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PAYS Feasibility Study

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Prepared for:

Ameren Missouri

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Disclaimer: The views and opinions expressed in this study are those of the authors and do not necessarily reflect the official policy, position, operations, outcomes of any study participant, and the results of this study have not been vetted by all study participants.

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Introduction

Ameren Missouri requested a feasibility study of the Pay As You Save (PAYS) on-bill tariff program to evaluate whether the program model is a feasible and recommended addition to the existing Ameren Missouri residential energy efficiency portfolio. PAYS is a trademarked program model that has been implemented in a number of programs around the country as an alternative to financing programs, primarily by cooperative and municipal utilities. PAYS programs can vary, but typically include these key characteristics:

- Cost recovery through a meter-based tariff, or charge on the utility bill
- The charge is set at or below 80% of the expected average monthly savings, and collected for 80% or less of the useful life of the upgrade
- Disconnection is allowed for non-payment of the tariff
- No minimum credit requirement for eligibility.

To be feasible for a Missouri investor-owned utility (IOU), a PAYS tariff program must able to operate cost-effectively according to standard regulatory tests, offer funding for a reasonable number of measures that might otherwise require financing, and not present any legal or regulatory obstacles. In addition, although it is not a requirement for feasibility, best practices indicate that the program should address a defined gap in the market for financing services for energy efficiency upgrades.

PAYS has both benefits and limitations relative to a standard rebate program or energy efficiency financing program. PAYS is usually referred to as an investment and cost recovery program model, rather than a financing program, because it requires the utility to make an investment in the metered property and recover that investment through a temporary tariff on that meter, rather than making a loan directly to a customer. The tariff is paid by the current occupant until the cost is paid off, and the charge is discontinued. If the customer moves and leaves behind the energy saving improvement, the charge is transferred to the next occupant who will also experience the benefits associated with the measure. As a result of this feature, PAYS is more easily accessed by renters than most types of financing.

The PAYS model ensures that the tariff amount is less than the utility bill savings (usually by at least 20%), which provides an assurance of immediate bill savings to customers, and automatically limits eligible measures to those that save energy. In most PAYS programs, the participant can make a co-payment of any remaining upfront cost if the PAYS investment doesn't cover the full amount, which allows a wider array of energy-saving eligible measures. In addition, by recovering the money it gives out to individuals, plus interest, PAYS has the potential to be less costly than a standard rebate program.

However, restricting the tariff amount to 80% of the bills savings over 80% of the measure life can limit upfront funding amounts to significantly less than the overall measure cost. In addition, energy audits that are necessary to determine potential savings can add substantially to the program costs. Administrative and legal costs related to managing charges over time, including managing nonpayment

and transferring tariffs to a new resident could also negatively affect both the benefit-cost ratio of the program and the program administrator's relationship with the customer.

Though no specific program structure is required under PAYS, the program is typically delivered as a direct-install style program, where the administrator (or a subcontracted implementer) recruits customers likely to benefit from the program (such as lower-income customers in higher usage homes, or renters in higher usage apartments), and then provides a turnkey experience for participants. The program administrator conducts a home energy assessment to identify savings opportunities and prepare a customer-specific project proposal. This proposal will include the project cost, the amount that can be funded through PAYS, any necessary copay from the customer (if the full amount cannot be funded), estimated monthly savings, and the monthly tariff the utility will charge to recover the funded amount. If the homeowner agrees, the utility will either identify a contractor or help the customer select a contractor to install the upgrades, and perform a quality check on the completed project. The process to assess savings opportunities and review the project upon completion may involve a comprehensive energy audit, with a blower test and test-out (if shell measures are installed). The PAYS administrator typically absorbs the cost of the audit and test-out.

Study Objectives

Through this study, Cadmus addressed the following research questions and offers recommendations about the feasibility of PAYS as an offering for Ameren Missouri customers:

- Does a charge on a customer's utility bill that conforms to the PAYS model allow for funding of all or a substantial amount of the cost of any rebate eligible or other common energy efficiency measures?
- What is the cost to set up the PAYS infrastructure and operate the program, including funding the duties of the certification agent?
- What participation volume is required for the program to be cost-effective based on the total resource cost (TRC) test?
- Are there any regulatory or legal impediments to offering the PAYS model?
- Does PAYS address a gap in the finance market that is not covered by private market products or energy-specific financing programs?

Methodology

Cadmus used primary data collection and secondary research to assess the research objectives identified for the study.

Interviews and Secondary Research

Cadmus conducted two interviews with key stakeholders, one with Ameren Missouri energy efficiency program staff and legal counsel, and one with staff from an implementer of active PAYS programs. Both interviews discussed the potential need for an energy efficiency tariff or financing program, the potential limitations and benefits of PAYS relative to other program models, the requirements to set-up and implement PAYS, and potential legal or regulatory obstacles to PAYS.

In addition, Cadmus referenced secondary sources, including Cadmus' unpublished research. Secondary sources are cited throughout the report. To evaluate whether there was a market need for funding or financing, and whether an Ameren Missouri PAYS program could meet that need, Cadmus referenced five existing financing products or programs, and compared them to PAYS. Table 1 listed the five products and provides the source for each.

Table 1. Reference Financing Products for Financing Market Gap Analysis

Product Category	Reference Example	Source
Credit Card	**1 -** VISA Platinum Credit Card from Health Care Family Credit Union (HCFCU) (Richmond Heights, MO) **2 -** Bank of America Cash Rewards Card	**1 -** https://www.healthcarefamilycreditunion.org/credit-cards.html **2 –** https://www.bankofamerica.com/credit-cards/products/cash-back-credit-card/
Unsecured Personal Loan	United Credit Union Unsecured Loan (Columbia, MO)	https://www.unitedcu.org/loan-rates
Home Equity Line of Credit (HELOC)	Health Care Family Credit HELOC (Richmond Heights, MO)	https://www.healthcarefamilycreditunion.org/
Property Assessed Clean Energy (PACE)	Missouri Clean Energy District/HERO PACE (multiple locations)	https://www.mced.mo.gov/
On-bill Financing	Illinois Energy Efficiency Loan Program (EELP) (Illinois IOU territory)	http://ilenergyloan.com
PAYS	Ameren Missouri PAYS	N/A (as modeled in this Study)

Measure-Level Financial Analysis

The purpose of the measure-level financial analysis was to determine the amount of funding that Ameren Missouri could provide to an average customer under the PAYS program requirements, which cap the monthly payment at 80% of average expected savings, and limited the recovery period to 80% of the measure useful life. Cadmus established an illustrative list of energy efficiency upgrades, and then compiled average expected savings, costs, estimated useful life (EUL), and other inputs from the Ameren Missouri Technical Resource Manual (TRM) and other industry-recognized sources.

