIPTION

Insulation is added to a basement or crawl space. Insulation added above ground in conditioned space is modeled the same as wall insulation. Below ground insulation is adjusted with an approximation of the thermal resistance of the ground. Insulation in unconditioned spaces is modeled by reducing the degree days to reflect the smaller but non-zero contribution to heating and cooling load. Cooling savings only consider above grade insulation, as below grade has little temperature difference during the cooling season.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The requirements for participation in the program will be defined by the utilities.

DEFINITION OF BASELINE EQUIPMENT

The existing condition will be evaluated by implementation staff or a participating contractor and is likely to be no basement wall or ceiling insulation.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
The expected measure life is assumed to be 25 years.[455]

DEEMED MEASURE COST
The actual installed cost for this measure should be used in screening.

LOADSHAPE
Building Shell RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS
Where available savings from shell insulation measures should be determined through a custom analysis. When that is not feasible for the program the following engineering algorithms can be used with the inclusion of an adjustment factor to de-rate the heating savings.

$$\Delta kWh = (\Delta kWh\_cooling + \Delta kWh\_heating)$$

Where:

ΔkWh_cooling = If central cooling, reduction in annual cooling requirement due to Insulation

$$= \frac{\left(\frac{1}{R_{OldAG}} - \frac{1}{(R_{Added} + R_{OldAG})}\right) * L_{BWT} * H_{BWAG} * (1 - FF) * CDD * 24 * DUA}{(1000 * \eta Cool)}$$

R_{Added} = R-value of additional spray foam, rigid foam, or cavity insulation.
R_{OldAG} = R-value value of foundation wall above grade.
= Actual, if unknown assume 1.0[456]
L_{BWT} = Length (Basement Wall Total) of basement wall around the entire insulated perimeter (ft)
H_{BWAG} = Height (Basement Wall Above Grade) of insulated basement wall above grade (ft)
FF = Framing Factor, an adjustment to account for area of framing when cavity insulation is used
= 0% if spray foam or external rigid foam
= 25% if studs and cavity insulation[457]
24 = Converts hours to days
CDD = Cooling Degree Days
= Dependent whether basement is conditioned:

Weather Basis (City based upon)	Conditioned Space CDD 65 [458]	Unconditioned Space CDD 75 [459]
St Louis, MO	1646	762

DUA = Discretionary Use Adjustment (reflects the fact that people do not always operate their AC when conditions may call for it).
= 0.75[460]
1000 = Converts Btu to kBtu
ηCool = Seasonal energy efficiency ratio of cooling system (kBtu/kWh)
= Actual (where it is possible to measure or reasonably estimate). If unknown assume the following:[461]

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455 Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007.
456 ORNL Builders Foundation Handbook, crawl space data from Table 5-5: Initial Effective R-values for Uninsulated Foundation System and Adjacent Soil, 1991, http://www.ornl.gov/sci/roofs+walls/foundation/ORNL_CON-295.pdf.
457 ASHRAE, 2001, “Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP),” Table 7.1
458 National Climatic Data Center, calculated from 1981-2010 climate normals with a base temp of 65°F.
459 The base temperature should be the outdoor temperature at which the desired indoor temperature stays constant, in balance with heat loss or gain to the outside and internal gains. Since unconditioned basements are allowed to swing in temperature, are ground coupled, and are usually cool, they have a bigger delta between the two (heating and cooling) base temperatures. 75F for cooling and 50F for heating are used based on professional judgment. Five year average cooling degree days with 75F base temp are provided from DegreeDays.net because the 30 year climate normals from NCDC are not available at base temps above 72F.
460 This factor's source is: Energy Center of Wisconsin, May 2008 metering study; “Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research,” p31.
461 These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for central AC was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

Age of Equipment	ηCool Estimate
Before 2006	10
2006 - 2014	13
Central AC After 1/1/2015	13
Heat Pump After 1/1/2015	14

ΔkWh_heating = If electric heat (resistance or heat pump), reduction in annual electric heating due to insulation

$$= \frac{\left(\begin{array}{c}\left(\left(\frac{1}{R_{OldAG}} - \frac{1}{(R_{Added} + R_{OldAG})}\right) * L_{BWT} * H_{BWAG} * (1-FF)\right) + \\ \left(\left(\frac{1}{R_{OldBG}} - \frac{1}{(R_{Added} + R_{OldBG})}\right) * L_{BWT} * (H_{BWT} - H_{BWAG}) * (1-FF)\right)\end{array}\right) * HDD * 24 * DUA * ADJ_{Basement}}{(3412 * \eta Heat)}$$

Where

R_{OldBG} = R-value value of foundation wall below grade (including thermal resistance of the earth)[462]
= dependent on depth of foundation (H_basement_wall_total – H_basement_wall_AG):
= Actual R-value of wall plus average earth R-value by depth in table below
For example, for an area that extends 5 feet below grade, an R-value of 7.46 would be selected and added to the existing insulation R-value.

Below Grade R-value									
Depth below grade (ft)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Earth R-value (°F-ft^2-h/Btu)	2.44	4.50	6.30	8.40	10.44	12.66	14.49	17.00	20.00
Average Earth R-value (°F-ft2-h/Btu)	2.44	3.47	4.41	5.41	6.42	7.46	8.46	9.53	10.69
Total BG R-value (earth + R-1.0 foundation) default	3.44	4.47	5.41	6.41	7.42	8.46	9.46	10.53	11.69

H_{BWT} = Total height of basement wall (ft)

HDD = Heating Degree Days
= dependent on whether basement is conditioned:

Weather Basis (City based upon)	Conditioned Space HDD 65 [463]	Unconditioned Space HDD 50 [464]
St Louis, MO	4486	1,911

ηHeat = Efficiency of heating system
= Actual. If not available refer to default table below:[465]

System Type	Age of Equipment	HSPF Estimate	ηHeat (Effective COP Estimate) (HSPF/3.412)*0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.9
	2015 and after	8.2	2.0
Resistance	N/A	N/A	1.0

462 Adapted from Table 1, page 24.4, of the 1977 ASHRAE Fundamentals Handbook.
463 National Climatic Data Center, calculated from 1981-2010 climate normals with a base temp of 60°F, consistent with the findings of Belzer and Cort, Pacific Northwest National Laboratory in "Statistical Analysis of Historical State-Level Residential Energy Consumption Trends," 2004.
464 The base temperature should be the outdoor temperature at which the desired indoor temperature stays constant in balance with heat loss or gain to the outside and internal gains. Since unconditioned basements are allowed to swing in temperature, are ground coupled, and are usually cool, they have a bigger delta between the two (heating and cooling) base temperatures. 75F for cooling and 50F for heating are used based on professional judgment. National Climatic Data Center, calculated from 1981-2010 climate normals.
465 These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.

$ADJ_{Basement}$= Adjustment for basement wall insulation to account for prescriptiveengineering algorithms overclaiming savings.
= 88%[466]

ΔkWh_heating = If gas *furnace* heat, kWh savings for reduction in fan run time
= ΔTherms * F_e * 29.3

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption
= 3.14%[467]

29.3 = kWh per therm

SUMMER COINCIDENT PEAK DEMAND

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0009474181[468]

NATURAL GAS SAVINGS

If Natural Gas heating:

ΔTherms =

$$= \frac{\left(\begin{array}{c}\left(\left(\frac{1}{R_{OldAG}} - \frac{1}{(R_{Added} + R_{OldAG})}\right) * L_{BWT} * H_{BWAG} * (1 - FF)\right) + \\ \left(\left(\frac{1}{R_{OldBG}} - \frac{1}{(R_{Added} + R_{OldBG})}\right) * L_{BWT} * (H_{BWT} - H_{BWAG}) * (1 - FF)\right)\end{array}\right) * HDD * 24 * ADJ_{Basement}}{(100{,}000 * \eta Heat)}$$

Where

ηHeat = Efficiency of heating system
= Equipment efficiency * distribution efficiency
= Actual[469] - If not available, use 71%[470]

100,000 = Converts Btu to therms

Other factors as defined above

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

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[466] Based upon comparing algorithm derived savings estimate and evaluated bill analysis estimate in the following 2012 Massachusetts report: "Home Energy Services Impact Evaluation," August 2012. See "Insulation ADJ calculations.xls" for details or calculation.

[467] F_e is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300-record sample (non-random) out of 1495 was 3.14%. This is, appropriately, ~50% greater than the ENERGY STAR® version 3 criteria for 2% F_e. See "Programmable Thermostats Furnace Fan Analysis.xlsx" for reference.

[468] Based on Ameren Missouri 2016 loadshape for residential cooling end-use.

[469] Ideally, the system efficiency should be obtained either by recording the AFUE of the unit or performing a steady state efficiency test. The distribution efficiency can be estimated via a visual inspection and by referring to a look up table such as that provided by the Building Performance Institute - (http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf - or by performing duct blaster testing.

[470] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey). In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 16 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

3.7.6 Storm Windows

DESCRIPTION
Storm windows installed on either the interior or exterior of existing window assemblies can reduce both heating and cooling loads by reducing infiltration and solar heat gain and improving insulation properties. Glass options for storm windows can include traditional clear glazing as well as low-emissivity (Low-E) glazing. Low-E glass is formed by adding an ultra-thin layer of metal to clear glass. The metallic-oxide (pyrolytic) coating is applied when the glass is in its molten state, and the coating becomes a permanent and extremely durable part of the glass. This coating is also known as "hard-coat" Low-E. Low-E glass is designed to redirect heat back towards the source, effectively providing higher insulating properties and lower solar heat gain as compared to traditional clear glass. This characterization captures the savings associated with installing storm windows to an existing window assembly (retrofit).

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT
An interior or exterior storm window installed according to manufacturer specifications.

DEFINITION OF BASELINE EQUIPMENT
The existing window assembly.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT
20 years[471]

DEEMED MEASURE COST
The actual capital cost for this measure should be used when available and include both material and labor costs. If unavailable, the cost for a low-e storm window can be assumed as \$7.85/ft^2 of window area (material cost) plus \$30 per window for installation expenses.[472] For clear glazing, cost can be assumed as \$6.72/ft^2 of window area (material cost) plus \$30 per window for installation expenses.[473]

LOADSHAPE
Building Shell RES

[471] Task ET-WIN-PNNL-FY13-01_5.3: Database of Low-E Storm Window Energy Performance across U.S. Climate Zones. KA Cort and TD Culp, September 2013. Prepared for the U.S. Department of Energy by Pacific Northwest National Laboratory. PNNL-22864.
[472] Task ET-WIN-PNNL-FY13-01_5.3: Database of Low-E Storm Window Energy Performance across U.S. Climate Zones. KA Cort and TD Culp, September 2013. Prepared for the U.S. Department of Energy by Pacific Northwest National Laboratory. PNNL-22864.
[473] A comparison of Low-E to clear glazed storm windows available at large national retail outlets showed the average incremental cost for Low-E glazing to be \$1.13/ft^2. Installation costs are identical.

Algorithm

CALCULATION OF SAVINGS

The following reference tables show savings factors (kBtu/ft^2) for both heating and cooling loads for each of the seven weather zones defined by the TRM.[474] They are used with savings equations listed in the electric energy and gas savings sections to produce savings estimates. If storm windows are left installed year-round, both heating and cooling savings may be claimed. If they are installed seasonally, only heating savings should be claimed. Savings are dependent on location, storm window location (interior or exterior), glazing type (clear or Low-E) and existing window assembly type.

St Louis, MO

Heating:

Savings in kBtu/ft^2		Base Window Assembly			
		SINGLE PANE, DOUBLE HUNG	DOUBLE PANE, DOUBLE HUNG	SINGLE PANE, FIXED	DOUBLE PANE, FIXED
Storm Window Type	CLEAR EXTERIOR	47.7	13.3	48.5	12.3
	CLEAR INTERIOR	49.8	17.9	49.0	14.2
	LOW-E EXTERIOR	51.5	13.3	53.2	19.3
	LOW-E INTERIOR	57.7	20.3	55.9	17.5

Cooling:

Savings in kBtu/ft^2		Base Window Assembly			
		SINGLE PANE, DOUBLE HUNG	DOUBLE PANE, DOUBLE HUNG	SINGLE PANE, FIXED	DOUBLE PANE, FIXED
Storm Window Type	CLEAR EXTERIOR	23.0	10.5	22.5	9.6
	CLEAR INTERIOR	23.9	10.7	24.4	9.8
	LOW-E EXTERIOR	29.5	15.4	29.3	9.3
	LOW-E INTERIOR	28.8	14.2	29.0	13.4

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \Delta kWh\_cooling + \Delta kWh\_heating$$

Where:

ΔkWh_cooling = If storm windows are left installed during the cooling season and the home has central cooling, the reduction in annual cooling requirement due to air sealing

$$= \frac{\Sigma_{cool} * A}{\eta Cool}$$

Σ_{cool} = Savings factor for cooling, as tabulated above.

A = Area (square footage) of storm windows installed.

ηCool = Efficiency (SEER) of Air Conditioning equipment (kBtu/kWh)

= Actual (where it is possible to measure or reasonably estimate) - If unknown, assume the following:[475]

Age of Equipment	SEER Estimate
Before 2006	10
2006 - 2014	13
Central AC After 1/1/2015	13
Heat Pump After 1/1/2015	14

474 Savings factors are based on simulation results, documented in "Storm Windows Savings.xlsx."

475 These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for central AC was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

ΔkWh_heating = If electric heat (resistance or heat pump), reduction in annual electric heating due to air sealing

$$= \frac{\Sigma_{heat} * A}{\eta Heat * 3.412}$$

Σ_{heat} = Savings factor for heating, as tabulated above.

ηHeat = Efficiency of heating system

= Actual - If not available refer to default table below:[476]

System Type	Age of Equipment	HSPF Estimate	ηHeat (Effective COP Estimate) (HSPF/3.412)*0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.92
	2015 and after	8.2	2.04
Resistance	N/A	N/A	1

3.412 = Converts kBtu to kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:

ΔkWh_cooling = As calculated above.

CF = Summer System Peak Coincidence Factor for Cooling

= 0.0009474181[477]

NATURAL GAS SAVINGS

If Natural Gas heating:

$$\Delta Therms = \frac{\Sigma_{heat} * A}{\eta Heat * 100}$$

Where:

ηHeat = Efficiency of heating system

= Equipment efficiency * distribution efficiency

= Actual[478] - If not available, use 71%[479]

100 = Converts kBtu to therms

Other factors as defined above

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[476] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.

[477] Based on Ameren Missouri 2016 loadshape for residential cooling end-use.

[478] Ideally, the system efficiency should be obtained either by recording the AFUE of the unit, or performing a steady state efficiency test. The distribution efficiency can be estimated via a visual inspection and by referring to a look up table such as that provided by the Building Performance Institute - (http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf - or by performing duct blaster testing.

[479] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey). In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 16 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

3.7.7 Kneewall and Sillbox Insulation

DESCRIPTION

This measure describes savings from adding insulation (for example, blown cellulose, spray foam) to wall cavities (this includes kneewall and sillbox areas). This measure requires a member of the implementation staff evaluating the pre- and post-project R-values and to measure surface areas. The efficiency of the heating and cooling equipment in the home should also be evaluated if possible.

This measure was developed to be applicable to the following program type: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The requirements for participation in the program will be defined by the utilities.

DEFINITION OF BASELINE EQUIPMENT

The existing condition will be evaluated by implementation staff or a participating contractor and is likely to be empty wall cavities.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 25 years.[480]

DEEMED MEASURE COST

The actual installed cost for this measure should be used in screening.

LOADSHAPE

Building Shell RES

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (\Delta kWh\_cooling + \Delta kWh\_heating)$$

Where

ΔkWh_cooling = If central cooling, reduction in annual cooling requirement due to insulation

$$= \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{Wall}}\right) * A_{Wall} * (1 - FramingFactor_{Wall}) * CDD * 24 * DUA}{(1000 * \eta Cool)}$$

R_{Wall} = R-value of new wall assembly including all layers between inside air and outside air (ft^2.°F.h/Btu)

R_{Old} = R-value value of existing assembly and any existing insulation (ft^2.°F.h/Btu)
(Minimum of R-5 for uninsulated assemblies[481])

A_{Wall} = Net area of insulated wall (ft^2)

$FramingFactor_{Wall}$ = Adjustment to account for area of framing
= 25%[482]

CDD = Cooling Degree Days:[483]

Weather Basis (City based upon)	CDD 65
St Louis, MO	1646

24 = Converts days to hours

[480] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007.
[481] An estimate based on review of Madison Gas and Electric, Exterior Wall Insulation, R-value for no insulation in walls, and NREL's Building Energy Simulation Test for Existing Homes (BESTEST-EX).
[482] ASHRAE, 2001, "Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP)," Table 7.1.
[483] National Climatic Data Center, calculated from 1981-2010 climate normals with a base temperature of 65°F.