Starting with a list of common energy efficiency measures that provide electrical savings and are listed in the Ameren Missouri TRM, we selected those measures that are likely to require financing (assumed to

include measures that cost at least $250) and are not portable (and therefore will remain at the meter site regardless of whether the occupants move). Though LEDs did not meet the criteria, Cadmus added them as a measure to be considered as part of packaged upgrades. This list of measures is illustrative, and not meant to be exclusive of measures that might be beneficial or eligible in a PAYS program.

Since PAYS programs typically involve a home energy audit that identifies multiple measures to install in one house, we also modeled two versions of a whole-home package. Both packages include an air-source heat pump (ASHP), ceiling insulation, air sealing, four LEDs, and a learning thermostat. One package includes savings associated with the early replacement of measures while the other reflects replace-on-failure savings. These packages are meant to illustrate the types of measures that might be installed in a whole-home scenario, rather than being exhaustive. (Cadmus did not include an energy audit as a measure, but included it as part of the implementation costs of the program).

Cadmus also included a hypothetical package of measures to reflect the average cost per project and average savings per project found by a recent evaluation of the Ouachita Electric Cooperative PAYS program.[1] Ouachita Electric Cooperative provided program data for 198 households, including the improvements implemented and date of implementation, as well as utility bill histories for a subset of participants. Cadmus utilized the report's data for average cost of installations and gross savings per household.

Table 2 shows the final list of measures Cadmus analyzed by end-use category.

[1] OptiMiser, LLC. *Ouachita HELP PAYS Residential Energy Efficiency Program Evaluation.* February 2018.

[redacted]

Table 2. List of Analyzed Measures

End-Use Category	Measure
Building Shell	Air Sealing
	Insulation (attic, wall)
	Windows
HVAC	Air-Source Heat Pump
	Central Air Conditioner
	Ductless Heat Pump
	ECM Auto Fan
	Ground-Source Heat Pump
Hot Water	Heat Pump Water Heater
Lighting and Appliances	Clothes Dryer
	Clothes Washer
	Learning Thermostat
	LED Bulbs
	Refrigerator
Packages	Whole-Home Package: ASHP, attic insulation, air sealing, four LEDs, learning thermostat
	Ouachita Package

Cadmus collected estimated values for effective useful life (EUL), per-unit energy savings, demand reduction, and incremental measure costs from the Ameren Missouri TRM where available.

In cases where the Ameren Missouri TRM did not provide a value or did not provide inputs for savings algorithms, Cadmus used information from the Missouri TRM (draft)[2] or the Illinois Statewide TRM for Energy Efficiency.[3] None of these sources provided full measure cost estimates for clothes washers and dryers or for wall insulation. Instead, we used the average of a random sample of retail prices posted online to determine a full measure cost estimate. For wall insulation only, we added an estimated labor cost based on attic insulation. Cadmus sampled retail prices from Home Depot, Ace Hardware, Ingram's Water and Air, AC Wholesalers, and Sears.

We determined per-unit energy savings and demand reduction for both replace-on-failure (ROF) and early replacement (ER) scenarios where appropriate. An ROF scenario assumes the participant's equipment has failed, and the only alternative to installing the efficient equipment is to install the least

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2 *Missouri Technical Reference Manual Volume 3: Residential Measures.* March 31, 2017. Available online: https://energy.mo.gov/sites/energy/files/MOTRM2017Volume3.pdf

3 *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 6.0*. February 8, 2017. Available online: http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_6/Final/IL-TRM_Effective_010118_v6.0_Vol_3_Res_020817_Final.pdf

costly equipment currently available on the market. The ROF measure savings is the difference in energy usage between these two alternatives, both of which are more efficient than the equipment being replaced.

However, an ER scenario assumes that a participant is replacing older, but still working, equipment. The TRM estimate for per-unit savings takes into account the period of time that the participant could have continued using the older equipment, which is most likely less efficient than any equipment currently available for purchase. As a result, the per-unit savings are typically much higher in an ER scenario.

The savings estimates from the Ameren Missouri TRM are based in part on evaluated results from Ameren Missouri residential energy efficiency programs. As such, values represent the average participant in Ameren programs, and may not reflect expected savings from particular subgroups, such as low income or multifamily homes.

Cadmus calculated the monthly bill savings for each measure by multiplying the monthly energy savings by a weighted average of Ameren Missouri's residential base variable rate for electricity. We determined the monthly energy savings for each measure by distributing the annual savings estimate over the 12 months of the year according to load profiles appropriate to the measure provided by Ameren Missouri. We calculated the average residential variable rate by weighting the winter and summer month rates of $0.0758 and $0.1261, respectively, by the "HVAC Bldg Shell" load profile. Cadmus selected this load profile as most closely representing the total household load profile for an average home.

Cadmus determined the maximum measure cost that could be funded through PAYS for each measure as the present value of the maximum PAYS tariff (80% of the expected monthly bill savings) over a duration equal to 80% of the measure's EUL, discounted at the interest rate of 5.95%.[4] For those measures where the maximum PAYS tariff resulted in a funded amount greater than the full cost of the measure, including interest and fees, Cadmus assessed a reduced tariff based on a duration of 10 years (in all cases, shorter than 80% of the measure EUL). We selected the 10-year duration to reduce the total amount paid by the account holder and to reduce the chance that the tariff will need to be transferred to another occupant, while still allowing for a very low monthly tariff charge.

Program Cost-Effectiveness Analysis

For the program to achieve cost-effectiveness, the program measures collectively must be able to generate sufficient savings to cover their own incremental costs as well as the fixed or general costs for program administration. To assess the potential for cost-effectiveness at the program level, Cadmus selected two measures estimated to provide energy bill savings in excess of the measure cost, based on the measure-level analysis: ASHP replacing a furnace and air conditioner and the whole-home package, assuming an early replacement scenario for both. We also included a third measure, an ASHP replacing an ASHP on an early replacement basis. These are not the only measures that could cost-effectively be incorporated into a PAYS program, but are meant to illustrate the potential for cost-effectiveness across

[4] See the *Program Administration* section for an explanation of the interest rate.

measures with different savings-to-cost ratios that would also be likely to be commonly installed through PAYS. These three measures are outlined in Table 3.

Table 3. Measures Included in Cost-Effectiveness Analysis

ID	Measure Name	Baseline Assumption	kWh	Funded Cost[a]
23	ASHP Replacing Furnace/AC	Electric Resistance Furnace: HVAC	10,749	$7,632
24	ASHP Replacing ASHP	Electric Resistance with ASHP: HVAC	4,221	$7,632
40	Whole Home Package	See individual measures	12,697	$9,499

[a]Funded cost is the full measure cost, less any available rebate, plus the 5% nonpayment loss fee, which is included in the funded amount.

Total Resource Cost Test

The Missouri Public Service Commission (MPSC) considers the total resource cost test (TRC) a preferred cost-effectiveness test. Implemented under the Missouri Energy Efficiency Investment Act (MEEIA).[5] Programs or measures are cost-effective when the total benefits exceed total costs, or where the benefit-to-cost ratio exceeds 1.

The TRC test measures the dollar benefits of energy savings against all costs paid by either the participant or the utility to install the measures, and attempts to determine cost-effectiveness at a holistic level. In effect, the test answers whether the combined group of utility and participants saves money by implementing the program and the corresponding projects.

Cadmus used the basic TRC benefits and costs described by the California Standard Practice Manual,[6] modified to include costs specific to the long-term tariff program. The benefits included in the TRC test are the avoided energy, capacity, and transmission and distribution costs from installed measures. As participants reduce their energy use, the utility avoids fuel purchases and defers capacity and transmission and distribution construction, maintenance, and upgrades. Line losses are also reduced and counted as a benefit.

TRC costs include the utility costs to operate the program and the participants' costs to purchase more efficient equipment (the incremental measure cost and interest charges included in the tariff). The incremental measure cost is the amount the participant pays in excess of the standard equipment cost to purchase the more efficient equipment.

To calculate benefits, we used measure data collected in the measure-level financial analysis. We then applied the avoided costs and line losses provided by Ameren Missouri. To model program costs, we calculated the deferred cost of replacement for each early replacement measure, and summed

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5 Missouri Statute 393.1075 (4) "Missouri Energy Efficiency Investment Act" Available online http://revisor.mo.gov/main/PageSelect.aspx?section=393.1075

6 *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001. http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf

[redacted]

administrative costs identified through our interviews and secondary research. The benefits and costs included in the TRC are listed in Table 4. Because customer rebates are a transfer of funds from the utility to customer, rather than an additional cost to the transaction, they are not included as a separate cost.

Table 4. TRC Benefits and Costs

Parameter	Benefit	Cost
Avoided Energy	X	
Avoided Capacity	X	
Line Loss	X	
Program Administration		X
Marketing		X
Origination and servicing		X
Loan Default Fees and Costs		X
Loan Opportunity Carrying Costs		X
Incremental Measure Costs		X

Inputs

Table 5 shows measure-specific inputs Cadmus used in our cost-effectiveness analysis. Measure costs assume an early replacement scenario for all three measures. For early replacement measures, we calculated a deferred replacement cost instead of using the straight incremental cost. The deferred replacement cost is the full cost of the high efficiency measure less the present value of the cost for a new standard measure at the end of the existing measure's remaining useful life (assumed to be one-third of the efficient measure's EUL).

Table 5. Measure-Specific Inputs

Measure	EUL	Remaining Useful Life	kWh Savings	kW Savings	Deferred Replacement Cost
ASHP Replacing Furnace/AC	18	6	10,749	5.01	$4,259
ASHP Replacing ASHP	18	6	4,221	1.97	$4,558
Whole-Home Package	18	6	12,900	6.17	$3,142

Table 6 shows the utility assumptions and associated program costs used in the cost-effectiveness analysis (see the *Administrative Costs Summary* section for a more detailed discussion of program costs). We used Ameren Missouri's borrowing rate as the cost of capital as well as the discount rate. The opportunity cost of capital and carrying cost for the investment amount represents the lost opportunity or expense of interest payments. The opportunity cost is the present value of the interest that the participant will pay over the life of the tariff, discounted at an estimated minimal rate of return. Since this is a conceptual rate, we used the U. S. Treasury bond rate as a proxy. We assumed tariff nonpayment and write-offs due to customer complaints or other factors of 5%, offset by a nonpayment loss fee of 5% charged to the participant. Fixed utility program costs include program staff, marketing, and evaluation costs. In addition, we assumed program implementation and origination costs fixed at

[redacted]

$60,000 for participation less than 60 customers, with no variable cost. For 60 or more customers, we assumed implementation costs of $1,000 per customer, with no fixed amount.

Cadmus assumed Ameren Missouri would offer PAYS as part of its residential energy efficiency portfolio of programs. We included only costs considered to be program costs eligible for recovery under MEEIA rules in the cost-effectiveness analysis. Other costs associated with the set-up and launch of PAYS, specifically the staff time required to design the program, and the costs to prepare the Ameren Missouri billing system to integrate with outside providers, are not included in this assessment.

[redacted]

Measure Mix and Participation

Cadmus completed cost-effectiveness analysis for three measure scenarios:

- Scenario 1: all ASHP replacing furnace
- Scenario 2: all whole home
- Scenario 3: combination of 45% ASHPs replacing furnace and air conditioners, 45% standard whole-home packages, and 10% ASHPs replacing ASHPs

Scenario 1 and Scenario 2 represent programs consisting of single measures and are used to assess how well each of the two measures, in isolation, could support total program costs. Scenario 3 is a combined-measure program that is more representative of the range of projects included in a typical PAYS program. This scenario includes both measures from the first two scenarios, as well as 10% ASHPs replacing ASHPs, a measure that generates lower savings relative to the full measure cost.

Participation Levels

Because some costs are fixed and others are incurred on a per-participant basis, the ratio of total program benefits to total program costs varies depending on the number of measures installed through the program. In this analysis, Cadmus assumed one measure or package of measures was installed per participating home. Cadmus evaluated the program across a range of participation levels to assess the sensitivity of the cost-effectiveness ratio to the volume of participation. For each scenario, under both net-to-gross (NTG) assumptions, we conducted a breakeven analysis to determine what level of participation would be necessary for the program to achieve a benefit/cost ratio of 1:1. We also assessed cost-effectiveness for each scenario assuming 50, 250, and 750 participants. The low end of the range represents the low end of actual participation in existing PAYS programs, while the upper end of the range represents the maximum participation of existing PAYS programs, scaled to Ameren Missouri's larger customer base.

Net-to-Gross Ratio

The NTG ratio determines what percentage of the gross savings achieved from the upgrade would not have occurred if the PAYS program did not exist. In this case, the NTG ratio measured the percentage of savings that would not have occurred without PAYS, as distinct from the savings that would not have occurred without the rebate, for those measures that also had a rebate. For all projects that used both PAYS and a rebate, some percentage of the total gross savings would have occurred anyway, without rebates or PAYS. These savings do not count as program benefits under the TRC test. Some of the remaining savings would have occurred with just a rebate (no PAYS), and some of the savings would have occurred with just PAYS (no rebate). To illustrate the potential impacts of an NTG analysis, Cadmus tested each program scenario described above first at an NTG of 1.00 and then at an NTG of 0.62.

Cadmus used the NTG ratio of 1.00 as reasonable assumption for a typical PAYS program that targets low-income, high-energy usage homes with working equipment. Without the trigger of broken or failing equipment, where the home has existed with high-energy bills for several years, it is unlikely the participant would have installed efficiency measures on their own, even with the incentive of a rebate. This implies both very low free ridership and minimal contribution from the rebate program (and therefore does not allocate any savings to rebate program).