DUA = Discretionary Use Adjustment (reflects the fact that people do not always operate their AC when conditions may call for it)
= 0.75[484]

1000 = Converts Btu to kBtu

ηCool = Seasonal Energy Efficiency Ratio of cooling system (kBtu/kWh)
= Actual (where it is possible to measure or reasonably estimate) - If unknown, assume the following:[485]

Age of Equipment	ηCool Estimate
Before 2006	10
2006 - 2014	13
Central AC after 1/1/2015	13
Heat Pump after 1/1/2015	14

kWh_heating = If electric heat (resistance or heat pump), reduction in annual electric heating due to insulation

$$= \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{Wall}}\right) * A_{wall} * (1 - FramingFactor_{Wall}) * HDD * 24 * ADJWall}{(\eta Heat * 3412)}$$

HDD = Heating Degree Days:[486]

Weather Basis (City based upon)	HDD 65
St Louis, MO	4486

ηHeat = Efficiency of heating system
= Actual - If not available, refer to default table below:[487]

System Type	Age of Equipment	HSPF Estimate	ηHeat (Effective COP Estimate) (HSPF/3.412)*0.85
Heat Pump	Before 2006	6.8	1.7
	2006 - 2014	7.7	1.9
	2015 and after	8.2	2.0
Resistance	N/A	N/A	1.0

3412 = Converts Btu to kWh

ADJ_{Wall} = Adjustment for wall insulation to account for prescriptive engineering algorithms consistently overclaiming savings
= 63%[488]

ΔkWh_heating = If gas *furnace* heat, kWh savings for reduction in fan run time
= ΔTherms * F_e * 29.3
Where:
F_e = Furnace fan energy consumption as a percentage of annual fuel consumption
= 3.14%[489]
29.3 = kWh per therm

[484] This factor's source is: Energy Center of Wisconsin, May 2008 metering study; "Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research," p31.
[485] These default system efficiencies are based on the applicable minimum federal standards. In 2006 the federal standard for central AC was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.
[486] National Climatic Data Center, calculated from 1981-2010 climate normals with a base temp of 60°F, consistent with the findings of Belzer and Cort, Pacific Northwest National Laboratory in "Statistical Analysis of Historical State-Level Residential Energy Consumption Trends," 2004.
[487] These default system efficiencies are based on the applicable minimum Federal Standards. In 2006 the federal standard for heat pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time means that using the minimum standard is appropriate. An 85% distribution efficiency is then applied to account for duct losses for heat pumps.
[488] Based upon comparing algorithm derived savings estimate and evaluated bill analysis estimate in the following 2012 Massachusetts report: "Home Energy Services Impact Evaluation," August 2012. See "Insulation ADJ calculations.xls" for details or calculation.
[489] F_e is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300-record sample (non-random) out of 1495 was 3.14%. This is, appropriately, ~50% greater than the ENERGY STAR® version 3 criteria for 2% F_e. See "Furnace Fan Analysis.xlsx" for reference.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh_{cooling} * CF$$

Where:

CF = Summer peak coincidence demand (kW) to annual energy (kWh) factor
= 0.0009474181[490]

NATURAL GAS SAVINGS

ΔTherms (if Natural Gas heating)

$$= \frac{\left(\frac{1}{R_{old}} - \frac{1}{R_{wall}}\right) * A_{wall} * (1 - FramingFactor_{Wall}) * HDD * 24 * ADJWall}{(\eta Heat * 100{,}000)}$$

Where:

HDD = Heating Degree Days:[491]

Weather Basis (City based upon)	HDD 65
St Louis, MO	4486

ηHeat = Efficiency of heating system
= Equipment efficiency * distribution efficiency
= Actual[492] - If not available, use 71%[493]

100,000 = Converts Btu to therms

Other factors as defined above

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

[490] Based on Ameren Missouri 2016 loadshape for residential cooling end-use.

[491] National Climatic Data Center, calculated from 1981-2010 climate normals with a base temp of 65°F, consistent with the findings of Belzer and Cort, Pacific Northwest National Laboratory in "Statistical Analysis of Historical State-Level Residential Energy Consumption Trends," 2004.

[492] Ideally, the system efficiency should be obtained either by recording the AFUE of the unit, or performing a steady state efficiency test. The distribution efficiency can be estimated via a visual inspection and by referring to a look up table such as that provided by the Building Performance Institute - (http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf - or by performing duct blaster testing.

[493] This has been estimated assuming that natural gas central furnace heating is typical for Missouri residences (the predominant heating is gas furnace with 48% of Missouri homes (based on Energy Information Administration, 2009 Residential Energy Consumption Survey). In 2000, 29% of furnaces purchased in Missouri were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years, so units purchased 16 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows: ((0.29*0.92) + (0.71*0.8)) * (1-0.15) = 0.71.

3.8 Miscellaneous

3.8.1 Home Energy Report

DESCRIPTION

These behavior/feedback programs send energy use reports to participating residential electric or gas customers in order to change customers' energy use behavior. Savings impacts are evaluated by ex-post billing analysis comparing consumption before and after (or with and without) program intervention and require M&V methods that include customer-specific energy usage regression analysis and randomized controlled trial (RCT) experimental designs, among others (see national protocols developed under the sponsorship of the US Department of Energy[494]). As such, calculation of savings achieved by the program for the year is treated as a custom protocol.

Given that actual monitored energy use is needed, as an ex-post input for these custom calculations, estimates of program savings are used for program planning and goal setting at the beginning of the program cycles. Estimated deemed values are based on previous actual program performance developed through forecasting analysis from the program implementer, or taken from actual savings values from comparable programs delivered by other program administrators.

HER Program Deemed Savings Estimates for 2016-2018 Planning

Utility Program	Gross Electric Savings (kWh/home)	Gross Demand Savings (kW/home)
Ameren Missouri Home Energy Report[495]	150	.07

DEFINITION OF EFFICIENT CASE

The efficient case is a customer who receives an HER.

DEFINITION OF BASELINE CASE

The baseline case is a customer who does not receive an HER.

DEEMED LIFETIME OF PROGRAM SAVINGS

The expected measure life is assumed to be 1 year.

DEEMED MEASURE COST

It is assumed that most behavior changes in residential settings can be accomplished with homeowner labor only and without investment in new equipment. Therefore, without evidence to the contrary, measure costs in such residential programs focused on motivating changes in customer behavior may be defined as $0.

LOADSHAPE

Building Shell RES

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE:

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494 Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations; SEEAction (State and Local Energy Efficiency Action Network- EPA/DOE), 2012; The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Residential Behavior Protocol, NREL/ DOE, 2015.

495 The deemed values used by Ameren Missouri for planning purposed are derived by finding a reasonable medium between the average of 147 kWh savings/participant/year (per the KCP&L GMO 2016-2018 plan filed on August 28, 2015; KCPL MEEIA Report with Appendices NP 8-28-2015.pdf) and the average of 154 kWh savings/participation/year (per the KCP&L GMO 2016-2018 plan filed August 28, 2015; GMO MEEIA Report with Appendices NP 8-28-2015.pdf).

3.8.2 Demand Response Advanced Thermostat

DESCRIPTION

This measure characterizes the energy and demand savings for an advanced thermostat enrolled in the Residential DR Program. The program controls customer energy loads and also reduces energy usage by utilizing a continuous load shaping strategy during non-peak hours. Savings impacts are evaluated by ex-post analysis comparing demand and consumption with and without program intervention, utilizing field data which may be available through advanced thermostats' 2-way communication ability. The program will require M&V methods that include customer-specific energy usage regression analysis and randomized controlled trial (RCT) experimental designs, among others. As such, calculation of both demand and energy savings achieved by the program for the year are treated as a custom protocol.

Given that actual monitored field data is needed as ex-post inputs for these custom calculations, estimates of program savings are used for program planning and goal setting at the beginning of the program cycles.

Demand Response Smart Thermostat Deemed Savings Estimates for 2019-2024 Planning[496]

Utility Program	Gross Electric Savings (*Annual*) (kWh/thermostat)	Gross Demand Savings (*Event*) (kW/thermostat)[497]
Demand Response Advanced Thermostat	177	1.53

This measure was developed to be applicable to the following program type: DR.

DEFINITION OF EFFICIENT CASE

The efficient case is a customer who participated in the DR program.

DEFINITION OF BASELINE CASE

The baseline case is a customer who is not participating in the DR program and who has installed a thermostat with default enabled capability—or the capability to automatically—establish a schedule of temperature set points according to driving device inputs above and beyond basic time and temperature data of conventional programmable thermostats. This category of products and services is broad and rapidly advancing with regard to their capability, usability, and sophistication, but at a minimum the baseline customer must have installed a thermostat capable of two-way communication and exceed the typical performance of manual and conventional programmable thermostats through the automatic or default capabilities described above.

DEEMED LIFETIME OF PROGRAM SAVINGS

The expected measure life is assumed to be 11 years.

DEEMED MEASURE COST

It is assumed that program-controlled changes in residential settings are accomplished without homeowner investment in new equipment. Therefore, without evidence to the contrary, measure costs in such residential programs focused on program controlled changes in customer behavior may be defined as $0.

LOADSHAPE

HVAC RES

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

[496] Estimated deemed values are developed through forecasting analysis from the program implementer using actual program performance taken from comparable programs delivered by other program administrators. Gross annual energy savings are those associated with a continuous load shaping strategy applied throughout the year during non-peak hours. Gross event demand savings are those associated with demand response events.

[497] Actual average event demand reductions weather normalized to historical system peak conditions. Temperatures coincident with system peak events averaged 99°F from 1981-2010. Residential DR event kW savings will be normalized to this temperature.

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE
For MEEIA 2019-21 Plan

APPLICABILITY

This Rider EEIC – Energy Efficiency Investment Charge (Rider EEIC) is applicable to all kilowatt-hours (kWh) of energy supplied to customers served under Company's Service Classification Nos. 1(M), 2(M), 3(M), 4(M), 11(M), and 12(M), excluding kWh of energy supplied to "opt-out" or "Low-income" customers.

An Ameren Missouri Low-income customer who has received assistance from Missouri Energy Assistance (a.k.a. Low Income Home Energy Assistance Program or LIHEAP), Winter Energy Crisis Intervention Program, or Summer Energy Crisis Intervention Program and (i) whose account has not automatically been exempt from Rider EEIC, or (ii) who has been charged Rider EEIC charges and whose account has not been credited for said charges, may provide the Company, via facsimile to **866.297.8054**, via email to **myhomeamerenmissouri@ameren.com**, or via regular mail to **Ameren Missouri, P.O. Box 790352, St. Louis, MO 63179-0352**

a. documentation of the assistance received in the form of:

    i. a copy of the Division of Social Services Family Support Division ("DSSFSD") form EA-7 energy assistance payment notice received by the Low-income customer, or

    ii. a copy of the DSSFSD LIHEAP Energy Assistance direct payment check received by the Low-income customer, or

    iii. a copy of the Contract Agency energy crisis intervention program ("ECIP") payment notification letter received by the Low-income customer, or

    iv. a printout of the Low-income customer's DSSFSD LIHEAP EA E1RG System Registration screen identifying the supplier, benefit amount and payment processing date.

b. Upon receipt of the documentation, the Company will credit the Low-income customer's account within 12 billing months following the documented receipt of energy assistance for:

    i. energy efficiency investment charges, and

    ii. any municipal charges attributable to said EEIC charges that were previously charged to the Low-income customer;

c. Upon receipt of the documentation, for the remainder of the 12 months following the documented receipt of energy assistance, the Company will exempt such Low-income customer from any Rider EEIC charges thereafter imposed. The exemption will be evidenced on the Low-income customer's bill as an EEIC charge, followed by a credit.

Charges passed through this Rider EEIC reflect the charges approved to be billed from the implementation of the Missouri Energy Efficiency Investment Act (MEEIA) 2019-21 Plan and any remaining unrecovered balances from the MEEIA 2016-18 Plan. Those charges include:

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

APPLICABILITY (Cont'd.)

1) Program Costs, Company's Throughput Disincentive (TD) and Earnings Opportunity Award (if any) for each Effective Period (EP).

2) Reconciliations, with interest, to true-up for differences between the revenues billed under this Rider EEIC and total actual monthly amounts for:

    i) Program Costs incurred in the MEEIA 2019-21 Plan and/or remaining unrecovered Program Cost balances for MEEIA 2016-18;

    ii) Company's TD incurred in the MEEIA 2019-21 Plan and/or remaining unrecovered TD balances for MEEIA 2016-18;

    iii) Amortization of Earnings Opportunity Award ordered by the Missouri Public Service Commission (Commission) for the MEEIA 2019-21 Plan and/or remaining unrecovered EO balances for MEEIA 2016-18.

3) Any Ordered Adjustments.

Charges under this Rider EEIC shall continue after the anticipated December 31, 2021 end of the non-low-income portions of the MEEIA 2019-21 Plan and after December 31, 2024 for the low-income portion of the MEEIA 2019-21 Plan until such time as the charges described in items 1), 2), and 3) above have been billed. Any programs and/or balance associated with the low-income portions of the MEEIA 2019-21 Plan may be rolled into the recovery mechanism for an approved MEEIA program that commences in 2022.

Charges arising from the MEEIA 2019-21 Plan that are the subject of this Rider EEIC shall be reflected in one "Energy Efficiency Invest Chg" on customers' bills in combination with any charges arising from a rider that is applicable to previous MEEIA plans.

DEFINITIONS

As used in this Rider EEIC, the following definitions shall apply:

"Deemed Savings Table" means a list of Measures derived from the Company's TRM that characterizes associated gross energy and demand savings with Company-specific Measure parameters where available, as outlined in Appendix F to the MEEIA 2019-21 Plan and updated as provided for herein based on EM&V *ex-post* gross adjustments.

"Earnings Opportunity Award" (EO) means the dollar amount calculated for each Program Year by the EO Calculator as described in the Earnings Opportunity Award Determination section below.

"Effective Period" (EP) means the billing months for which an approved EEIR is to be effective, i. e., the 12 billing months beginning with the February billing month and ending with the January billing month unless here is an additional Rider EEIC filing is made to change the Energy Efficiency Investment Rate components during a calendar year, the EP for such a filing shall begin with the June or October billing month and end with the subsequent January billing month.

"End Use Category" means the unique summary category of end-use load shapes. The list of End Use Categories is included in Appendix G to the MEEIA 2019-21 Plan.

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

DEFINITIONS (Cont'd.)

"Incremental Internal Labor Cost and Associated Benefits" (IIL) means the labor costs and associated benefits of personnel 1) hired by Ameren Missouri after Commission approval of the MEEIA 2019-21 Plan that were (a) not hired to replace an Ameren Missouri or Ameren Services Company employee whose labor and benefit costs were accounted for in Ameren Missouri's prior general rate proceeding, (b) hired by Ameren Missouri and assigned exclusively to support Ameren Missouri's MEEIA Programs; and 2) were not an Ameren Missouri or Ameren Services Company employee whose labor and benefit costs were accounted for in Ameren Missouri's prior general rate proceeding.

"Evaluation Measurement & Verification" (EM&V) means the performance of studies and activities intended to evaluate the process of the Company's Program delivery and oversight and to estimate and/or verify the estimated actual energy and demand savings, cost effectiveness, and other effects from demand-side Programs.

"Incentive" means any consideration provided by the Company, including, but not limited to, buy downs, markdowns, rebates, bill credits, payments to third parties, direct installation, giveaways, and education, which encourages the adoption of Program Measures.

"Low-Income" customers means those Service Classification 1(M) residential customers eligible for the low income exemption provisions contained in Section 393.1075.6, RSMo. As approved in File No. ER-2014-0258, customers eligible under this definition will be exempt from Rider EEIC charges for 12 billing months following assistance received from either Missouri Energy Assistance (a.k.a. Low Income Home Energy Assistance Program or LIHEAP), Winter Energy Crisis Intervention Program, Summer Energy Crisis Intervention Program, the Company's Keeping Current Low Income Pilot Program, and/or the Company's Keeping Cool Low Income Pilot Program.

"Measure" means the same as defined in 4 CSR 240-20.092(1)FF.

"MEEIA 2016-18 Plan" means Company's "2016-18 Energy Efficiency Plan" approved in File No. EO-2015-0055.

"MEEIA 2019-21 Plan" means Company's "2019-21 MEEIA Energy Efficiency Plan" approved in File No. EO-2018-0211 as may be amended.

"Programs" means MEEIA 2019-21 programs listed in tariff sheet nos. 174 and 174.1.

"Program Costs" means any prudently incurred Program expenditures, including such items as Program planning, education Programs, Program design, administration, delivery, end-use Measures and Incentive payments, advertising expense, EM&V, market potential studies, work on a Company and/or statewide Technical Resource Manual, and IIL.

"Program Year" means the period of Programs that ends on December 31 of each year of the MEEIA 2019-21 Plan. The first Program Year will be 10 months long and each subsequent Program Year will be 12 months long.

"TRM" means the Company's Technical Resource Manual (attached as Appendices G-I to the MEEIA 2019-21 Plan) and updated based on EM&V *ex-post* gross adjustments.

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

ENERGY EFFICIENCY INVESTMENT RATE (EEIR) DETERMINATION

The EEIR during each applicable EP is a dollar per kWh rate for each applicable Service Classification calculated as follows:

EEIR = [NPC + NTD + NEO + NOA]/PE

Where:

NPC = Net Program Costs for the applicable EP as defined below,

NPC = PPC + PCR

PPC = Projected Program Costs is an amount equal to Program Costs projected by the Company to be incurred during the applicable EP.

PCR = Program Costs Reconciliation is equal to the cumulative difference, if any, between the PPC revenues billed resulting from the application of the NPC component of the EEIR and the actual Program Costs incurred through the end of the previous EP (which will reflect projections through the end of the previous EP due to timing of adjustments). Such amounts shall include monthly interest charged at the Company's monthly short-term borrowing rate. Any remaining PCR balance from MEEIA 2016-18 shall be rolled into the PCR calculation starting February 2022.

NTD = Net Throughput Disincentive for the applicable EP as defined below,

NTD = PTD + TDR

PTD = Projected Throughput Disincentive is the Company's TD projected by the Company to be incurred during the applicable EP. For the detailed method for calculating the TD, see Sheet 91.17.

TDR = Throughput Disincentive Reconciliation is equal to the cumulative difference, if any, between the PTD revenues billed during the previous EP resulting from the application of the NTD component of the EEIR and the Company's TD through the end of the previous EP (which will reflect projections through the end of the previous EP due to timing of adjustments). Such amounts shall include monthly interest charged at the Company's monthly short-term borrowing rate. Any remaining TDR balance from MEEIA 2016-18 shall be rolled into the TDR calculation starting February 2024.

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

EEIR DETERMINATION (Cont'd.)

NEO = Net Earnings Opportunity for the applicable EP as defined below,

NEO = EO + EOR

EO = Earnings Opportunity is equal to the sum of the monthly amortizations of each Program Year's Earnings Opportunity Award multiplied by the number of billing months in the applicable EP.

A monthly amortization shall be determined by dividing each Program Year's Earnings Opportunity Award by 12. The monthly amortization of each Program Year's Earnings Opportunity Award will continue through each subsequent EEIR determination until such time that the total Earnings Opportunity Award for that Program Year has been fully amortized.

EOR = Earnings Opportunity Reconciliation is equal to the cumulative difference, if any, between the EO revenues billed resulting from the application of the EEIR and the monthly amortization of the EO through the end of the previous EP (which will reflect projections through the end of the previous EP due to timing of adjustments). Such amounts shall include monthly interest charged at the Company's monthly short-term borrowing rate. Any remaining EO balance from MEEIA 2016-18 shall be rolled into the EOR calculation starting February 2022.

NOA = Net Ordered Adjustment for the applicable EP as defined below,

NOA = OA + OAR

OA = Ordered Adjustment is the amount of any adjustment to the EEIR ordered by the Commission as a result of prudence reviews and/or corrections under this Rider EEIC. Such amounts shall include monthly interest at the Company's monthly short-term borrowing rate.

OAR = Ordered Adjustment Reconciliation is equal to the cumulative difference, if any, between the OA revenues billed resulting from the application of the EEIR and the actual OA ordered by the Commission through the end of the previous EP (which will reflect projections through the end of the previous EP due to timing of adjustments). Such amounts shall include monthly interest charged at the Company's monthly short-term borrowing rate.

PE = Projected Energy, in kWh, forecasted to be delivered to the customers to which the Rider EEIC applies during the applicable EP.

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

EEIR DETERMINATION (Cont'd.)

The EEIR components and total EEIR applicable to the individual Service Classifications shall be rounded to the nearest $0.000001.

Allocations of charges for each applicable Service Classification will be made in accordance with the MEEIA 2019-21 Plan.

This Rider EEIC shall not be applicable to customers that have satisfied the opt-out provisions contained in Section 393.1075.7, RSMo or the Low-income exemption provisions described herein.

TD DETERMINATION

Monthly TD is the sum of the TD calculation for all End Use Categories and Demand Response Event Net Energy (DRENE).

The TD for each End Use Category shall be determined by the following formula:

$$\mathbf{TD = MS \times NMR \times NTGF}$$

Where:

TD = Throughput Disincentive, in dollars, to be collected for a given month, for a given Service Classification.

MS = Monthly Savings, is the sum of all Programs' monthly savings, in kWh, for a given month, for a given Service Classification. The MS for each End Use Category shall be determined by the following formula:

$$\mathbf{MS = ((MAS_{CM} / 2) + CAS - RB) \times LS + DRENE_{CM}}$$

Where:

MAS_{CM} = The sum of (MC x ME) for all Measures in a Program in the current calendar month.

MC = Measure Count. MC for a given month, for a given Service Classification, for each Measure, is the number of each Measure installed in the current calendar month. For the Home Energy Report Program, the number of reports mailed during the current calendar month shall be used as the Measure Count.

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

TD DETERMINATION (Cont'd.)

ME = Measure Energy. ME will be determined as follows, for each Measure:

a. For Measures in the Deemed Savings Table (including Residential Demand Response energy savings not included in $DRENE_{CM}$), the ME is the annual total of normalized savings for each Measure at customer meter per Measure defined in the Company's current Deemed Savings Table.

b. For Measures not in the Deemed Savings Table, the ME will be the annual value attributable to the installations reported monthly by the Program administrator.

CM = Current calendar month.

CAS = Cumulative sum of MAS of all prior calendar months for each End Use Category for the MEEIA 2019-21 Plan.

RB = Rebasing Adjustment. The RB shall equal the CAS applicable as of the date used for MEEIA normalization when base rates are adjusted in any general electric rate case or otherwise resulting in new retail electric rates becoming effective during the accrual and collection of TD pursuant to this MEEIA 2019-21 Plan. In the event base rates are adjusted by more than one general electric rate case or otherwise resulting in new rates becoming effective during the accrual and collection of TD pursuant to this MEEIA 2019-21 Plan occurs, the RB adjustment shall include each and every prior RB adjustment calculation.

LS = Load Shape. The LS is the monthly load shape percent (%) for each End-Use Category (included in the MEEIA 2019-21 Plan).

$DRENE_{CM}$ = Demand Response Event Net Energy for the Current Month. $DRENE_{CM}$ is the net energy savings resulting from demand response events during the month as reported by the program administrator consistent with TRM guidance. $DRENE_{CM}$ incurred during the time period used for establishing billing determinants in general rate proceedings will be added back to those billing determinants and will not be included in the Rebasing Adjustment.

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

TD DETERMINATION (Cont'd.)

NMR = Net Margin Revenue. NMR values for each applicable Service Classification and by End Use Category where applicable are as follows:

Month	Service Classifications 1(M)Res $/kWh	2(M)SGS $/kWh
January	0.040912	0.048845
February	0.042255	0.050525
March	0.044016	0.053255
April	0.047279	0.056875
May	0.048669	0.058104
June	0.103081	0.089681
July	0.103081	0.089681
August	0.103081	0.089681
September	0.103081	0.089681
October	0.044204	0.054614
November	0.047620	0.056771
December	0.044224	0.054182

	MISC./AIR COMP./ PROCESS/MOTORS			COOLING			EXT LIGHTING		
Month	3M	4M	11M	3M	4M	11M	3M	4M	11M
January	0.028837	0.029367	0.022321	0.020434	0.018259	0.012194	0.020459	0.020099	0.014092
February	0.030424	0.028156	0.023022	0.021371	0.016681	0.012194	0.021389	0.016704	0.014169
March	0.027963	0.029522	0.023028	0.020814	0.018474	0.024788	0.020832	0.018730	0.012477
April	0.031394	0.029638	0.023969	0.036473	0.033537	0.025435	0.024082	0.020250	0.014023
May	0.033144	0.031688	0.022296	0.047361	0.050122	0.038579	0.023474	0.019354	0.009123
June	0.067466	0.063761	0.047784	0.085470	0.085609	0.070991	0.043839	0.035239	0.016554
July	0.064869	0.062199	0.047090	0.079600	0.077784	0.056470	0.041855	0.034766	0.015981
August	0.064941	0.062284	0.048728	0.080858	0.081328	0.065873	0.042049	0.034934	0.016664
September	0.064744	0.061714	0.050555	0.086388	0.088530	0.080601	0.043088	0.035014	0.016628
October	0.031406	0.030110	0.026031	0.035669	0.032810	0.026007	0.022105	0.018803	0.012432
November	0.031883	0.029601	0.025073	0.036271	0.018471	0.025714	0.022845	0.018645	0.012223
December	0.031376	0.029519	0.024128	0.021906	0.018622	0.012194	0.022103	0.018646	0.012434

UNION ELECTRIC COMPANY **ELECTRIC SERVICE**

MO.P.S.C. SCHEDULE NO. 6 Original SHEET NO. 91.20

CANCELLING MO.P.S.C. SCHEDULE NO. ______ SHEET NO. ______

APPLYING TO **MISSOURI SERVICE AREA**

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

TD DETERMINATION (Cont'd.)

	HVAC/BUILDING SHELL			LIGHTING			REFRIG.		
Month	3M	4M	11M	3M	4M	11M	3M	4M	11M
January	0.030917	0.034631	0.028109	0.030337	0.030348	0.024101	0.027471	0.026660	0.020583
February	0.033918	0.032668	0.028694	0.031578	0.029642	0.024224	0.028762	0.026023	0.021209
March	0.031923	0.032861	0.026006	0.029073	0.030255	0.024219	0.026635	0.028083	0.022631
April	0.031832	0.028600	0.024521	0.033868	0.032836	0.027072	0.031028	0.029251	0.023497
May	0.039836	0.040345	0.030636	0.035269	0.034421	0.025065	0.031754	0.029905	0.020457
June	0.084589	0.084532	0.069979	0.071685	0.068874	0.052904	0.064432	0.060088	0.044804
July	0.079186	0.077313	0.056050	0.068940	0.066079	0.050737	0.061809	0.058246	0.041439
August	0.080331	0.080699	0.065254	0.068929	0.067052	0.052405	0.062076	0.058860	0.044228
September	0.082673	0.083918	0.075671	0.066718	0.064139	0.053394	0.061824	0.058139	0.046254
October	0.031611	0.030361	0.025126	0.033523	0.032705	0.029243	0.030010	0.028407	0.024185
November	0.034071	0.028774	0.032796	0.032968	0.031579	0.026602	0.030481	0.028224	0.022780
December	0.032547	0.033151	0.022975	0.031876	0.029846	0.025098	0.029911	0.027204	0.022469

	COOK.			DHW			HEAT.		
Month	3M	4M	11M	3M	4M	11M	3M	4M	11M
January	0.029335	0.028072	0.021931	0.028914	0.026605	0.020530	0.030918	0.034632	0.028109
February	0.030444	0.028181	0.022646	0.029624	0.027128	0.021175	0.033936	0.032692	0.028717
March	0.027954	0.031021	0.025800	0.026900	0.030259	0.024917	0.032333	0.033374	0.026423
April	0.034623	0.033511	0.027992	0.033877	0.032666	0.027083	0.034872	0.031897	0.028295
May	0.035035	0.034118	0.024764	0.034614	0.033575	0.024223	0.031898	0.030089	0.020648
June	0.072717	0.070125	0.054609	0.072634	0.070024	0.056577	0.043387	0.034696	0.015898
July	0.069795	0.067217	0.047024	0.069797	0.066151	0.044496	0.041418	0.034215	0.015898
August	0.070017	0.068352	0.052298	0.069950	0.068273	0.051532	0.041611	0.034412	0.015898
September	0.069062	0.067034	0.056678	0.068093	0.065836	0.055321	0.066915	0.064383	0.053671
October	0.033170	0.032272	0.028720	0.032781	0.031795	0.028691	0.033552	0.032740	0.027396
November	0.032781	0.032064	0.025111	0.032649	0.031565	0.023978	0.034641	0.029296	0.033757
December	0.032272	0.029187	0.026321	0.032145	0.028226	0.025832	0.032552	0.033158	0.022980

	OFFICE			VENT		
Month	3M	4M	11M	3M	4M	11M
January	0.028912	0.029008	0.022823	0.027075	0.027309	0.021202
February	0.030128	0.027775	0.022932	0.028366	0.025517	0.021266
March	0.027659	0.028321	0.022770	0.026315	0.026726	0.021190
April	0.031335	0.029612	0.023893	0.030946	0.029067	0.023391
May	0.033021	0.031531	0.022134	0.032051	0.030286	0.020851
June	0.065832	0.061780	0.045606	0.064034	0.059606	0.043470
July	0.063333	0.060295	0.046200	0.062011	0.058795	0.044294
August	0.063397	0.060440	0.047069	0.062115	0.058907	0.045558
September	0.062184	0.058580	0.046787	0.061305	0.057503	0.045482
October	0.031362	0.030056	0.025896	0.030392	0.028873	0.024566
November	0.031416	0.029112	0.024666	0.029407	0.026561	0.022237
December	0.030371	0.028225	0.022762	0.029943	0.028088	0.022198

DATE OF ISSUE ______ DATE EFFECTIVE ______

ISSUED BY Michael Moehn President St. Louis, Missouri
NAME OF OFFICER TITLE ADDRESS

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
For MEEIA 2019-21 Plan

TD DETERMINATION (Cont'd.)

The Company shall file an update to NMR rates by month by Service Classification and by end–use category contemporaneous with filing any compliance tariff sheets in any general electric rate case reflecting the rates set in that case, and the billing determinants used in setting rates in such case. Updates to the NMR values shall be calculated following the same process described in the Marginal Rate Analysis section of the MEEIA 2019-21 Plan.

NTGF = Net-To-Gross Factor. For each Program Year, all TD calculations will assume a NTGF of 0.85 until such time as a NTGF is determined through EM&V for that Program Year. Thereafter, for each given Program Year, the NTGF determined through EM&V will be used prospectively starting with the month in which the Earnings Opportunity Award is determined.

Annual kWh savings per Measure will be updated prospectively in the Company's TRM and Deemed Savings Table.

EARNINGS OPPORTUNITY AWARD DETERMINATION

An Earnings Opportunity Award shall be calculated for each Program Year using the EO Calculator submitted with the MEEIA 2019-21 Plan as Appendix N. The Earnings Opportunity Award will not go below zero dollars ($0). If Commission-approved new programs are added to the Program, the Company may seek Commission approval to have the targets and the cap of the Earnings Opportunity Award adjusted. For each Program Year the Earnings Opportunity Award shall be adjusted for the difference, with carrying cost at the Company's monthly short-term interest rate, between TD revenues billed resulting from the application of the EEIR and what those revenues would have been if:

(1) The ME used in the calculation were the normalized savings for each Measure at customer meter per Measure determined through EM&V *ex-post* gross analysis for each Program Year, and

(2) The NTGF used in the calculation was the net-to-gross values determined through EM&V.

FILING

The Company shall make a Rider EEIC filing each calendar year to be effective for the subsequent calendar year's February billing month. The Company is allowed or may be ordered by the Commission to make one other Rider EEIC filing in each calendar year with such subsequent filing to be effective beginning with either the June or October billing month. Rider EEIC filings shall be made at least 60 days prior to their effective dates.

PRUDENCE REVIEWS

A prudence review shall be conducted no less frequently than at 24-month intervals in accordance with 4 CSR 240-20.093(11). Any costs which are determined by the Commission to have been imprudently incurred or incurred in violation of the terms of this Rider EEIC shall be addressed through an adjustment in the next EEIR determination and reflected in factor OA herein.