We tested a second NTG ratio to model a program that is not targeted exclusively to hard-to-reach markets, where the rebate program is a more important driver of participation. Because the costs from the rebate program are not included in this analysis, any savings that result only from the rebate should also be excluded. In a 2016 study for the California investor-owned utilities, Cadmus tested three

methodologies to assess the relative influence of PACE financing and utility rebates on customers' decisions to invest in an efficiency upgrade. The analyses were based on a survey of 3,501 California homeowners who had completed a home energy–related upgrade in the past three years. The allocation to financing across the three methods ranged from 55% to 67% of the measure savings, with an average of 62% (equal to an NTG ratio of 0.62). This reduced NTG excludes savings that are either due to free ridership or allocated to the rebate program. [7]

Cadmus applied the NTG ratio to the benefits and variable costs (nonpayment loss fee, interest charges, and measure cost) included in the cost-effectiveness test. Table 7 summarizes the different scenarios Cadmus tested.

Table 7. Measure Mix, Participation and NTG Scenarios

Scenario	Measures Included	Participation Levels	NTG Levels
Scenario 1	ASHP replacing a furnace and air conditioner (100%)	Breakeven, 50, 250, 750	1.00, 0.62
Scenario 2	Whole-home package of upgrades (100%)	Breakeven, 50, 250, 750	1.00, 0.62
Scenario 3	• ASHP replacing a furnace and air conditioner (45%) • Whole-home package of upgrades (45%) • ASHP replacing an ASHP (10%)	Breakeven, 50, 250, 750	1.00, 0.62

[7] Cadmus. *HERO Program Savings Allocation Methodology Study: Final Report*. Prepared for Pacific Gas & Electric, San Diego Gas and Electric, Southern California Edison, and Southern California Gas Company. October 3, 2016. Available online: http://www.calmac.org/publications/HERO_Allocation_Method_Study_Final_Report.pdf

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Findings

In this section, we provide findings across three general categories: program administration, measure-level *analysis, and program cost-effectiveness.*

Program Administration

Cadmus used secondary data and interviews with key stakeholders to better understand Ameren Missouri's likely requirements to offer a PAYS program.

Partner Roles

Figure 1 shows the key roles in a PAYS program. The necessary partners, and the exact role of each, will depend on the organizations involved, the size of the program, the regulatory context, and finally, the program administrator's preference. Green boxes indicate a program administrator or partner. The solid arrows indicate a flow of funds, while the dotted arrows indicate a relationship.

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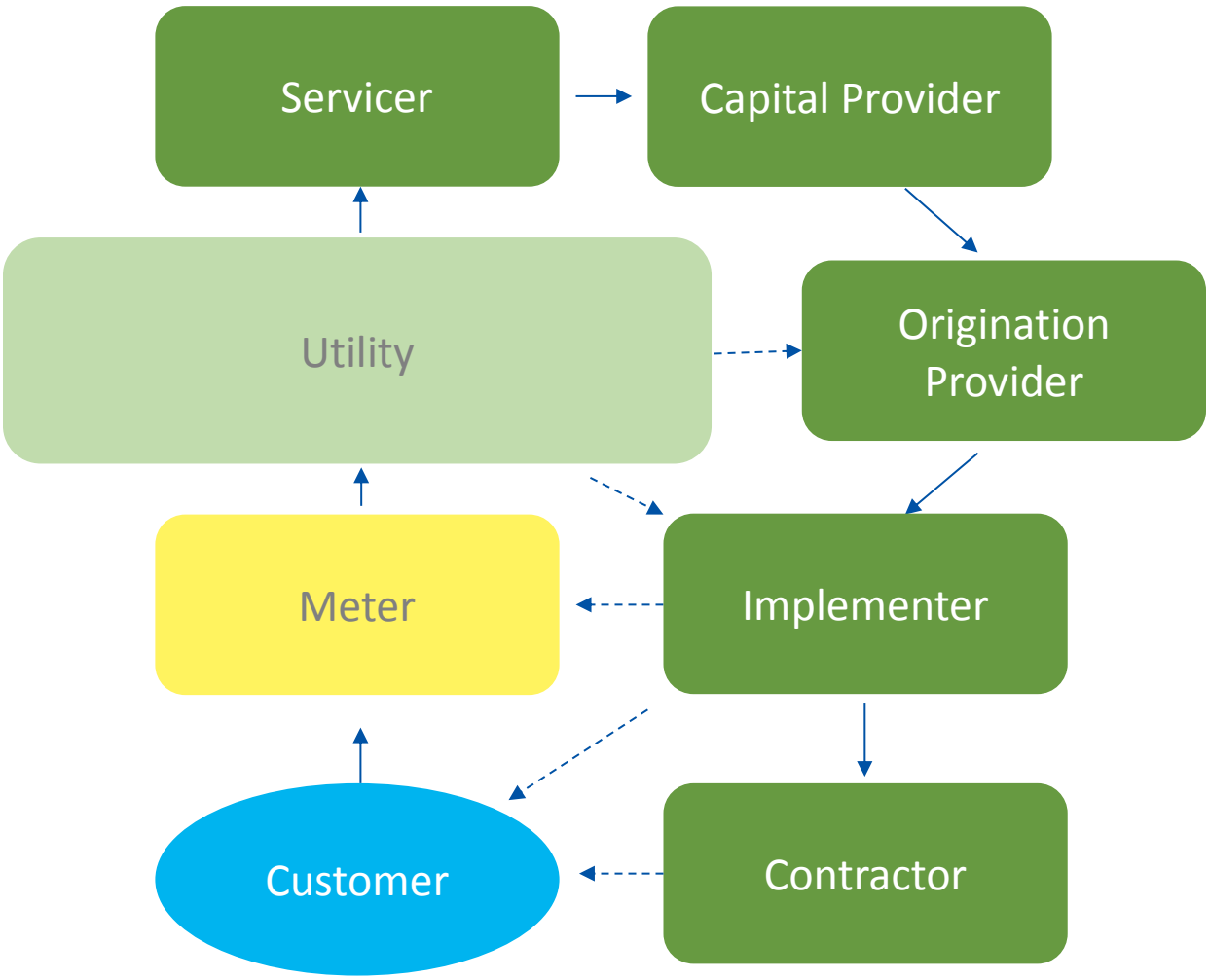
Figure 1. PAYS Program Design



Different on-bill programs handle the roles of origination, implementation, and servicing in different ways. Specialized organizations exist to handle each of these roles. Alternatively, in some programs, they may be all be managed by a single entity, or distributed across the utility and one or two other partners. For example, Ameren Missouri staff reported that potential partners for the planned on-bill program were specialized providers, offering either origination or servicing.

Servicer

Servicing includes tracking monthly payments against the total amount due over the duration of the tariff. The utility may remit payments from participants directly to the servicer, or remit payments based on servicer reports to the capital provider.

Capital Provider

The capital provider is usually a lender or broker that works with outside investors to provide a source of funds for the program. While it is possible for a utility to operate a PAYS program using internal

resources and capital, most utilities choose to partner with organizations that specialize in this function. The origination provider may serve as a liaison with a capital provider.

Utility

The utility's role is to provide general oversight and management for all parties involved in the program, provide data and contact information for customers to facilitate outreach, provide data to support audits and program evaluation, and to collect the tariff payments on the utility bill. The utility will also hold tariff payments and remit them either to the servicer or to the lender. The utility may retain responsibility for the long-term function of the equipment or upgrades installed, depending on the structure of the agreement with the customer.

Origination Provider

Origination consists of managing available capital, reviewing applications for funding; ensuring projects meet program requirements, and releasing funds to contractors. Origination providers may also source capital. Ameren Missouri staff reported that origination providers they consulted charged discovery and management fees for this service.

Implementer

Implementation includes outreach to participants, overseeing audit services and installation, performing quality control, and ensuring projects meet program guidelines. The interviewed PAYS implementer reported that this organization typically performs all the day-to-day "on the ground" operation of the program. This includes outreach, ongoing customer communication and support through completion of the project, coordinating audits and installations, and performing quality control checks.

Contractor

Some administrators use a network of subcontractors to perform audits and complete upgrades, and in other programs, the implementer will do some aspects of this work internally, while the utility staff provide quality control. The contractor is typically responsible for only the installation of the equipment, including any failure of the equipment during its lifetime that results from improper installation.

Sourcing Capital

One of the critical functions of a PAYS program is that it covers the upfront cost of home upgrades, meaning it must have sufficient capital available to pay contractors immediately as soon is work is complete and approved. Though the PAYS design does not explicitly reference using low-cost capital to fund projects, other PAYS requirements make it difficult for the program to support market rate or higher interest rates. The requirement to fund only what can be recovered through a charge limited to 80% of expected monthly savings limits the total amount the program can provide. The higher the interest rate, the less funding is available to cover the cost of the measure. In addition, the program is usually targeted to low-income customers, who are least able to pay higher interest rates.

Cadmus found that cooperative utilities, which are the most common administrators of PAYS programs, are often able to leverage funding from the federal government, through grants or similar dedicated programs. For example, a cooperative in Roanoke, North Carolina received capital at low interest rates

through a USDA Rural Utilities Service program. Another program, administered by the Mountain Association for Community Economic Development (MACED) in Kentucky, used a combination of philanthropic investments and federal funds. However, most federal programs and grants exclude investor-owned utilities (IOUs) such as Ameren Missouri.

Many IOU-administered on-bill programs use capital sourced from the private market. For example, the Illinois EELP, administered by five IOUs, subcontracted with a specialized lender that managed origination as well as sourcing capital from outside investors. Because investors are primarily interested in optimizing their return, IOU program administrators often provide some form of credit enhancement to reduce the cost (interest rate) of the capital provided. A credit enhancement is any policy or program feature that provides enhanced protection from risk of default, or nonpayment. Credit enhancements can take many forms, but may include loan guarantees, payment guarantees, loss reserve funds, or service shutoff for non-payment.

In the case of the Illinois EELP, IOUs were required by legislation to make all scheduled payments to the program investor, regardless of whether they had collected the funds from the participants. This payment guarantee allowed the lender to find capital at the utilities' corporate borrowing rate, around 5%. The utilities accepted some risk from potential nonpayment. However, the tariff allows the utilities to disconnect service for nonpayment of the tariff, and to write-off defaults in the case that disconnection and other collections protocols do not result in payment.

The PAYS implementer reported that several PAYS programs also use a loss reserve to protect the utility against nonpayment. A loss reserve is a dedicated fund that the program administrator can access after reasonable collection measures have been exhausted to recover unpaid tariffs. Loss reserve funds are typically set equal to a certain percentage of the outstanding loan balance, just above the expected default rate. This limits the amount of funding needed in reserve, but protects the administrator (and ratepayers) from having to absorb the cost of any unrecovered investment. The money in a loss reserve fund can come from any source. For example, the MACED program charges a one-time 5% fee to participants to fund a loss reserve, creating a loss reserve fund equal to 5% of outstanding investment volume. Since default rates for PAYS, as well as most other residential energy efficiency programs, are below 3%, the 5% reserve more than covers the risk.[8] The interviewed PAYS implementer reported that a PAYS program in Arkansas uses a grant from the Arkansas Energy Office to fund its loss reserve, and the Roanoke, NC program uses a loss reserve funded by a local non-profit.

In addition to credit enhancements, the PAYS administrator noted that the PAYS design incorporates several features intended to limit nonpayment. For example, PAYS emphasizes a tariff structure rather than a loan, which in many cases allows the utility to shut off service if the participant doesn't pay the tariff. In addition, the tariff is structured so that the participant's monthly bill, including the tariff, should

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[8] Cadmus. *California Joint Utilities Financing Research: Existing Programs Review.* Report for Pacific Gas & Electric, Southern California Edison, Southern California Gas, and San Diego Gas and Electric. April 22, 2014. Accessed online

be lower on average than it was before the project was installed (and therefore easier for the participant to pay). Finally, while the program does not allow a minimum credit score, program administrators usually require that participants be current on their utility bills. As a result, according to the interviewed PAYS implementer, nonpayment rates in PAYS programs are consistently low.[9]

Program Design

Prior to launching a PAYS program, administrators typically work with the PAYS service mark owner, Energy Efficiency Institute (EEI), the PAYS implementer, or another organization closely affiliated with EEI, to customize the PAYS design to meet the administrator's need. According to the interviewed PAYS implementer, the design is very flexible and can be tailored to meet an administrator's specific goals. Within the requirements of PAYS, the administrator will need to make several decisions during the design phase, including how to deliver the program to market, customer eligibility requirements, and whether to place additional restrictions on measures beyond the basic PAYS requirements.

The characteristics common to most PAYS programs, as described earlier, are as follows[10]:

- Participant accepts an opt-in utility tariff that is tied to meter, with disconnection allowed for non-payment
- The tariff, which is included as a line item on the utility bill, is capped at 80% of estimated savings, and charged for no more than 80% of the useful life of the upgrade
- Payments end if upgrade fails and is not repaired
- Tariff runs with the meter and remains in effect for subsequent customers at that location until cost recovery is complete
- No credit score or minimum income level is required to participate
- Renters are eligible

Cost Recovery through a Tariff Charge

This section describes the tariff characteristics and benefits to administrators and participants.

Tariff Characteristics

The tariff charge is central to the PAYS design, and makes the program fundamentally different from a loan program. In a loan program, the administrator provides financing to the borrower, and the borrower, regardless of how their circumstances may change, is obligated to repay the loan. In a PAYS program, the program administrator makes an investment in the property at a specific meter, and adds

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[9] Cadmus' independent research also found low nonpayment rates among energy efficiency financing and PAYS programs, although the primary drivers of this low rate are not clear. See the *Default and Nonpayment* section below for a more detailed discussion.