UNION ELECTRIC COMPANY **ELECTRIC SERVICE**

MO.P.S.C. SCHEDULE NO. 6 Original SHEET NO. 91.22

CANCELLING MO.P.S.C. SCHEDULE NO. SHEET NO.

APPLYING TO **MISSOURI SERVICE AREA**

RIDER EEIC
ENERGY EFFICIENCY INVESTMENT CHARGE (Cont'd.)
(Applicable To Determination of EEIR Beginning February, 20XX through the Billing Month of January 20XX)

MEEIA 2016-18 EEIR Components (Applicable to MEEIA Cycle 2 Plan)

Service Class	NPC/PE ($/kWh)	NTD/PE ($/kWh)	NEO/PE ($/kWh)	NOA/PE ($/kWh)
1(M)-Residential Service	$0.000000	$0.000000	$0.000000	$0.000000
2(M)-Small General Service	$0.000000	$0.000000	$0.000000	$0.000000
3(M)-Large General Service	$0.000000	$0.000000	$0.000000	$0.000000
4(M)-Small Primary Service	$0.000000	$0.000000	$0.000000	$0.000000
11(M)-Large Primary Service	$0.000000	$0.000000	$0.000000	$0.000000
12(M)-Large Transmission Service	$0.000000	$0.000000	$0.000000	$0.000000

MEEIA 2019-21 EEIR Components (Applicable to MEEIA Cycle 3 Plan)

Service Class	NPC/PE ($/kWh)	NTD/PE ($/kWh)	NEO/PE ($/kWh)	NOA/PE ($/kWh)
1(M)-Residential Service	$0.000000	$0.000000	$0.000000	$0.000000
2(M)-Small General Service	$0.000000	$0.000000	$0.000000	$0.000000
3(M)-Large General Service	$0.000000	$0.000000	$0.000000	$0.000000
4(M)-Small Primary Service	$0.000000	$0.000000	$0.000000	$0.000000
11(M)-Large Primary Service	$0.000000	$0.000000	$0.000000	$0.000000
12(M)-Large Transmission Service	$0.000000	$0.000000	$0.000000	$0.000000

Summary EEIR Components and Total EEIR

Service Class	NPC ($/kWh)	NTD ($/kWh)	(NEO+NPI) ($/kWh)	NOA ($/kWh)	Total EEIR ($/kWh)
1(M)-Residential Service	$0.000000	$0.000000	$0.000000	$0.000000	**$0.000000**
2(M)-Small General Service	$0.000000	$0.000000	$0.000000	$0.000000	**$0.000000**
3(M)-Large General Service	$0.000000	$0.000000	$0.000000	$0.000000	**$0.000000**
4(M)-Small Primary Service	$0.000000	$0.000000	$0.000000	$0.000000	**$0.000000**
11(M)-Large Primary Service	$0.000000	$0.000000	$0.000000	$0.000000	**$0.000000**
12(M)-Large Transmission Service	$0.000000	$0.000000	$0.000000	$0.000000	**$0.000000**

DATE OF ISSUE DATE EFFECTIVE

ISSUED BY Michael Moehn President St. Louis, Missouri
NAME OF OFFICER TITLE ADDRESS

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ENERGY EFFICIENCY AND DEMAND SIDE MANAGEMENT PROGRAMS

*Indicates Addition

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ENERGY EFFICIENCY AND DEMAND SIDE MANAGEMENT PROGRAMS (Cont'd)

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ENERGY EFFICIENCY MEEIA 2019-21

PURPOSE

The purpose of the Energy Efficiency Portfolio, which consists of several programs, is to proactively impact customer energy use and decrease peak demand in such a way as to reduce electric consumption and coincidized peak demand. With the exception of low-income and education programs, the programs included in this tariff are expected to be cost effective, having a Total Resource Cost Test ratio of greater than 1.0.

DEFINITIONS

Unless otherwise defined, capitalized terms used in Tariff Sheet Nos. 221 through 244.1 have the following meanings:

Applicant – A customer who has submitted a program application or has had a program application submitted on their behalf by an agent or Trade Ally.

Business Program – An energy efficiency program that is available to a customer receiving electric service under Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M).

Deemed Savings Table – A list of Measures derived from the Company's TRM that characterizes associated gross energy and demand savings with Company-specific measure parameters where available.

Demand-Side Programs Investment Mechanism (DSIM) - A mechanism approved by the Commission in the Company's filing for demand-side program approval in File No. EO-2018-0211.

Incentive – Any consideration provided by the Company directly or through the Program Administrator, Trade Ally, and/or Program Partners which encourages the adoption of Measures, including in the form of cash, buydowns, markdowns, rebates, bill credits, payments to third parties, direct installation, donations or giveaways, and education.

Measure – An end-use measure, energy efficiency measure, and energy management measure as defined in 4 CSR 240-22.020(18), (20), and (21).

MEEIA 2019-21 Demand-Side Management Plan - Company's “2019-21 MEEIA Energy Efficiency Plan” approved in File No. EO-2018-0211 as may be amended.

Participant – An energy-related decision maker who implements one or more end-use Measures as a direct result of a demand-side program.

Program Administrator – The Company or entity selected by the Company to provide program design, promotion, administration, implementation, and delivery of services.

Program Partner - A retailer, distributor, or other service provider that the Company or the Program Administrator has approved to provide specific program services through execution of a Company-approved service agreement.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

DEFINITIONS (Cont'd.)

Program Period – The period from March 1, 2019 through December 31, 2021, unless sooner terminated under the TERM provision of this tariff. Programs may have slightly earlier deadlines for certain activities, as noted on the Company website AmerenMissouri.com/EnergyEfficiency.

Program Provider – An entity that meets the criteria defined by a Program Administrator to provide specific program products and/or services.

Project – One or more Measures proposed by an Applicant in a single application.

Residential Program – Energy efficiency programs available to residential customers in the Company’s Missouri service area being served under the Residential Service Rate 1(M) rate schedule and for multifamily properties identified under Residential Programs it will also include: Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M).

Technical Resource Manual (TRM) – A Company-specific compilation of Measures and associated characteristics with formulas used for calculating gross energy and demand savings using default inputs.

Trade Ally – An independent contractor that the Company or the Program Administrator has approved to provide specific program services through execution of a Company-approved service agreement.

Measure Benefit/Cost (B/C) Test – Each non-prescriptive Project must pass the B/C Test by having a value of 1.0 or greater. B/C Test value equals the present value of the benefits of each Measure over the useful life of each Measure divided by the incremental cost to implement the Project Measures. The benefits of the Measure include the Company's estimated avoided costs.

AVAILABILITY

Except as otherwise provided in the terms governing a particular program, programs are available uniformly to all customers qualifying for service under Service Classifications Residential Service Rate 1(M), Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M). Some programs may also require that services be phased-in on a geographical or other basis to better manage resources. Some services may only be available through participating Program Partners, Program Providers, or Trade Allies.

Unless otherwise provided for in the tariff sheets governing a particular program, customers may participate in multiple programs, but may receive only one Incentive per Measure.

Business Programs are not available to customers electing to opt-out of energy efficiency program funding under 4 CSR 240-20.094(7).

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

AVAILABILITY (Cont'd.)

A customer may elect not to participate (opt-out) in the Company's demand-side management Business Programs under 4 CSR 240-20.094(7) if they:

1. Have at least one account with a demand of 5,000 kW in the previous 12 months with the Company;
2. Operate an interstate pipeline pumping station; or
3. Have one or more accounts with aggregate coincident demand of 2,500 kW in the previous 12 months with the Company and have a comprehensive demand-side or energy efficiency program with achieved savings at least equal to those expected from the Company-provided demand-side programs.

A customer electing not to participate (opt-out) must provide written notice to the Company no earlier than September 1 and not later than October 30 to be effective for the following calendar year, but shall still be allowed to participate in interruptible or curtailable rate schedules or tariffs offered by the Company. None of the Business Programs are considered to be an interruptible or curtailable rate schedule. Upon election by a customer to opt-out, either under this or earlier MEEIA programs, that designation will continue for 10 years, beginning with the calendar year subsequent to the submission of the opt-out unless the Company is notified the customer wishes to revoke its opt-out status.

TERM

This tariff (Sheet Nos. 221-221.5) and the tariffs reflecting each specific energy efficiency program (Sheet Nos. 222-244.1)shall be effective from March 1, 2019 through December 31, 2021, except that the programs shall terminate immediately, and without further Commission action, on the effective date of any court order, judgment, or opinion or Commission order that changes or eliminates the approved DSIM or Technical Resource Manual, unless the changes are initiated or accepted by the Company. Programs may not be available or fully implemented in all geographic locations on the tariff effective date. Consult AmerenMissouri.com/EnergyEfficiency to determine the status of the programs. Programs may have earlier deadlines for certain activities, as noted on the Company's website AmerenMissouri.com/EnergyEfficiency.

If the programs are terminated prior to December 31, 2021 under this provision, only Incentives for qualifying Measures that meet either of the following criteria prior to the termination date will be valid: (a) customer has returned a signed commitment Incentive offer and it has been accepted by the Program Administrator; or (b) the customer provides affirmation that requirements for participation have been met.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

DESCRIPTION

The reductions in demand and energy consumption will be accomplished through the following Business Programs:

1. Standard Incentive Program
2. Custom Incentive Program
3. Retro-Commissioning Incentive Program
4. New Construction Incentive Program
5. Small Business Direct Install Incentive Program
6. Social Services Program
7. Education Programs
   - Building Operator Certification (BOC)

The reductions in demand and energy consumption will be accomplished through the following Residential Programs:

1. Lighting Program
2. Energy Efficient Products Program
3. HVAC Program
4. Home Energy Reports Program
5. Energy Efficiency Kits Program
6. Appliance Recycling Program
7. Multi-Family Market Rate Program
8. Single Family Low-Income Program
9. Multi-Family Low-Income Program
10. Education Programs
    - Science, Technology, Engineering, and Mathematics (STEM) Education
    - Home Building Code Compliance
    - Workplace Employee Education
    - Smart Home Energy Management
    - Real Estate Audits

Program Administrator may collaborate and co-deliver components of programs with other utilities (i.e. gas and water utilities) to create synergies.

Program details regarding the interaction between the Company or Program Administrators and customers participating in the programs, Incentives paid directly to customers, available Measures, Measure ranges, availability of the programs, eligibility, and application and completion requirements may be adjusted through the change process as presented below. Those details, additional details on each program, and other details such as process flows, application instructions, and application forms will be provided on the Company's website AmerenMissouri.com/EnergyEfficiency or by calling 800-552-7583.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

CHANGE PROCESS

The change process is applicable to changes in a program detail regarding the interaction between the Company or Program Administrators and customers participating in the programs.

1. Identify need for program detail change regarding the interaction between the Company or Program Administrators and customers participating in the programs;
2. Discuss proposed change with implementer;
3. Discuss proposed change with evaluator;
4. Analyze impact on program and portfolio (cost effectiveness, goal achievement, etc.);
5. Inform the Staff, Office of the Public Counsel, and the Missouri Department of Economic Development – Division of Energy (DE) of the proposed change, the time within which it needs to be implemented, provide them the analysis that was done and consider recommendations from them that are received within the implementation timeline (the implementation timeline shall be no less than five business days from the time that the Staff, Office of the Public Counsel, and the DE are informed and provided the above-referenced analysis);
6. Take timely received recommendations into account and incorporate them where the Company believes it is appropriate to do so;
7. Notify and train customer contact personnel (Contact Center, Energy Advisors, Business Center, Customer Relationship Managers, Customer Service Advisors) of the changes;
8. Make changes to forms and promotional materials;
9. Update program website;
10. File updated web pages and, if appropriate, updated list of Measures and Incentive amounts in File No. EO-2018-0211; and
11. Inform Participants, Program Providers, Program Partners, Trade Allies, etc.

Company will also continue to discuss and provide information on ongoing program and portfolio progress at quarterly regulatory stakeholder update meetings.

PROGRAM COSTS

Costs of the Business Programs and Residential Programs contained herein shall be reflected in a charge titled "Energy Efficiency Invest Chg" appearing as a separate line item on customers' bills and applied to customers' bills as a per kilowatt-hour charge as specified in the Residential Service Rate 1(M), Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), and Large Transmission Service Rate 12(M) rate schedules. All customers taking service under said rate schedules shall pay the charge regardless of whether a particular customer utilizes a demand-side program available hereunder, unless the customer is an eligible business which has opted-out as provided for previously or it is a residential customer who qualifies for the low-income exemption as outlined in Rider EEIC 2019-21.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

PROGRAM DESCRIPTIONS

The following pages contain other descriptions and terms for the programs being offered under this tariff.

CHANGES IN MEASURES OR INCENTIVES

Company may offer the Measures contained in the TRM. The offering of Measures that are not contained in or that do not meet the custom measure definition within Company's TRM must be approved by the Commission. Changes to Measures and inputs contained in the Deemed Savings Table will be completed by following steps 3,4,5,6, 10 & 11 of the 11-step change process. Not all Measures listed in the TRM will be offered at all times. The actual Measures being offered, and Incentives available to customers, will be listed on Company's website, AmerenMissouri.com/EnergyEfficiency. The Measures and Incentives being offered are subject to change. Customers must reference AmerenMissouri.com/EnergyEfficiency or call 800-552-7583 for the list of currently available Measures. The website will expressly state in conspicuous language that the Measures and Incentives are subject to change. Should a Measure or Incentive offering shown on Company's website differ from the corresponding Measure or Incentive offering shown in the currently effective notice filed in File No. EO-2018-0211, the stated Measure or Incentive offering as shown in the currently effective notice shall govern.

ENERGY EFFICIENCY MEEIA 2019-21

Business Standard Incentive Program

PURPOSE

The Standard Incentive Program (Program) will provide pre-set Incentives for energy efficient products that are readily available in the marketplace. Standard Incentives will be fixed per each Measure unit. The primary objective of the Standard Incentive Program is to provide an expedited, simple solution for customers interested in purchasing efficient technologies that will produce verifiable energy savings.

AVAILABILITY

This Program is available during the Program Period, and is voluntary and available to all customers receiving electric service under Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M) that also meet the Standard Incentive Program Provisions below.

PROGRAM PROVISIONS

The Program Administrator will provide the necessary services to effectively implement the program and to strive to attain the energy savings targets. Standard Incentives for Measures will be provided to qualifying customers that provide completed Standard Incentive Applications or validation qualification through a wholesale outlet as indicated below:

1. Customer must complete a Standard Incentive Application form, available at www.ameren.com/missouri/energy-efficiency/business/program-overview; or where applicable, complete validation qualification with wholesale Program Provider;
2. Customer must provide proof of equipment purchase and installation date;
3. Measures must be purchased and installed after March 1, 2019;
4. Measures for which customer has received an Incentive under a different Business Program or Residential Program are not eligible for this Standard Incentive Program;
5. Measures must be part of a Project having an installed TRC ratio greater than 1.0; and
6. Standard Measures must be installed as a retrofit in an existing facility.

By applying for the Standard Incentive Program, the customer agrees that the Project may be subject to random on-site inspections by the Program Administrator.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

Business Standard Incentive Program (Cont'd.)

ELIGIBLE MEASURES AND INCENTIVES

Standard Incentives filed in File No. EO-2018-0211 and additional Measures covered by the TRM are eligible for program benefits and Incentives and may be offered during the Program Period. These include, but are not limited to, the following equipment types:

1. HVAC (Heating, Ventilation, and Air-conditioning)
2. Lighting
3. Refrigeration
4. Cooking
5. Water Heating
6. Motors
7. Controls

Additional Program details, eligible Measures, and Incentives can be found at www.ameren.com/missouri/energy-efficiency/business/program-overview.

ENERGY EFFICIENCY MEEIA 2019-21

Business Custom Incentive Program

PURPOSE

The Custom Incentive Program (Program) will provide financial assistance to customers to support implementation of energy efficiency improvement opportunities which are available at the time of equipment replacement, facility modernization, and industrial process improvement. A "Custom Incentive" is a direct payment or bill credit to a Participant for installation of Measures that are part of Projects that have been pre-approved by the Program Administrator.

AVAILABILITY

This Program is available during the Program Period, and is voluntary and available to all customers receiving electric service under Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M) that also meet Custom Incentive Program Provisions below.

PROGRAM PROVISIONS

The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets. Customers may apply for a Custom Incentive for Measures under consideration which:

1. Reduce energy consumption compared to the currently installed system, or when there is not an existing system, the standard efficiency system currently available in the market;
2. Have not yet been installed and for which purchase and/or installation commitments have not yet been made;
3. Have not received an Incentive for the Measure under a different Business Program or Residential Program;
4. Are not one of the Measures eligible for an Incentive under the Standard Incentive Program; and
5. Are being installed in an existing facility.

Prior to purchasing and installing Measure(s), Applicant must submit a Custom Incentive Application form that provides data about the applicable facility and potential Measure(s). The Program Administrator will perform a desk review of the Custom Incentive Application to determine eligibility, Measure Benefit/Cost Test results, estimated energy savings and Custom Incentive amount for each Measure. The Program Administrator may perform a site visit to verify baseline conditions. If approved, the Program Administrator will submit an Incentive commitment offer to customer. Upon receipt of a customer-signed Incentive commitment, the Custom Incentive amount will be reserved.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

Business Custom Incentive Program (Cont'd.)

PROGRAM PROVISIONS (Cont'd.)

Following installation of approved Custom Measures, the Participant will submit a Completion Certificate to the Program Administrator. The Completion Certificate will require supporting Project documentation to include, but not limited to: final Custom Measure costs, a completion date for each Custom Measure, specification sheets, and invoices for all Custom Measures. If necessary, the Custom Incentive amount will be recalculated. Every Custom Incentive Application for a Custom Incentive requires pre-approval by the Program Administrator and may be subject to on-site verification by the Program Administrator prior to payment of the Custom Incentive amount.

ELIGIBLE MEASURES AND INCENTIVES

All energy savings Measures that are not offered through other Business Programs are eligible. Additional Program details and Incentives may be found at www.ameren.com/missouri/energy-efficiency/business/program-overview.

ENERGY EFFICIENCY MEEIA 2019-21

Business Retro-Commissioning Program

PURPOSE

The Retro-Commissioning Program (Program) will capture energy and demand reductions from existing facilities by optimizing building system energy use and overall efficiency. Through this Program, the Company will provide energy assessment services and assistance in implementing identified solutions to customers to ensure that their systems are operating at optimal energy efficiency.

AVAILABILITY

This Program is available during the Program Period, and is voluntary and available to all customers receiving electric service under Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M) that also meet the following Program Provisions. Participants in this Program will be those customers with a facility that has all of the following criteria:

1. At least one of the following conditions:
   a. Higher than average electric energy intensities(kWh/ft^2) based on business type;
   b. Minimum of 100,000 ft^2 of conditioned space; or
   c. Presence of an energy management system (EMS);
2. Mechanical equipment is operational; and
3. Will yield cost-effective energy savings according to a Retro-Commissioning Assessment Study.

A "Retro-Commissioning Assessment Study" is a detailed analysis performed by Retro-Commissioning Program Providers on Projects passing the initial screening which is used to identify sub-optimal system operational performance and to identify corrections which will yield cost-effective energy savings.

PROGRAM PROVISIONS

The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets. Program benefits have been designed to provide cost effective Retro-Commissioning services to eligible facilities and include:

1. Recruitment and training of Retro-Commissioning Program Providers;
2. Benchmarking of candidate facilities using ENERGY STAR Portfolio Manager® or other comparable procedures to identify facilities with Retro-Commissioning opportunities;
3. Access to a group of pre-qualified Retro-Commissioning Program Providers that can provide studies performed by trained auditors to identify cost effective building system optimization Measures;
4. Assisting building owners with contractor acquisition and management during the implementation process;
5. Building owner staff training on Retro-Commissioning operations;
6. Verification of operating results; or
7. Ongoing monitoring of Retro-Commissioned building systems to promote persistence of improvements.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

Business Retro-Commissioning Program (Cont'd.)

PROGRAM PROVISIONS (Cont'd.)

The Incentives provided through the Retro-Commissioning Program will be limited to those Measures which are determined to achieve energy efficiency improvements through the calibration, maintenance, and optimization of current systems.

ELIGIBLE MEASURES AND INCENTIVES

Additional Program details and Incentives may be found at www.ameren.com/missouri/energy-efficiency/business/program-overview.

ENERGY EFFICIENCY MEEIA 2019-21

Business New Construction Incentive Program

PURPOSE

The New Construction Incentive Program (Program) will capture energy and demand reductions from new construction projects by interacting with building owners and designers during the design and/or construction process. The Program encourages building owners and designers to evaluate and install systems with higher energy efficiencies than the designed systems through training, design Incentives, and installation Incentives.

DEFINITIONS APPLICABLE TO NEW CONSTRUCTION INCENTIVE PROGRAM ONLY

Baseline Building Design - The baseline building design will be established on a case-by-case basis, and the more stringent of either minimum market standards, the facility's original design, the local energy code, or any legal or contractual construction requirements shall apply. Baseline building design will be documented in the Technical Analysis Study (TAS).

Technical Analysis Study (TAS) - An energy savings estimate that clearly describes the energy efficiency/process improvement opportunity, with concise and well-documented presentations of the analysis method used to estimate energy savings, and the assumptions used to generate Project capital cost estimates. Each TAS will:

1. Describe the proposed facility (typically with a sketch or blueprint showing site layout or floor plan);
2. Describe the Baseline Building Design and provide its estimated electricity use and estimated annual Operations & Maintenance costs;
3. Describe the efficient equipment to be added along with key performance specifications;
4. Provide estimated electricity use for the efficient condition;
5. Provide the energy and demand savings calculations, together with the source of input parameter numbers and justification for each assumption made;
6. Provide the incremental cost to implement the Project; and
7. Provide the estimated financial Incentive and estimated annual cost savings, together with the financial metric(s) requested by the customer (i.e., simple payback, Internal Rate of Return, Return on Investment).

Whole Building Area Method – An energy analysis methodology in which the design team examines the integration of all building components and systems and determines how they best work together to save energy and reduce environmental impact.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

Business New Construction Incentive Program (Cont'd.)

AVAILABILITY

This Program is available during the Program Period, and is voluntary and available to all customers receiving electric service under Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M) that also meet the New Construction Program Provisions. Eligible facilities' applications include new facilities built from the ground up, additions to existing facilities, or major renovation of existing facilities requiring significant mechanical and/or electrical equipment alteration.

PROGRAM PROVISIONS

The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets. Program benefits are tailored to Projects based on their phase in the development process.

TAS and the Whole Building Area Method may be used to determine Project energy savings.

ELIGIBLE MEASURES AND INCENTIVES

Additional Program details, eligible Measures and Incentives may be found at www.ameren.com/missouri/energy-efficiency/business/program-overview.

ENERGY EFFICIENCY MEEIA 2019-21

Small Business Direct Install Incentive Program

PURPOSE

The Small Business Direct Install Incentive Program (Program) will provide installation of low-cost and/or no-cost energy-efficient Measures to small business customers. Program Providers will deliver, install, and complete paperwork for Measures provided for in this Program. The primary objective of the Small Business Direct Install Incentive Program is to remove participation barriers for small businesses through a simple and streamlined process. Program Providers will identify additional energy efficiency opportunities that may qualify for Incentives under the Standard Incentive Program or Custom Incentive Program.

AVAILABILITY

This Program is available during the Program Period, and is voluntary and available to all customers in the Small General Service Rate 2(M) rate class that also meet the Small Business Direct Install Incentive Program Provisions, below.

PROGRAM PROVISIONS

The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets. Small Business Direct Install Incentives for Measures will be provided to qualifying customers that provide completed Small Business Direct Install Incentive Applications as indicated below:

1. Customer must complete a Small Business Direct Install Incentive Application form;
2. Qualifying Measures must be installed by a participating Small Business Direct Install Program Provider after March 1, 2019;
3. Measures must be part of a Project having an installed TRC ratio greater than 1.0; and
4. Measures must be installed as a retrofit in an existing facility.

By applying for the Small Business Direct Install Incentive Program, the customer agrees that the Project may be subject to random on-site inspections by the Program Administrator.

ELIGIBLE MEASURES AND INCENTIVES

Small Business Direct Install Incentives filed in File No. EO-2018-0211 and additional Measures covered by the TRM are eligible for Program benefits and Incentives and may be offered during the Program Period. These include, but are not limited to, the following equipment types:

1. HVAC (Heating, Ventilation, and Air-conditioning)
2. Lighting
3. Refrigeration
4. Motors
5. Water Heating
6. Smart Thermostat

Additional Program details and Incentives may be found at AmerenMissouri.com/SBDI.

ENERGY EFFICIENCY MEEIA 2019-21

Business Social Services Program

PURPOSE

The objective of the Social Services Program (Program) is to deliver long-term energy savings and bill reductions to social service business customers. This will be achieved through a variety of prescriptive measures and comprehensive retrofits.

DEFINITIONS APPLICABLE TO BUSINESS SOCIAL SERVICES PROGRAM ONLY

Social Services – Nonprofit tax exempt business customer that provides social services to the low-income public, such as food banks, food pantries, soup kitchens, homeless shelters, employment services, worker training, job banks, and childcare.

AVAILABILITY

This Program is available during the Program Period. The Program is voluntary and available to Social Services' facilities receiving electric service under Company's Small General Service Rate 2(M) or Large General Service Rate 3(M) classifications where the facility as a whole, or a dedicated part of a facility, is primarily used to provide Social Services. Measures will be available to the portion of the facility primarily used to provide Social Services.

PROGRAM PROVISIONS

The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain energy savings.

Customer must certify that all or part of the specific facility for which the Measures and/or retrofits are targeted is primarily utilized for Social Services. Measures for which customer has received an Incentive under a different Business Program or Residential Program are not eligible for this Social Services Program;

ELIGIBLE MEASURES AND INCENTIVES

Social Services Incentives filed in File No. EO-2018-0211 and additional Measures covered by the TRM are eligible for Program benefits and Incentives and may be offered during the Program Period. These may include, but are not limited to, the following equipment types:

1. HVAC (Heating, Ventilation, and Air-conditioning)
2. Lighting
3. Refrigeration
4. Cooking
5. Water Heating
6. Motors
7. Controls

Additional Program details and Incentives may be found at www.ameren.com/missouri/energy-efficiency/business/program-overview.

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UNION ELECTRIC COMPANY **ELECTRIC SERVICE**

MO.P.S.C. SCHEDULE NO. 6 Original SHEET NO. 229

CANCELLING MO.P.S.C. SCHEDULE NO. SHEET NO.

APPLYING TO **MISSOURI SERVICE AREA**

THIS SHEET RESERVED FOR FUTURE USE

DATE OF ISSUE DATE EFFECTIVE

ISSUED BY Michael Moehn President St. Louis, Missouri

NAME OF OFFICER TITLE ADDRESS

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ENERGY EFFICIENCY MEEIA 2019-21
Residential Lighting Program

PURPOSE

The Lighting Program (Program) is intended to reduce energy use in residential lighting by encouraging selection of ENERGY STAR®-qualified lighting products.

AVAILABILITY

The Lighting Program is available for the Program Period. Residential customers may participate in the Lighting Program by acquiring program ENERGY STAR® LED lighting products, ENERGY STAR® fixtures, and other emerging ENERGY STAR®-qualified lighting technologies from participating Program Partners through purchase or other approved distribution methods.

PROGRAM PROVISIONS

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets. The Lighting Program Administrator will provide Lighting Program services and Incentives to Program Partners for the purpose of increasing awareness, sales, and market share of residential ENERGY STAR®-qualified products promoted by the Lighting Program.

Lighting Program promotions will be made available on-line and at Program Partner locations and distribution channels within the Company’s electric service territory. Participating Lighting Program Partners will be listed on the AmerenMissouri.com/lighting website with store name and location listed, as well as any in-store promotions being offered.

ELIGIBLE MEASURES AND INCENTIVES

Energy Efficient Lighting Products filed in File No. EO-2018-0211 and additional Lighting Products covered by the TRM are eligible for Program benefits and Incentives and may be offered for promotion during the Program Period. Eligible Lighting Products and Incentives paid directly to customers may be found at AmerenMissouri.com/lighting.

ENERGY EFFICIENCY MEEIA 2019-21

Residential Energy Efficient Products Program

PURPOSE

The purpose of the Energy Efficient Products Program (Program) is to raise customer awareness of the benefits of "high-efficiency" products (ENERGY STAR®, Consortium for Energy Efficiency (CEE) Tiers, or better). The Program is intended to reduce energy use by encouraging residential customers to purchase qualifying efficient products.

AVAILABILITY

The Energy Efficient Products Program is available for the Program Period. Residential customers may participate in the Program by acquiring Program energy efficient products from participating Program Partners through on-line purchases or other approved distribution methods.

PROGRAM PROVISIONS

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and strive to attain the energy savings targets. The Energy Efficient Products Program incorporates various Program Partners, products, Incentive mechanisms and Program delivery strategies. The Program Administrator may partner with other utilities (i.e. gas and water utilities) to create synergies.

The Company and the Program Administrator will follow a multi-faceted approach to marketing highly efficient appliances and products with an emphasis on ENERGY STAR®. Company will leverage the CEE and others to identify efficiency tiers above ENERGY STAR® for additional offers.

ELIGIBLE MEASURES AND INCENTIVES

Energy Efficient Products Measures filed in File No. EO-2018-0211 and additional Measures covered by the TRM are eligible for Program benefits and Incentives and may be offered for promotion during the Program Period. Eligible Energy Efficient Products and Incentives paid directly to customers may be found at AmerenMissouri.com/products.

ENERGY EFFICIENCY MEEIA 2019-21

Residential HVAC Program

PURPOSE

The purpose of the HVAC Program (Program) is to obtain energy and demand savings through improvement in operating performance of new residential central cooling systems or replacement of existing residential central cooling systems.

AVAILABILITY

The HVAC Program is available for the Program Period, and Services under this Program are available to Customers on the Residential Service Rate 1(M).

PROGRAM PROVISIONS

The Program improves the efficiency of new and existing central air conditioning systems, including heat pumps, by installation of new equipment. The Program may also promote installation of heat pump water heaters, smart thermostats, efficient products, natural gas program rebates, or enrollment in a residential demand response program.

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and strive to attain the energy and demand savings targets. Company will provide Incentives to encourage sales of energy efficient products and properly installed HVAC energy saving upgrades.

The Program will employ the Program Administrator’s preferred protocols to verify system eligibility for Program Measures.

ELIGIBLE MEASURES AND INCENTIVES

HVAC related Program Measures filed in File No. EO-2018-0211 and additional Measures covered by the TRM are eligible for Program benefits and Incentives and may be offered for promotion during the Program Period. Eligible Measures and Incentives paid directly to customers may be found at AmerenMissouri.com/HVAC.

ENERGY EFFICIENCY MEEIA 2019-21

Residential Home Energy Reports Program

PURPOSE

The purpose of the Home Energy Reports Program (Program) is to obtain energy and demand savings by focusing on energy consumption behavior changes of participating customers. This is a behavior modification program.

AVAILABILITY

The Home Energy Reports Program is available for the Program Period. Services under this Program are available to Customers on the Residential Service Rate 1(M). The Program Administrator will work with customer data to select Program Participants. Home Energy Reports will be mailed and/or emailed to targeted residential customers on an established frequency for the duration of the Program. Customers who do not wish to receive a report will be able to contact Ameren Missouri to be removed from participation.

PROGRAM PROVISIONS

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets.

ELIGIBLE MEASURES AND INCENTIVES

The Program focuses on energy consumption behavior changes that result in reduced electricity consumption. As such, the overall metric is reduced monthly/annual energy consumption. There are no specific energy efficiency Measures associated with the Program. However, there may be rewards associated with behavior changes that lead to reduced energy consumption. Additional Program details may be found at AmerenMissouri.com/myreport.

ENERGY EFFICIENCY MEEIA 2019-21

Residential Energy Efficiency Kits Program

PURPOSE

The objective of the Energy Efficiency Kits Program (Program) is to raise customer awareness of the benefits of "high-efficiency" products (ENERGY STAR©, Consortium for Energy Efficiency (CEE) Tiers, or better) and to educate residential customers about energy use in their homes and to offer information, products, and services to residential customers to save energy cost-effectively.

AVAILABILITY

The Energy Efficiency Kits Program is available for the Program Period to Residential customers and may be offered through various channels, such as direct mail, secondary education schools, and community based organizations.

PROGRAM PROVISIONS

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and strive to attain the energy savings targets. The Energy Efficiency Kits Program incorporates various Program Partners, products, incentive mechanisms, and program delivery strategies.