[10] Clean Energy Works. "Inclusive Financing for Efficiency Upgrades." Accessed online May 10, 2018: https://drive.google.com/open?id=0BzYyDNPW3cwwOFBzc3NyTTF2MEE

a tariff to the payment obligation for that meter to recover their cost. The current customer at that meter, regardless of whether that person was the original project beneficiary, pays the tariff until costs are fully recovered, and also benefits from the energy savings provided by the measure.

Another key characteristic of PAYS is that the tariff is structured to be less than the amount the participant will save on average on their energy bill. The program administrator typically provides the participant with an energy audit at the administrator's expense, to estimate the potential energy saving benefit of the proposed project. The proposal also informs participants that the tariff payment will be set at 80% of the expected savings. The participant is expected to use this information to decide whether to participate, and which upgrades to select.

For measures that provide lower savings relative to total cost, PAYS administrators may not be able to fund the full upfront cost of the measure under the PAYS requirements. A measure may still be eligible for partial funding if the participant is willing to pay the remaining amount as a copayment.

Tariff Benefits

The tariff mechanism and structure of the tariff provide a few key benefits to the program. First, the PAYS design allows renters that pay their own electric bill to participate directly. While it would normally be counterintuitive for a renter to invest in a property they do not own, the tariff structure ensures the participant will not have to make payments if they are not receiving benefits. Renters must still receive permission from the landlord to made changes to the property. In addition, the landlord must agree to the tariff since the landlord becomes responsible for tariff payments if the renter moves out and no new tenant moves in.

Second, the tariff cap ensures the participant should experience positive cash flow from the PAYS investment over the course of a year (assuming the participant does not have to provide a co-payment). By setting the payment at 80% of the expected savings, PAYS incorporates a cushion to account for differences in the forecast savings (determined through an energy audit on the property) and the actual savings. Potential differences may result from unusually mild weather, changes in the participant's behavior, or inaccuracies in the energy audit. The interviewed PAYS implementer reported that they use custom-designed auditing software designed to provide a conservative savings estimate.

The tariff provides additional protection for participants because PAYS typically allows the tariff to be waived if the upgrade fails. The PAYS implementer reported that if installed equipment, such as an air-source heat pump fails, the implementer will visit the property to assess whether the contractor is at fault. If so, the implementer will require the contractor to fix or replace the equipment, and the tariff is suspended until equipment is repaired. It was not clear how an administrator would manage an equipment failure where the contractor was not at fault. In addition, it was not clear how administrators would manage equipment failure after the contract with the implementer had ended, if the tariff charge was still in place.

Finally, in many cases, the tariff provides an additional security for the capital provider in that the program administrator can shut-off service if the PAYS tariff is not paid (even if the actual service charge

is paid). As discussed earlier (see *Sourcing Capital*, above) energy efficiency financing programs are generally found to have default rates below 3.0%. However, most financing programs require a minimum credit score, and may have other requirements for borrowers, or use property or tax liens, to ensure participants are likely to repay the loan or investment. Since PAYS does not allow minimum credit score requirements or liens, shut-off may be the only consequence to participants that do not pay the tariff. However, not all PAYS programs include this feature. In an interview conducted for another study, the MACED program administrator indicated that he did not know if the program tariff, which had to be approved by the Kentucky Public Service Commission, allowed for shut-off, but that regardless the program did not consider it an option.

Considerations for Ameren Missouri

In 2017, Ameren Missouri conducted extensive research and planning to offer a non-PAYS on-bill financing program based on a stipulation and agreement (S&A) document that outlined requirements for the program.[11]

Key requirements in the S&A included the following:

- The total loaned amount should not exceed $5 million.
- Customers will see the loan repayment amount as a line item on their Ameren Missouri utility bill.
- Loans will be non-transferable and not tied-to-the-meter
- Customers will not have utility services disconnected solely due to loan non-repayment (in accordance with existing MPSC regulation)
- A third-party lender will provide unsecured loans at a fixed interest rate with very limited or no up-front customer payment.
- Loans will be available for various terms not to exceed 7 years.
- Loans will be available for up to $10,000 per customer.

Program Design Considerations

Some of the S&A requirements, if applying to PAYS, would be favorable. For example, the S&A specifically allows an on-bill payment. The total loan volume of $5 million is equivalent to the size of the Ameren Illinois portion of the Illinois EELP program, and is larger than the loan volume of a typical PAYS program. Based on the average loan size and the participation needed for the program to be cost-effective, Ameren Missouri could fund a PAYS program for multiple years (see the *Program Cost-Effectiveness Analysis* section below). In addition, the maximum loan size of $10,000 is greater than the average PAYS loan.

[11] Missouri Public Service Commission. Non-unanimous stipulation and agreement regarding use of R&D funds and modification of measure incentives. File No. EO-2015-0055.

[redacted]

However, several of the S&A requirements, if applying PAYS, could impede Ameren Missouri's ability to offer the program. Notably, the S&A prohibited a tariff tied to the meter, which is a central component of PAYS. Disallowing this feature makes the program far less attractive to renters, because it would require paying off any remaining balance if the renter leaves the property. If the payment is not structured as a tariff, it is not clear that Ameren Missouri would have any authority to waive or suspend payments in the case of equipment failure. In addition, the S&A prohibits service disconnection for failure to make loan payments, another reason PAYS programs rely on a tariff model. Disallowing shut-off removes a credit enhancement aspect of the program, potentially making it more difficult to find low-cost capital.

The S&A also stipulates a 7-year loan term maximum. Seven years is lower than the minimum needed to recover costs for the majority of major efficiency measures, assuming the payment is capped at 80% of the expected monthly savings, as required by PAYS. (See the *Measure-Level Financial Analysis* section for a more detailed discussion of the amounts recoverable through PAYS for common energy efficiency measures.)

An additional obstacle that Ameren Missouri would need to navigate relates to the MEEIA cycle. The S&A proposes that Ameren Missouri offer the on-bill program as part of its energy efficiency portfolio funded through its MEEIA application. However, the MEEIA program cycle is 3 years, and there is no guarantee that MEEIA will be renewed at the end of each cycle.

The S&A was specific to a different on-bill program, and not all conditions would necessarily be included in a similar S&A for PAYS. Ameren Missouri would need to conduct additional research to determine how existing regulations and the MEEIA rules would impact development of a PAYS program specifically.

Ameren Missouri would also need to research other potential legal issues related to PAYS. The PAYS program design includes several unique features that are untested in an IOU context. For example, it is not clear if the utility would face any liability in the case that participants do not achieve the expected level of savings, or the installed equipment fails for reasons that are not the fault of the contractor. In addition, the interviewed PAYS implementer reported that when structuring the payment as a tariff, the administrator is not required to obtain a lending license. Ameren Missouri should review the consumer lending regulations specific to the state of Missouri, if the program is structured as a loan rather than a tariff.