The Company and the Program Administrator will follow a multi-faceted approach to educate Participants and effectuate installation of energy efficient products and actions addressed in the Energy Efficiency Kits. Company will leverage the CEE and others to identify efficiency tiers above ENERGY STAR for additional products. The Program Administrator may partner with other utilities (i.e. gas and water utilities) to create synergies.

ELIGIBLE MEASURES AND INCENTIVES

Energy Efficiency Kits Measures filed in File No. EO-2018-0211 and additional Measures covered by the TRM approved are eligible for Program benefits and Incentives and may be offered for promotion during the Program Period. Additional Program details may be found at AmerenMissouri.com/education.

ENERGY EFFICIENCY MEEIA 2019-21

Residential Appliance Recycling Program

PURPOSE

The Appliance Recycling Program (Program) is a voluntary program designed to encourage the retirement of inefficient, working refrigerators, freezers and appliances by providing an Incentive to take the units out of homes and recycle them in an environmentally safe manner.

AVAILABILITY

The Program is available during the Program Period. All Company customers receiving service under the Residential Service Rate 1(M) are eligible for this Program.

PROGRAM PROVISIONS

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and strive to attain the energy savings targets. The following general process will be followed to serve Participants in the Program:

- Participants contact the Program toll-free or online at AmerenMissouri.com/fridge to schedule the appliance pick up.
- At the Participant's address the Program Partner team verifies the unit is operational, it meets program guidelines, and removes it from the home.
- The unit is taken to the Program Partner facility and all materials are recovered for recycling or disposed of in accordance with Environmental Protection Agency (EPA)-approved practices.
- Incentives are sent to Participants following the pick-up appointment.

ELIGIBLE MEASURES AND INCENTIVES

Recycling related Measures covered by the TRM are eligible for Program benefits and Incentives and may be offered for promotion during the Program Period. Additional Program details and Incentives paid directly to customers may be found at AmerenMissouri.com/fridge.

ENERGY EFFICIENCY MEEIA 2019-21

Multi-Family Market Rate Program

PURPOSE

The objective of the Multi-Family Market Rate Program (Program) is to deliver long-term energy savings and bill reductions to residential customers residing in multi-family properties that do not qualify for the Multi-Family Low-Income Program. This will be achieved through Incentives for a variety of incentivized energy saving Measures and comprehensive retrofits.

AVAILABILITY

The Program is available for the Program Period to owners and operators of non-low-income multi-family properties of three or more dwelling units with eligible customers receiving service under the Residential Service Rate 1(M) or Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M).

PROGRAM DESCRIPTION

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets.

The Program Administrator will provide or approve installation of Program-specified energy efficiency Measures for multi-family properties and may provide custom Incentives for Measures that have been pre-authorized by the Program Administrator for dwelling units, common areas, building shell and whole-building systems.

The Program Administrator may partner with other utilities (i.e. gas and water utilities) to create synergies.

Measures installed pursuant to the Multi-Family Market Rate Program are not eligible for Incentives through any of the Company's other energy efficiency programs.

ELIGIBLE MEASURES AND INCENTIVES

Multi-Family Market Rate Measures filed in File No. EO-2018-0211 and additional Measures covered by the TRM are eligible for Program benefits and Incentives and may be offered for promotion during the Program Period. Eligible Measures and Incentives directly paid to customers, property owners, or property managers may be found at AmerenMissouri.com/multifamily.

ENERGY EFFICIENCY MEEIA 2019-21

Residential Single Family Low-Income Program

PURPOSE

The objective of the Single Family Low-Income Program (Program) is to deliver long-term energy savings and bill reductions to residential single family low-income customers. This will be achieved through a variety of channels to educate customers about energy use in their homes and to offer information, products and services to residential customers to save energy wisely. This allows the customer to identify and initiate the process of installing long-term energy efficiency upgrades and practices.

AVAILABILITY

The Program is available for the Program Period to:

1. Qualifying single family low-income customers receiving service under the Residential Service Rate 1(M) residing in single family detached housing, duplexes, and mobile homes (wood-frame bolted to steel chassis, designed to be transported); or
2. Organizations who perform qualified installations or distributions to homes of qualified low-income residential end users may participate in this Program by making application for a low-income efficiency housing grant.

In order to qualify for participation, low-income Participants must meet one of the following income eligibility requirements:

1. Participation in federal, state, or local subsidized housing program.
2. Proof of resident income levels at or below 80% of area median income (AMI) or 200% of federal poverty level.
3. Fall within a census tract included on Company's list of eligible low-income census tracts.

PROGRAM DESCRIPTION

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets. The Program Administrator will provide one-on-one energy education and install a comprehensive package of whole house energy saving Measures at no or low cost to customer. Incentives under this Program will be provided toward individually metered homes in neighborhoods served and selected by Company or approved low-income efficiency housing grant organizations. In some instances, an individual home may be referred to the Program by a qualified low-income assistance agency. The Program Administrator may partner with other utilities (i.e. gas and water utilities) to create synergies. Participants in selected low-income neighborhoods are limited to the one-time receipt of energy efficiency Measures under this Program. Measures installed pursuant to the Program are not eligible for Incentives through any of the Company’s other energy efficiency or demand response programs.

ENERGY EFFICIENCY MEEIA 2019-21 (Cont'd.)

Residential Single Family Low-Income Program (Cont'd.)

ELIGIBLE MEASURES AND INCENTIVES

Single Family Low-Income Measures filed in File No. EO-2018-0211 and additional Measures covered by the TRM are eligible for Program benefits and Incentives and may be offered for promotion during the Program Period. Eligible Measures and Incentives directly paid to customers may be found at Amerenmissouri.com/CommunitySavers.

ENERGY EFFICIENCY MEEIA 2019-21

Residential Multi-Family Low-Income Program

PURPOSE

The objective of the Multi-Family Low-Income Program (Program) is to deliver long-term energy savings and bill reductions to residential low-income customers residing in multi-family properties. This will be achieved through education and a variety of directly installed energy saving Measures and comprehensive retrofits.

AVAILABILITY

The Multi-Family Low-Income (MFLI) Program is available for the Program Period to owners and operators of any multi-family properties of three or more dwelling units receiving service under the Residential Service Rate 1(M) or Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M) meeting one of the following eligibility requirements:

1. Participation in federal, state, or local subsidized housing program.
2. Proof of resident income levels at or below 80% of area median income (AMI) or 200% of federal poverty level.
3. Fall within a census tract included on Company's list of eligible low-income census tracts.

Where a multi-family property does not meet one of the eligibility criteria listed above and has a combination of qualifying tenants and non-qualifying tenants, at least 50% of the tenants must be eligible for the entire property to qualify.

PROGRAM DESCRIPTION

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and to strive to attain the energy savings targets. The Program Administrator will provide or approve installation of Program specified energy efficiency Measures and may provide custom Incentives for Measures that have been pre-authorized by the Program Administrator for tenant units, common areas, building shell and whole-building systems. Participating properties may receive Incentives to defray the cost of attending Building Operator Certification Training to support their energy efficiency journey. The Program Administrator may partner with other utilities (i.e. gas and water utilities) to create synergies.

ELIGIBLE MEASURES AND INCENTIVES

Program Measures filed in File No. EO-2018-0211 and additional Measures covered by the TRM approved in File No. EO-2018-0211 are eligible for Program benefits and Incentives and may be offered for promotion during the Program Period. Eligible Measures and Incentives directly paid to customers, property owners or property managers may be found at Amerenmissouri.com/CommunitySavers. Measures installed pursuant to the MFLI Program are not eligible for Incentives through any of the Company’s other Energy Efficiency or Demand Response programs.

ENERGY EFFICIENCY MEEIA 2019-21

Education Programs

PURPOSE

The purpose of Education Programs is to raise customer awareness of the benefits of energy efficiency and conservation, and Ameren Missouri's energy efficiency programs.

AVAILABILITY

Education Programs are available for all or a portion of the Program Period, and may be offered to either commercial or residential customers based on the specified delivery channel(s). Education Programs will be available to a target set of customers and include, but are not limited to, the following:

Science, Technology, Engineering, and Mathematics (STEM) Education – Curriculum for high school students focused on aspects of energy generation and delivery with particular emphasis on consumption and energy efficient equipment and behaviors.

Home Building Code Compliance – Education provided to builders, sub-contractors, designers, and others in the home building industry that are focused on high-energy impact measures that are commonly missed in residential code compliance.

Workplace Employee Education – Designed to educate residential customers at their workplace on energy use, tactics to reduce energy consumption and to promote long-term energy savings.

Smart Home Energy Management – Educates residential customers about Smart Home Energy Management products and availability, to advance and increase adoption of those technologies.

Real Estate Audits – Designed to use real estate institutions as a channel to encourage the use of home energy audits to improve home performance prior to the purchase of a new home.

Building Operator Certification (BOC) – BOC is a nationally-recognized, competency-based training and certification program for operations and maintenance staff working in commercial, institutional, or industrial buildings. BOC achieves measurable energy savings in the operation of public facilities and commercial buildings by training individuals directly responsible for day-to-day operations.

PROGRAM PROVISIONS

The Program Administrator will provide the necessary services to deliver education through targeted channels. Education programs incorporate various Program Partners and delivery strategies. Additional program details may be found at AmerenMissouri.com/energyefficiencyeducation.

The Program Administrator may partner with other utilities (i.e. gas and water utilities) to create synergies.

THIS SHEET RESERVED FOR FUTURE USE

THIS SHEET RESERVED FOR FUTURE USE

DEMAND RESPONSE MEEIA 2019-21

PURPOSE

The purpose of the Business and Residential Demand Response Programs is to proactively impact customer energy use in such a way as to reduce demand (kW) and/or energy (kWh). The programs included in this tariff are expected to be cost effective having a Total Resource Cost Test ratio of greater than 1.0.

DEFINITIONS

Unless otherwise defined, capitalized terms used in Tariff Sheet Nos. 247 through 249.1 have the following meanings:

Business Demand Response Program – A demand response program that is available to a customer receiving electric service under Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M).

Demand Response Event (Event) – A period of time up to four hours during which the Company will ask the demand response participants to reduce their energy use.

DSIM (Demand-Side Programs Investment Mechanism) - A mechanism approved by the Commission in the Company's filing for demand-side program approval in File No. EO-2018-0211 as may be amended.

Incentive – Any consideration provided by the Company directly or through the Program Administrator, Trade Ally, and/or Program Partners which encourages the adoption of Measures or behaviors that reduce energy usage and/or demand, including in the form of cash, bill credit, payment to third party, donations or giveaways, public education programs, buydowns, markdowns, rebates, bill credits, direct installation, and education.

Program Administrator – The entity selected by the Company to provide program design, promotion, administration, implementation, and delivery of services.

Program Partner - A retailer, distributor, or other service provider that the Company or the Program Administrator has approved to provide specific program services through execution of a Company-approved service agreement.

Program Period – The period from March 1, 2019 through December 31, 2021 unless sooner terminated under the TERM provision of this tariff. Programs may have slightly earlier deadlines for certain activities, as noted on the Company website AmerenMissouri.com/demandresponse.

Program Provider – An entity that meets the criteria defined by a Program Administrator to provide specific program products and/or services.

Program Season – The portion of the calendar year, May through September inclusive, in which demand response events may be called.

Residential Demand Response Program – A Demand Response program available to residential customers in the Company’s Missouri service area being served under the Residential Service Rate 1(M) rate schedule.

DEMAND RESPONSE MEEIA 2019-21 (Cont'd.)

DEFINITIONS (Cont'd.)

Trade Ally – An independent contractor that the Company or the Program Administrator has approved to provide specific program services through execution of a Company-approved service agreement.

AVAILABILITY

Except as otherwise provided in the terms governing a particular program, business programs are available uniformly to all customers qualifying for service under Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M). Customers participating in a business program must have metering provided by Company that can record intervals of energy and demand of one hour or smaller. Residential programs are available to residential customers in the Company's Missouri service area being served under the Residential Service Rate 1(M) rate schedule. Some programs may also require that services be phased-in on a geographical or other basis to better manage resources. Some services may only be available through participating Program Partners, Program Providers, or Trade Allies.

Unless otherwise provided for in the tariff sheets governing a particular program, customers may participate in multiple Programs, but may receive only one Incentive per Measure.

Business Programs are also not available to customers electing to opt-out of energy efficiency program funding under 4 CSR 240-20.094(7).

TERM

This tariff (Sheet Nos. 247 - 247.3) and the tariffs reflecting each specific demand response program (Sheet Nos. 248, 249 and 249.1) shall be effective from March 1, 2019 through December 31, 2021, except that the programs shall terminate immediately, and without further Commission action, on the effective date of any court order, judgment, or opinion or Commission order that changes or eliminates the approved DSIM or Technical Resource Manual, unless the changes are initiated or accepted by the Company. Programs may not be available or fully rolled-out on the tariff effective date. Consult AmerenMissouri.com/demandresponse to determine the status of the programs. Programs may have earlier deadlines for certain activities, as noted on the Company's website AmerenMissouri.com/demandresponse.

If the programs are terminated prior to December 31, 2021 under this provision, only Incentives for qualifying Measures that have been executed prior to the programs' termination and in accordance with the appropriate demand response program provisions will be provided to the customer.

DEMAND RESPONSE MEEIA 2019-21 (Cont'd.)

DESCRIPTION

The modifications in kW and kWh consumption will be accomplished through the following Programs:

1. Business Demand Response Program
2. Residential Demand Response Program

Program details regarding the interaction between the Company or Program Administrators and customers participating in the Programs, such as Incentives paid directly to customers, available Measures, Measure Ranges, availability of the programs, eligibility, and application and completion requirements may be adjusted through the change process as presented below. Those details, additional details on each program, and other details such as process flows, application instructions, and application forms will be provided on the Company's website AmerenMissouri.com/demandresponse or by calling 800-552-7583.

CHANGE PROCESS

The change process is applicable to changes in a program detail regarding the interaction between the Company or Program Administrators and customers participating in the Programs.

1. Identify need for program detail change regarding the interaction between the Company or Program Administrators and customers participating in the Programs;
2. Discuss proposed change with implementer;
3. Discuss proposed change with evaluator;
4. Analyze impact on program and portfolio (Cost effectiveness, goal achievement, etc.);
5. Inform the Staff, Office of the Public Counsel, and the Missouri Department of Economic Development – Division of Energy (DE) of the proposed change, the time within which it needs to be implemented, provide them the analysis that was done and consider recommendations from them that are received within the implementation timeline (the implementation timeline shall be no less than five business days from the time that the Staff, Office of the Public Counsel, and the DE are informed and provided the above-referenced analysis);
6. Take timely received recommendations into account and incorporate them where the Company believes it is appropriate to do so;
7. Notify and train customer contact personnel (Contact Center, Energy Advisors, Business Center, Key Account Executives, Customer Service Advisors) of the changes;
8. Make changes to forms and promotional materials;
9. Update program website;
10. File updated web pages and, if appropriate, updated list of Measures and Incentive amounts in File No. EO-2018-0211; and
11. Inform Participants, Program Providers, Trade Allies, etc.

Company will also continue to discuss and provide information on ongoing program and portfolio progress at quarterly regulatory stakeholder update meetings.

DEMAND RESPONSE MEEIA 2019-21 (Cont'd.)

PROGRAM COSTS

Costs of the Demand Response Programs reflected herein shall be reflected in a charge titled "Energy Efficiency Invest Chg" appearing as a separate line item on customers' bills and applied to customers' bills as a per kilowatt-hour charge as specified in the Residential Service Rate 1(M), Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), and Large Transmission Service Rate 12(M) rate schedules. All customers taking service under said rate schedules shall pay the charge regardless of whether a particular customer utilizes a demand-side program available hereunder, unless the customer has opted-out as provided for previously or qualifies for the low-income exemption as outlined in Rider EEIC 2019-21.

PROGRAM DESCRIPTIONS

The following pages contain other descriptions and terms for the programs being offered under this tariff.

CHANGES IN MEASURES OR INCENTIVES

Residential Demand Response Program – The Company may offer Measures contained in Company's approved Plan in File No. EO-2018-0211. The actual Measures being offered, and Incentives available to customers, will be listed on Company's website, AmerenMissouri.com/demandresponse. The Measures and Incentives being offered are subject to change – customers must consult AmerenMissouri.com/demandresponse for the list of currently available Measures. The website will expressly state in conspicuous language that the Measures and Incentives are subject to change. Should a Measure or Incentive offering shown on Company’s website differ from the corresponding Measure or Incentive offering shown in the currently effective notice filed in File No. EO-2018-0211, the stated Measure or Incentive offering as shown in the currently effective notice shall govern.

Business Demand Response Program – The Company will not directly offer specific Incentives for Measures. The Company will engage a Program Administrator who will contract with the customer to provide kW and kWh savings to the Company. Customer payments will vary by industry and ability to reduce kW and kWh. The Program Administrator's contact information will be listed on AmerenMissouri.com/demandresponse.

DEMAND RESPONSE MEEIA 2019-21

Business Demand Response Program

PURPOSE

The Business Demand Response Program (Program) will be operated by a demand-response aggregator (who will be the Program Administrator) to obtain energy and demand reductions from existing facilities by incentivizing customers to reduce energy usage through direct load control, manual response, and/or the use of behind the meter assets such as energy management systems or other properly permitted dispatchable assets. The Program Administrator will contract with eligible business customers to obtain the energy and demand reductions.

AVAILABILITY

This Program is available for the Program Period. This Program is available for dispatch 24 hours a day and 7 days a week during the Program Season. It is voluntary, and available to all customers qualifying for service under Service Classifications Small General Service Rate 2(M), Large General Service Rate 3(M), Small Primary Service Rate 4(M), Large Primary Service Rate 11(M), or Large Transmission Service Rate 12(M) provided the customer has metering provided by Company that can record intervals of energy and demand of one hour or smaller.

PROGRAM PROVISIONS

The Company will hire a demand response aggregator who will be the Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and strive to attain the energy and demand savings targets. The Program Administrator will develop and enable each participating customer with a customized energy reduction plan and may provide control technology. Customers will have the opportunity to participate in Demand Response Events when initiated by the Company. Customer Incentives will be based on the availability and execution of reducing energy use during an Event. Customers can receive a demand reduction Incentive based on their average demand reduction during the Events in a program year. They can also receive an energy reduction Incentive based on the energy reduction for each Event. Participants will receive Incentive payments directly from the Program Administrator.

Maximum number of Events per Program Season – 10
Minimum number of Events per Program Season – 2
Maximum duration of an Event – 4 hours
Minimum notification before an Event - 1 hour

The Program Administrator will communicate in advance of a Demand Response Event to provide participants the greatest amount of notification to enhance their ability to reduce energy consumption during the Event.

DEMAND RESPONSE MEEIA 2019-21 (Cont'd.)

Business Demand Response Program (Cont'd.)

ELIGIBLE MEASURES AND INCENTIVES

The Program Administrator will deliver kW savings through business participants that contract directly with the Program Administrator using unique contract offerings and price points. There are no specific Measures associated with the Program. Additional information can be found at AmerenMissouri.com/demandresponse.

DEMAND RESPONSE MEEIA 2019-21

Residential Demand Response Program

PURPOSE

The Residential Demand Response Program (Program) will obtain energy and demand reductions from residences that have installed Program-eligible devices by incentivizing them to allow the Program Administrator to control their device's operation during peak Events for demand reduction and non-peak periods for energy reduction.

AVAILABILITY

This Program is available for the Program Period. The Program will dispatch Events to reduce peak demand during the Program Season and will reduce energy usage during normal operations throughout the year. It is voluntary, and available to customers in the Residential 1(M) rate class. To be eligible to participate, the customer must:

a) Have a central air conditioning system or other controllable device as required by the Program;
b) Have or purchase and install an eligible controlling device; and
c) Be able to connect the device to a home Wi-Fi network or other network as required by the Program.

PROGRAM PROVISIONS

The Company will hire a Program Administrator to implement this Program. The Program Administrator will provide the necessary services to effectively implement the Program and strive to attain the energy and demand savings targets. The Company and the Program Administrator will follow a multi-faceted approach to marketing the Program.

The Program Administrator will communicate with participants before a Demand Response Event. The Program Administrator will use Program-approved technologies to control the participant's device before and during an Event to maximize the demand savings during the Event while minimizing impact to customer comfort. The Program Administrator will also reduce energy usage by utilizing a continuous load shaping strategy during non-peak periods. Energy management activities undertaken through this Program will occur within customer-selected home temperature threshold set points to minimize customer comfort impact.

Participants will receive Incentives for participating in the Program, which may include upfront enrollment Incentives, an annual Incentive, and an installation Incentive.

Initially, the Program will provide an approved list of eligible WiFi enabled smart thermostats, but as technology, device capability, and the Program evolve, the Program may also obtain energy and demand savings from residences through other connected assets, such as hot water heaters, HVAC switches, residential energy storage, etc.

DEMAND RESPONSE MEEIA 2019-21 (Cont'd.)

Residential Demand Response Program (Cont'd.)

PROGRAM PROVISIONS (Cont'd.)

The Company will restrict the length of Demand Response Events to a total duration of no more than 4 hours during any 24-hour period and to a maximum of 10 Events per Program Season. A minimum of three (3) Events per Program Season will be dispatched with at least one (1) Event per Program Season dispatching all Participants.

ELIGIBLE MEASURES AND INCENTIVES

Eligible Demand Response Measures and Incentives paid to customers may be found at AmerenMissouri.com/rewards.

UNCHANGED - CUSTOMER NOTICE FOR 2019-24 MEEIA ENERGY EFFICIENCY PLAN

ENERGY EFFICIENCY INVESTMENT CHARGE CHANGE NOTICE

Ameren Missouri has filed its proposed energy efficiency programs for 2019-24 with the Missouri Public Service Commission (Commission). This filing follows the Missouri Energy Efficiency Investment Act (MEEIA).

Ameren Missouri proposes to offer its customers new energy efficiency and demand response programs. The programs are designed to help residential and business customers reduce their energy consumption. The cost of these programs will change your "Energy Efficiency Investment Charge," which is shown as a line item on your electric bill.

The Company's proposed programs show its commitment to energy efficiency. The full proposal can be found at www.AmerenMissouri.com/EnergyEfficiency..

What's different from past energy efficieny program offerings?

Compared to the currently approved 3-year programs, Ameren Missouri expects the new programs to be in effect for 6 years and have a goal to achieve 60% more overall energy savings and 200% more savings during the peak hour of demand on the hottest summer days.

Ameren Missouri expects the proposed energy efficiency programs to generate more lifetime utility cost savings than costs, resulting in estimated savings which are $920 million greater than costs. Because these programs are designed to lower energy sales, Ameren Missouri proposes that it be allowed to collect sums needed to cover operating costs not covered due to reduced sales of energy. Additionally, the Company requests an opportunity to recover an earnings opportunity based on the energy savings results achieved by the programs.

If new energy efficiency programs are approved by the Commission, what will it cost?

The cost of offering the programs, cost of reduced energy sales, and an earnings opportunity based on program performance will be collected through the "Energy Efficiency Investment Charge" on your bill.

The charge will be based on the amount of energy each customer consumes each month and will remain on bills for service delivered beginning February 2019 until at least 2026. Ameren Missouri estimates a residential customer using 1000 kWh of electricity a month will see an average charge of approximately $4.40 per month over the six years if all proposed programs are approved by the Commission.

Customers who receive qualifying energy assistance will be exempt from the Energy Efficiency Investment Charge.

A Commission decision is expected by the fourth quarter of 2018, and Ameren Missouri intends to implement the revised energy efficiency program beginning March 1, 2019. The Commission's case number is EO-2018-0211.

Comments and questions regarding Ameren Missouri's Application should be directed to the Company's customer contact center.

Phone: 1-800-552-7583
Email: Answers@ameren.com

If you wish to submit comments or secure additional information, you may contact either of the following:

The Office of the Public Counsel
P.O. Box 2230
Jefferson City, Missouri 65102
Telephone (866) 922-2959
Fax (573) 751-5562
Email mopco@ded.mo.gov

Missouri Public Service Commission
P.O. Box 360
Jefferson City, Missouri 65102
Telephone 1-800-392-4211
Email pscinfo@psc.mo.gov

Please reference case number EO-2018-0211.

Customer Bill Examples

Costs from the implementation of the MEEIA 2019-21 Plan are recovered through Rider – Energy Efficiency Investment Charge ("EEIC") and are specified in a line item on customers' energy statements. Below are examples of residential and business customer energy statements to illustrate placement.

Residential Customer Sample Energy Statement

Business Customer Sample Energy Statement

Ameren MISSOURI

- AmerenMissouri.com
- 1.877.426.3736
- PO Box 88068 Chicago, IL 60680-1068

Ameren payment processing center

FOCUSED ENERGY. *For life.*

Electric Service Details — **Service from 03/15/2018 - 04/16/2018 (32 days)**

Electric Meter Read

METER NUMBER	SERVICE FROM - TO	NO. DAYS	USAGE TYPE	READING TYPE	CURRENT READING	PREVIOUS READING	READING DIFFERENCE	MULTIPLIER	USAGE
75145508	03/15 - 04/16	32	Total kWh	Actual	2779.0000	2586.0000	193.0000	576.0000	111168.0000
75145508	03/15 - 04/16	32	Peak kW	Actual	0.6720	0.0000	0.6720	576.0000	387.0720

Usage Summary

Total kWh	111168.0000	Peak kW	387.1000
Total Billing Demand	387.1000	October Winter Base kW	316.8000
Winter Base Demand	316.8000	Base kWh Ratio	0.8183
Base kWh (HUD)	90969.0000	Seasonal kWh (HUD)	20199.0000

Rate 3M Large General Service

DESCRIPTION	USAGE	UNIT		RATE	CHARGE
Seasonal Energy Charge	20,199.00	kWh	@	$ 0.03890000	$785.74
Demand Charge	387.10	kW	@	$ 2.00000000	$774.20
Base Energy Charge / Hours Used	47,520.00	kWh	@	$ 0.06650000	$3,160.08
Base Energy Charge / Hours Used	43,449.00	kWh	@	$ 0.04940000	$2,146.38
Customer Charge					$95.07
Fuel Adjustment Charge	111,168.00	kWh	@	$ 0.00027000	$30.02
Energy Efficiency Program Charge	111,168.00	kWh	@	$ 0.00020000	$22.23
Energy Efficiency Investment Charge	111,168.00	kWh	@	$ 0.00448600	$498.70
				Total Service Amount	**$7,512.42**

DESCRIPTION	USAGE	UNIT		RATE	CHARGE
Missouri State Sales Tax	$7,512.42		@	$ 0.04225000	$317.40
Missouri Local Sales Tax	$7,512.42		@	$ 0.05454000	$409.73
St. Louis City Municipal Charge - Service	$7,512.42		@	$ 0.11111000	$834.70
				Total Tax Related Charges	**$1,561.83**
				Total Electric Charges	**$9,074.25**

Questions? Contact Ameren Missouri at **1.877.426.3736** or visit **AmerenMissouri.com.**

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Address Changes or Corrections

Name ______________________

Address ______________________

City, State, Zip ______________________

Phone Number ______________________

AmerenMissouri.com/WaysToPay

- **ONLINE** E-CHECK
- **PHONE** 866.268.3729
- **IN PERSON** FIND A PAY STATION AT AMERENMISSOURI.COM/PAYSTATION
- **ONLINE** CREDIT CARD
- **MAIL** STUB & CHECK

Accounting for MEEIA 2019-21

Portfolio:	CORP	U	BD	MAJ	MIN	FMC	RMC	T	PROJT	PR	ACTV	RT
J0HTZ - Res Education	UEC	1	21	908	EED	020	020		J0HTZ	01	M3PC	XX
J0HX3 - Biz Education	UEC	1	21	908	EED	020	020		J0HX3	01	M3PC	XX
J0HV0 - Communications	UEC	1	21	908	EED	020	020		J0HV0	01	M3PC	XX
J0HV1 - Potential Study	UEC	1	21	908	EED	020	020		J0HV1	01	M3PC	XX
J0HV2 - Data Tracking	UEC	1	21	908	EED	020	020		J0HV2	01	M3PC	XX
J0HWD - Incremental Labor	UEC	1	21	908	EED	020	020		J0HWD	01	M3PC	XX
J0HDX - Portfolio Gen Expense	UEC	1	21	908	EED	020	020		J0HDX	01	M3PC	XX

Business:	CORP	U	BD	MAJ	MIN	FMC	RMC	T	PROJT	PR	ACTV	RT
J0HV3 - Biz Standard	UEC	1	21	908	EED	020	020		J0HV3	01	M3PC	XX
J0HV4 - Biz Custom	UEC	1	21	908	EED	020	020		J0HV4	01	M3PC	XX
J0HV5 - Biz Retro-Commissioning	UEC	1	21	908	EED	020	020		J0HV5	01	M3PC	XX
J0HV6 - Biz New Construction	UEC	1	21	908	EED	020	020		J0HV6	01	M3PC	XX
J0HV7 - Biz (SBDI) Small Business Direct Install	UEC	1	21	908	EED	020	020		J0HV7	01	M3PC	XX
J0HV9 - Biz Demand Response	UEC	1	21	908	EED	020	020		J0HV9	01	M3PC	XX
J0HVB - Biz General Expense	UEC	1	21	908	EED	020	020		J0HVB	01	M3PC	XX
J0J48 - LL Biz Standard	UEC	1	21	908	EED	020	020		J0J48	01	M3PC	XX
J0J49 - LL Biz Custom	UEC	1	21	908	EED	020	020		J0J49	01	M3PC	XX
J0J4B - LL Biz Retro-Commisioning	UEC	1	21	908	EED	020	020		J0J4B	01	M3PC	XX
J0J4C - LL Biz New Construction	UEC	1	21	908	EED	020	020		J0J4C	01	M3PC	XX

Residential:	CORP	U	BD	MAJ	MIN	FMC	RMC	T	PROJT	PR	ACTV	RT
J0HVC - Res Lighting	UEC	1	21	908	EED	020	020		J0HVC	01	M3PC	XX
J0HVD - Res Products	UEC	1	21	908	EED	020	020		J0HVD	01	M3PC	XX
J0HVF - Res HVAC	UEC	1	21	908	EED	020	020		J0HVF	01	M3PC	XX
J0HVG - Res Kits	UEC	1	21	908	EED	020	020		J0HVG	01	M3PC	XX
J0HVH - Res Home Energy Report	UEC	1	21	908	EED	020	020		J0HVH	01	M3PC	XX
J0HVJ - Res Appliance Recycling	UEC	1	21	908	EED	020	020		J0HVJ	01	M3PC	XX
J0HVK - Res Demand Response	UEC	1	21	908	EED	020	020		J0HVK	01	M3PC	XX
J0HX8 - Res MF Market Rate	UEC	1	21	908	EED	020	020		J0HX8	01	M3PC	XX
J0HVL - Res General Expense	UEC	1	21	908	EED	020	020		J0HVL	01	M3PC	XX

Low Income:	CORP	U	BD	MAJ	MIN	FMC	RMC	T	PROJT	PR	ACTV	RT
J0HVM - LI Multifamily	UEC	1	21	908	EED	020	020		J0HVM	01	M3PC	XX
J0HVN - LI Single Family	UEC	1	21	908	EED	020	020		J0HVN	01	M3PC	XX
J0HX9 - LI Efficiency Housing Grant	UEC	1	21	908	EED	020	020		J0HX9	01	M3PC	XX
J0HVP - LI Social Service for Business	UEC	1	21	908	EED	020	020		J0HVP	01	M3PC	XX

Evaluation:	CORP	U	BD	MAJ	MIN	FMC	RMC	T	PROJT	PR	ACTV	RT
J0HVQ - EMV Low-Income Programs	UEC	1	21	908	EED	020	020		J0HVQ	01	M3PC	XX
J0HVR - EMV Res Programs	UEC	1	21	908	EED	020	020		J0HVR	01	M3PC	XX
J0HVS - EMV Biz Programs	UEC	1	21	908	EED	020	020		J0HVS	01	M3PC	XX
J0HVV - EMV Res Demand Response	UEC	1	21	908	EED	020	020		J0HVV	01	M3PC	XX
J0HVW - EMV Biz Demand Response	UEC	1	21	908	EED	020	020		J0HVW	01	M3PC	XX
J0HXB - EMV Gen Expense	UEC	1	21	908	EED	020	020		J0HXB	01	M3PC	XX