[redacted]

- [redacted]
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[redacted]

Capital Cost Assumptions for Ameren Missouri PAYS

Through the research and analysis conducted for this study, Cadmus determined that a PAYS program would not be feasible while adhering to the S&A terms for a non-PAYS on-bill program. The PAYS requirements for maximum tariff amounts and maximum tariff recovery periods are incompatible with the 7-year term required in the S&A. In addition, the capital provider's stipulations of a minimum credit score and limiting eligibility to owner-occupants are directly in conflict with the PAYS design. Further, the added costs for buy-down and default insurance, in addition to the possibility of other not-yet-identified costs to encourage participation and mitigate investor risk, would likely make the program not cost-effective at any level of participation.

The Ameren Missouri program team identified the lack of a credit enhancement as a major cost driver for the non-PAYS on-bill program. When planning the non-PAYS program, the Ameren Missouri program team had been unable to identify a credit enhancement meeting S&A rules for cost-recovery under MEEIA. However, the program team considered the MACED model to be a possible solution. Using

[redacted]

participant fees to fund the loss reserve creates a true barrier between nonpayment risk and ratepayers. (In this model, some seed funding may be required until participation reaches around 20, at which point five percent of the total funded amount would equal the average cost of a single project.)

Therefore, to model the administrative costs of a PAYS program, Cadmus assumed an Ameren Missouri PAYS program would include a 5% loss reserve fee for each completed project, rolled into the funded amount. In addition, we assumed the loss reserve would provide sufficient assurance to capital providers that Ameren Missouri could obtain capital at its corporate cost of borrowing, [redacted] Cadmus also assumed the MPSC and the capital provider would allow terms up to 20 years, and set no requirements for minimum loan amount, minimum credit score, or control of cost recovery (collections). While Cadmus considered these assumptions to be reasonable, they are untested. Actual costs to offer PAYS, or constraints imposed by regulators or partners, may be different from the model used in this study.

Program Implementation

According to the PAYS implementer, no IOUs currently offer a PAYS program. Nevertheless, the implementation experience of current PAYS providers provides insight into how the program might perform in Ameren Missouri territory. Through other PAYS research, as well as the interviews conducted for this study, Cadmus identified trends and lessons learned from existing programs. These are described in the following sections.

Set-up and Launch

Set-up and launch of a PAYS or other on-bill program can take between a few weeks to a few years, depending on a number of factors. According to the PAYS implementer, the single most important factor is that the utility be committed to moving the program forward, and actively champion the program through potential obstacles. In general, Cadmus found that unregulated cooperatives have been able to launch programs more quickly than regulated entities. For example, the North Carolina PAYS program administrator reported the set-up stage of the program took less than one year, and the most time-consuming aspect of the process was identifying the source of capital. The MACED program administrator, on the other hand, reported that the process to get the tariff approved by the state utility commission, and the program design in general approved by the state attorney general, took approximately 18 months. The interviewed PAYS implementer reported that once the tariff is approved, they, as the implementer, can launch a program in as little as three months

Ameren Missouri staff reported that, based on previous experience with modifications to their billing system, the utility estimate the cost to integrate with a servicing agent would cost [redacted] or more, depending on the types of upgrades required.

Participation

In research conducted outside this study, Cadmus found that annual participation in existing programs ranged from an average of 58 (MACED) to 198 (Ouachita, Arkansas). Several programs have been in existence for several years, and show consistent participation across years. The PAYS implementer

reported completing over 300 projects in Ouachita, Arkansas, since starting work there in 2016. Table 8 summarized participation in various PAYS programs around the country.

Table 8. Participation in PAYS Programs

Program	Total Participation To-Date	Years
Home Energy Loan Program (HELP) PAYS (Ouachita Electric Cooperative, Arkansas)	300+	2016 - 2018
Upgrade to $ave Program (Roanoke Electric Cooperative, NC)	400+	2014 – 2017
Help My House Pilot (Electric Cooperatives of South Carolina)	125	2011 – 2012
How$mart KY PAYS (MACED)	289	2011 – 2017
Average Annual Participation	90	n/a

Cadmus found little evidence of the percentage of PAYS participants that rent rather than own their home. However, most PAYS participants live in single-family homes, rather than multifamily units, which may be an indicator of minor renter participation. The interviewed PAYS implementer reported that of 85 of 300 retrofits Ouachita, Arkansas PAYS participants were multifamily units, and five were commercial properties, with the remainder single-family homes. The interviewed PAYS implementer reported that all 75 North Carolina projects in that program have been single-family. Of 65 projects evaluated for savings from the Ouachita program, four were multifamily units.

PAYS upgrades tend to cost on average around $5,000 to $6,000 per home, and typically include an HVAC upgrade and some weatherization. The Roanoke and MACED programs both offer a standard package of measures, customized based on audit results that includes an HVAC upgrade (nearly always an air-source heat pump), attic insulation and air sealing, LEDs, water heater blankets, and programmable thermostats. A recent evaluation of the Ouachita program found upgrades average $5,364 per home across 198 homes, and that heat pumps, air sealing, duct sealing, and attic insulation were each installed in 75% or more of participant homes.[12]

Most PAYS administrators are electric-only utilities, and typically target high-consumption homes, often responding to complaints of high bills. As a result, most participants have electric space-heating equipment and often have electric water heaters. This approach to program delivery ensures participants have significant savings opportunity, which reduces the need for copays. In Ameren Missouri's case, this targeted approach to program delivery would also improve the benefit-cost ratio. (Most existing PAYS programs are not evaluated for cost-effectiveness since they are offered through co-ops not subject to efficiency portfolio regulations.)

Integration with Other Rebates and Incentives

According to the PAYS implementer, the PAYS model recommends allowing participants to also use any existing rebates to reduce the upfront cost of the investment, though it is not required. The implementer reported that most PAYS offerings include few, if any, demand-side management programs

[12] OptiMiser, LLC. *Ouachita HELP PAYS Residential Energy Efficiency Program Evaluation.* February 2018.

other than PAYS. However, Roanoke program offers up to $500 for minor repairs that facilitate installation of energy-efficiency improvements, such as patching a roof or venting a clothes dryer. The Ouachita program allows participants to purchase dual-fuel HVAC upgrades, but requires customers install at least a 95 AFUE furnace to qualify for the gas utility rebates.

Ameren Missouri offers seven energy-efficiency programs for residential customers that provide a wide array of discounts and rebates on energy saving measures, and information and education about saving energy. The Ameren Missouri Heating and Cooling Program, which offers rebates for installation of high-efficiency HVAC equipment, would be complementary to a PAYS program. The rebates would reduce the upfront cost, making the program more likely to be able to fully fund these types of measures.[13]

Default and Nonpayment

Utility financing and tariff programs do not typically have default rates that can be compared to consumer lending products. Lenders simply end their relationship with a customer if they fail to repay their loan. Utilities have more complex relationships with customers, and typically dedicate more time to collections processes than a lender will. Where a lender may designate a loan to be in default after 3 - 6 months, a utility may continue to work with a customer that makes at least some payments for years. In the case of a financing payment (that is not approved as a tariff), the utility may be prohibited from shutting off service in the case of nonpayment. In addition, Ameren Missouri staff reported that any partial payments from customers would be required to be applied to the utility service first, and then the tariff charge.