	CORP	U	BD	MAJ	MIN	FMC	RMC	T	PROJT	PR	ACTV	RT
J0HXC - Res STEM Education	UEC	1	21	908	EED	020	020		J0HXC	01	M3PC	XX
J0HXD - Res Code Compliance	UEC	1	21	908	EED	020	020		J0HXD	01	M3PC	XX
J0HXF - Res Community Engagement and Rewards	UEC	1	21	908	EED	020	020		J0HXF	01	M3PC	XX
J0HXG - Res Smart Home Energy Management	UEC	1	21	908	EED	020	020		J0HXG	01	M3PC	XX
J0HXH - Res Real Estate Audits	UEC	1	21	908	EED	020	020		J0HXH	01	M3PC	XX
J0HXJ - Res Employee Education	UEC	1	21	908	EED	020	020		J0HXJ	01	M3PC	XX
J0HXK - Biz (BOC) Building Operator Certification	UEC	1	21	908	EED	020	020		J0HXK	01	M3PC	XX
J0HXL - Biz (SBER) Small Business Energy Reports	UEC	1	21	908	EED	020	020		J0HXL	01	M3PC	XX

Resource Type (RT)	
Customer Incentives	CI
Contract Services	EC
Admn/Professional Services	EX
Individual Expenses	80
Non-Taxable Meals	82
Purchases, Sponsorships, Conferences, Training	BX
LM Labor - Management	LM
MD Corporate Memberships - Use Major 930 Minor 228	MD
MT Individual Memberships - Use Major 921 Minor 072	MT
VX Vehicle Rental	VX
VF Vehicle Fuel	VF

Ameren Missouri - MEEIA 2019-21 Earnings Opportunity Summary - Portfolio

Performance Metric	Payout Rate	Payout Unit	PY1 Target	PY1 Payout	PY 1 Cap Dollars	PY2 Target	PY2 Payout	PY 2 Cap Dollars	PY3 Target	PY3 Payout	PY 3 Cap Dollars	100% payout	% of Target EO	Cap % Multiplier	Maximum Payout
Low Income Multi Family: criteria will be Average Percent Energy Savings Per Property; 85% Spend Threshold (admin. + incentive)	$33,333	$ / Percentage Point	0%	$0.00	$0	10%	$333,333	$416,667	15%	$500,000	$625,000	$833,333	2.8%	125.0%	$1,041,667
Low Income Single Family Incl. Mobile Homes: criteria will be Average Percent Energy Savings Per Property; 85% Spend Threshold (admin. + incentive; excludes energy efficiency grants)	$33,333	$ / Percentage Point	10%	$333,333	$416,667	10%	$333,333	$416,667	10%	$333,333	$416,667	$1,000,000	3.3%	125.0%	$1,250,000
Home Energy Report: criteria will be the evaluated MWh savings; TRC > 1.0 Threshold for PY 2020 & PY 2021	$4.73	$/MWh	35,250	$166,667	$175,000	35,250	$166,667	$175,000	35,250	$166,667	$175,000	$500,000	1.7%	105.0%	$525,000
EE MWh: criteria will be the evaluated 1st yr incremental MWh savings excluding HER, Low Income, Business Social Services, and DR programs.	$7.65	$/MWh	154,639	$1,182,492	$1,359,865	235,486	$1,800,711	$2,070,818	285,540	$2,183,464	$2,510,984	$5,166,667	17.2%	115.0%	$5,941,667
EE Coincident MW: criteria will be the evaluated last yr incremental MW reduction, coincident with system peak with **10-14yr life** excluding HER, Low Income, Business Social Services, and DR programs.	$87,086.33	$/MW	8.4	$727,734	$909,667	14.1	$1,227,503	$1,534,379	17.7	$1,544,763	$1,930,954	$3,500,000	11.7%	125.0%	$4,375,000
EE Coincident MW: criteria will be the evaluated 15th yr incremental MW reduction, coincident with system peak with **15 years and greater life** excluding HER, Low Income, Business Social Services, and DR programs.	$108,897.27	$/MW	30.6	$3,328,614	$4,160,767	46.7	$5,084,010	$6,355,013	55.9	$6,087,376	$7,609,220	$14,500,000	48.3%	125.0%	$18,125,000
Demand Response: criteria will be cumulative evaluated MW enrolled, coincident with system peak @ design criteria	$19,901.62	$/MW	36.50	$726,321	$907,901	74.83	$1,489,247	$1,861,559	114.8	$2,284,432	$2,855,539	$4,500,000	15.0%	125.0%	$5,625,000
Total				**$6,465,160**	**$7,929,868**		**$10,434,805**	**$12,830,102**		**$13,100,035**	**$16,123,364**	**$30,000,000**	**100%**		**$36,883,333**

Earnings Opportunity Calculator

Static Inputs-DO NOT CHANGE		**PY2019**	
Evaluation/Actual Inputs		**Total EO Payout**	**$ 6,465,160.37**
Formula			
EO Payout Amount			
			$ 30,000,000.00

Low-Income Multifamily

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)
Source	*Approved Plan*		*Calculation*	*General Ledger (Project Codes)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*	
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m
	$ 1,500,000	85%	$ 1,275,000	$ 1,500,000	100%	900,000	9,000,000	10.00%	0.00%	125.00%	0.000%	0.00%	$ 33,333.33

Low-Income Single Family (Excluding Efficiency Home Grants)

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)
Source	*Approved Plan*		*Calculation*	*General Ledger (Project Codes)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*	
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m
	$ 2,582,610	85%	$ 2,195,219	$ 2,582,610	100%	6,417,101	64,171,010	10.00%	10.00%	125.00%	12.500%	10%	$ 33,333.33

Home Energy Report

Description	Evaluated MWh savings for the HER	EO Target (MWh)	EO Cap Multiplier	EO Maximum (MWh)	EO Eligible Performance (MW)	Payout Amount per Unit (MWh)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	35,250	35,250	105.00%	37,013	35,250	$4.73	$ 166,666.67

EE MWh

Description	EE MWh: criteria will be the evaluated 1st yr incremental MWh savings excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MWh)	EO Cap Multiplier	EO Maximum (MWh)	EO Eligible Performance (MW)	Payout Amount per Unit (MWh)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	154,639	154,639	115.00%	177,835	154,639	$7.65	$ 1,182,491.71

EE Coincident MW 10 - 14 Year EUL

Description	EE Coincident MW: criteria will be the evaluated last yr incremental MW reduction, coincident with system peak with 10-14yr life excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*

Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	8.36	8.36	125.00%	10.45	8.36	$87,086	$ 727,733.89

EE Coincident MW 15 Year EUL and greater

Description	EE Coincident MW: criteria will be the evaluated 15th yr incremental MW reduction, coincident with system peak with 15 years and greater life excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	30.57	30.57	125.00%	38.21	30.57	$108,897	$ 3,328,613.58

DR Cumulative Enrolled MW

Description	Evaluated cumulative MW capability, coincident with system peak @ design criteria	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	36.50	36.50	125.00%	45.62	36.50	$19,902	$ 726,321.19

EO Payout Amount ($)
Calculation
n=l*100*m
$ -

EO Payout Amount ($)
Calculation
n=l*100*m
$ 333,333.33

Earnings Opportunity Calculator

Static Inputs-DO NOT CHANGE	
Evaluation/Actual Inputs	
Formula	
EO Payout Amount	

PY2020	
Total EO Payout	**$ 10,434,804.81**

Low-Income Multifamily

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*	
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m
	$ 2,200,000	85%	$ 1,870,000	$ 2,200,000	100%	1,650,000	16,500,000	10.00%	15.00%	125.00%	18.750%	10.00%	$ 33,333.33

Low-Income Single Family (Excluding Efficiency Home Grants)

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*	
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m
	$ 3,020,490	85%	$ 2,567,417	$ 3,020,490	100%	7,811,272	78,112,720	10.00%	10.00%	125.00%	12.500%	10%	$ 33,333.33

Home Energy Report

Description	Evaluated MWh savings for the HER	EO Target (MWh)	EO Cap Multiplier	EO Maximum (MWh)	EO Eligible Performance (MW)	Payout Amount per Unit (MWh)	Initial EO Payout Amount ($)	Evaluated TRC	TRC Threshold Metric	Budget Threshold Mutliplier	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*	*Evaluation Report*		*Calculation*	
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f	h	i	j=if h >i then 100%, else 0%	k=j*g
	35,250	35,250	105.00%	37,013	35,250	$4.73	$ 166,666.67	1.01	1.00	100%	$ 166,666.67

EE MWh

Description	EE MWh: criteria will be the evaluated 1st yr incremental MWh savings excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MWh)	EO Cap Multiplier	EO Maximum (MWh)	EO Eligible Performance (MW)	Payout Amount per Unit (MWh)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	235,486	235,486	115.00%	270,809	235,486	$7.65	$ 1,800,710.92

EE Coincident MW 10 - 14 Year EUL

Description	EE Coincident MW: criteria will be the evaluated last yr incremental MW reduction, coincident with system peak with 10-14yr life excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	14.10	14.10	125.00%	17.62	14.10	$87,086	$ 1,227,503.25

EE Coincident MW 15 Year EUL and greater

Description	EE Coincident MW: criteria will be the evaluated 15th yr incremental MW reduction, coincident with system peak with 15 years and greater life excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	46.69	46.69	125.00%	58.36	46.69	$108,897	$ 5,084,010.03

DR Cumulative Enrolled MW

Description	Evaluated cumulative MW capability, coincident with system peak @ design criteria	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	74.83	74.83	125.00%	93.54	74.83	$19,902	$ 1,489,247.28

EO Payout Amount ($)
Calculation
n=l*100*m
$ 333,333.33

EO Payout Amount ($)
Calculation
n=l*100*m
$ 333,333.33

Earnings Opportunity Calculator

Static Inputs-DO NOT CHANGE	
Evaluation/Actual Inputs	
Formula	
EO Payout Amount	

PY2021

Total EO Payout	**$**	**13,100,034.82**

Low-Income Multifamily

	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*	
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m
	$ 3,350,000	85%	$ 2,847,500	$ 3,350,000	100%	2,680,000	17,866,667	15.00%	15.00%	125.00%	18.750%	15.00%	$ 33,333.33

Low-Income Single Family (Excluding Efficiency Home Grants)

	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*	
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m
	$ 3,105,419	85%	$ 2,639,606	$ 3,105,419	100%	8,116,253	81,162,530	10.00%	10.00%	125.00%	12.500%	10%	$ 33,333.33

Home Energy Report

	Evaluated MWh savings for the HER	EO Target (MWh)	EO Cap Multiplier	EO Maximum (MWh)	EO Eligible Performance (MW)	Payout Amount per Unit (MWh)	Initial EO Payout Amount ($)	Evaluated TRC	TRC Threshold Metric	Budget Threshold Multiplier	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*	*Evaluation Report*		*Calculation*	
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f	h	i	j=if h >i then 100%, else 0%	k=j*g
	35,250	35,250	105.00%	37,013	35,250	$4.73	$ 166,666.67	1.01	1.00	100%	$ 166,666.67

EE MWh

	EE MWh: criteria will be the evaluated 1st yr incremental MWh savings excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MWh)	EO Cap Multiplier	EO Maximum (MWh)	EO Eligible Performance (MW)	Payout Amount per Unit (MWh)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	285,540	285,540	115.00%	328,371	285,540	$7.65	$ 2,183,464.04

EE Coincident MW 10 - 14 Year EUL

Description	EE Coincident MW: criteria will be the evaluated last yr incremental MW reduction, coincident with system peak with 10-14yr life excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	17.74	17.74	125.00%	22.17	17.74	$87,086	$ 1,544,762.86

EE Coincident MW 15 Year EUL and greater

Description	EE Coincident MW: criteria will be the evaluated 15th yr incremental MW reduction, coincident with system peak with 15 years and greater life excluding HER, Low Income, Business Social Services, and DR programs.	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	55.90	55.90	125.00%	69.88	55.90	$108,897	$ 6,087,376.39

DR Cumulative Enrolled MW

Description	Evaluated cumulative MW capability, coincident with system peak @ design criteria	EO Target (MW)	EO Cap Multiplier	EO Maximum (MW)	EO Eligible Performance (MW)	Payout Amount per Unit (MW)	EO Payout Amount ($)
Source	*Evaluation Report*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c	d=b*c	e=minimum of (a or d)	f	g=e*f
	114.79	114.79	125.00%	143.48	114.79	$19,902	$ 2,284,431.53

EO Payout Amount ($)
Calculation
n=l*100*m
$ 500,000.00

EO Payout Amount ($)
Calculation
n=l*100*m
$ 333,333.33

Earnings Opportunity Calculator

Static Inputs-DO NOT CHANGE	
Evaluation/Actual Inputs	
Formula	
EO Payout Amount	

PY2022

Total EO Payout	**$ 833,333.33**

Low-Income Multifamily

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)	EO Payout Amount ($)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m	n=l*100*m
	$ 5,160,000	85%	$ 4,386,000	$ 5,160,000	100%	4,644,000	30,960,000	15.00%	15.00%	125.00%	18.750%	15.00%	$ 33,333.33	$ 500,000.00

Low-Income Single Family (Excluding Efficiency Home Grants)

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)	EO Payout Amount ($)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m	n=l*100*m
	$ 2,998,947	85%	$ 2,549,105	$ 2,998,947	100%	4,333,075	43,330,750	10.00%	10.00%	125.00%	12.500%	10%	$ 33,333.33	$ 333,333.33

Earnings Opportunity Calculator

Static Inputs-DO NOT CHANGE	
Evaluation/Actual Inputs	
Formula	
EO Payout Amount	

PY2023

Total EO Payout	**$ 833,333.33**

Low-Income Multifamily

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)	EO Payout Amount ($)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m	n=l*100*m
	$ 6,400,000	85%	$ 5,440,000	$ 6,400,000	100%	5,760,000	38,400,000	15.00%	15.00%	125.00%	18.750%	15.00%	$ 33,333.33	$ 500,000.00

Low-Income Single Family (Excluding Efficiency Home Grants)

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)	EO Payout Amount ($)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m	n=l*100*m
	$ 2,911,828	85%	$ 2,475,054	$ 2,911,828	100%	4,330,112	43,301,120	10.00%	10.00%	125.00%	12.500%	10%	$ 33,333.33	$ 333,333.33

Earnings Opportunity Calculator

Static Inputs-DO NOT CHANGE	
Evaluation/Actual Inputs	
Formula	
EO Payout Amount	

PY2024

Total EO Payout	**$ 833,333.33**

Low-Income Multifamily

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)	EO Payout Amount ($)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m	n=l*100*m
	$ 6,400,000	85%	$ 5,440,000	$ 6,400,000	100%	5,760,000	38,400,000	15.00%	15.00%	125.00%	18.750%	15.00%	$ 33,333.33	$ 500,000.00

Low-Income Single Family (Excluding Efficiency Home Grants)

Description	Program Cost Budget (Admin + Incentive)	Budget Threshold Metric (%)	Budget Threshold Metric ($)	Actual Spend (Admin + Incentive)	Budget Threshold Multiplier (0% or 100%)	Evaluated First Year Incremental kWh	12 Months Usage for Participating Properties	Average kWh Savings Per Property	EO Target (%)	EO Cap Multiplier	EO Maximum (%)	EO Eligible Performance (%)	Payout Amount per Unit (Percentage Point)	EO Payout Amount ($)
Source	*Approved Plan*		*Calculation*	*Company Records to General Ledger (Project Code)*		*Evaluation Report*	*Evaluation Report/ Billing System*	*Calculation*			*Calculation*	*Calculation*		*Calculation*
Column ref	a	b	c=a*b	d	e=if d >=c then 100%, else 0%	f	g	h=f/g	i	j	k=i*j	l=e*[minimum of (h or k)]	m	n=l*100*m
	$ 2,971,789	85%	$ 2,526,021	$ 2,971,789	100%	4,419,207	44,192,070	10.00%	10.00%	125.00%	12.500%	10%	$ 33,333.33	$ 333,333.33

STATE OF MISSOURI

OFFICE OF THE PUBLIC SERVICE COMMISSION

I have compared the preceding copy with the original on file in this office and I do hereby certify the same to be a true copy therefrom and the whole thereof.

WITNESS my hand and seal of the Public Service Commission, at Jefferson City, Missouri, this 5th day of December 2018.

Morris L. Woodruff
Secretary

MOPSC Digitally signed by MOPSC
Date: 2018.12.05
13:43:50 -06'00'

MISSOURI PUBLIC SERVICE COMMISSION

December 5, 2018

File/Case No. EO-2018-0211

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Enclosed find a certified copy of an Order or Notice issued in the above-referenced matter(s).

Sincerely,

Morris L Woodruff

Morris L. Woodruff
Secretary

Recipients listed above with a valid e-mail address will receive electronic service. Recipients without a valid e-mail address will receive paper service.