Nonpayment rates for residential energy efficiency financing programs are generally low, and Cadmus found PAYS and on-bill nonpayment rates to be below 2% in other programs. In other PAYS research, Cadmus found that the Roanoke PAYS program had an effective default rate of 0.75%, and a representative reported they still expect to collect funds from some of those customers. The MACED How$mart KY program reported a nonpayment rate of 1.9%. Although not a PAYS program, the Illinois EELP had a nonpayment rate of 0.16% in its first three years.[14] Because underwriting and security, project details, and demographics of participants vary across programs, it is not clear what features of each program are driving the low default rate.

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[13] For those projects that used both a rebate and PAYS, evaluators would need to determine the appropriate allocation of the project net savings across the two programs, so that savings are not double-counted. Assuming projects are early replacement, the majority of the savings is likely to be allocated to PAYS, which could impact the Heating and Cooling program's cost-effectiveness. However, the maximum participation level modeled in this study (750 participants) would not represent a significant percentage of total Heating and Cooling program participation.

[14] Cadmus. Illinois On-Bill Financing Program Process Evaluation. Prepared for the Illinois Energy Association. June 2015. Available online: https://www.icc.illinois.gov/docket/files.aspx?no=11-0689&docId=230270

[redacted]

Administrative Costs Summary

Based on the findings described above, Cadmus estimated administrative costs for Ameren Missouri to offer a PAYS program. We incorporated only costs that could be recovered through the energy-efficiency portfolio budget into the cost-effectiveness analysis. Start-up costs, including staff time to develop the program and the cost for information technology upgrades, were not included in the cost-effectiveness analysis. Ameren Missouri would need to recover these costs through their regular rate cases.

The cost-effectiveness model discounts all costs and benefits over time, including the interest charges, back to the present value equivalent. Because the interest rate is equal to the discount rate, the model effectively assumes zero interest costs. However, there is an opportunity cost from carrying the funded amount over the duration of tariff. Cadmus conservatively modeled the opportunity cost as the present value of participant interest, discounted at a rate representing a minimal expected return. We used the U. S. Treasury 10-year bond rate of 2.88% as the proxy and included it as an additional cost in the cost-effectiveness analysis. Table 9 shows the administrative long-term cost assumptions.

Table 9. Program Long-Term Costs

Cost	Value	Source
Interest rate and discount rate (compounding)	[redacted]	Reported by Ameren Missouri staff
Discount rate for opportunity cost (compounding, applied to interest payments only)	2.88%	Assumed, based on the rate for the 10-year U.S. Treasury bond
Nonpayment rate and Loss reserve fee (one-time fee)	5.00%	Assumed

Cadmus compiled fixed program cost estimates from Ameren Missouri staff (based on their experience implementing residential energy efficiency programs, and planning an on-bill financing program), and Cadmus' other PAYS research. Table 10 presents fixed cost estimates. The implementation cost in this table applies only to scenarios where annual participation is less than 60 per year. At that level of participation, a variable (per-participant) fee may be insufficient to cover the implementer's costs.

Table 10. Program Fixed Costs

Cost	Value	Source
PAYS program design and licensing	[redacted]	[redacted]
Utility Administration (program staff)	[redacted]	[redacted]
Implementation (for annual participation less than 60)	[redacted]	[redacted]
Marketing and outreach	[redacted]	[redacted]
Evaluation	[redacted]	[redacted]

Table 11 presents variable costs. This table includes the per-participant cost of implementation that is applied in scenarios where annual participation is at least 60, or more.

[redacted]

Table 11. Program Variable Costs

Cost	Value	Source
Implementation (for annual participation of 60 or more)	[redacted]	[redacted]
Servicing (ten-year term)	[redacted]	[redacted]
Origination	[redacted]	[redacted]
Call Center	[redacted]	[redacted]

Measure-Level Financial Analysis

To determine to what measures Ameren Missouri could offer through PAYS, Cadmus collected expected savings and costs estimates for common energy efficiency measures, and then calculated the total amount of funding the utility could provide based on the PAYS requirements. The *Methodology* section of this report provides details on Cadmus' data sources and our approach to collecting and analyzing this data.[15]

Cadmus created a database of estimated costs and savings and other inputs for each of the target measures assuming different baseline scenarios. Table 12 shows the target measures, and the associated baseline, replacement scenarios, savings and cost. Measure savings are highly sensitive to the replacement scenario. Measures installed in place of working, older equipment (the ER scenario) achieve much higher savings than the same equipment installed on an ROF basis.

Table 12. Per-Unit Measure Costs and Savings

Item #	Measure	Efficiency Level	Baseline Equipment	Scenario	Capacity/ Size	Per-Unit kWh Savings	Full Measure Cost
1	Central Air Conditioner	14 SEER	Not specified	ER	3 ton	1,633	$2,856
2				ROF		323	$2,856
3		15 SEER	Not specified	ER	3 ton	1,923	$2,964
4				ROF		342	$2,964
5		16+ SEER	Not specified	ER	3 ton	1,922	$3,077
6				ROF		368	$3,077
7	Clothes Dryer	ENERGY STAR	Federal standard	ROF	Not specified	160	$495
8	Clothes Washer	CEE Tier 1	Federal standard	ROF	Not specified	99	$797
9		CEE Tier 2				134	$1,069
10		CEE Tier 3				152	$1,129
11	Refrigerator	ENERGY STAR	N/A	N/A	Not specified	807	$792
12	Thermostat (Learning)	N/A	Not specified	N/A	N/A	462	$249

[15] The measure-level financial analysis does not assess whether the measures selected are cost-effective. Cost-effectiveness tests, as modeled in this study, evaluate whether a measure or group of measures provide enough benefit in terms of avoided energy costs (avoided costs the utility would incur to provide electricity) over the measure EUL to offset the incremental cost incurred to purchase and install the higher-efficiency option. The measure-level financial analysis, on the other hand, is a comparison of the customer bill savings to the full upfront cost for a measure.

[redacted]

Item #	Measure	Efficiency Level	Baseline Equipment	Scenario	Capacity/ Size	Per-Unit kWh Savings	Full Measure Cost
13	Heat Pump Water Heater	Efficient products	Not specified	N/A	Not specified	2,531	$1,575
14	Air Sealing	N/A	N/A	N/A	N/A	740	$389
17	Window Replacement	N/A	N/A	N/A	24 sq. ft.	106	$6,229
18	Ceiling Insulation	R-30	R5	N/A	1,783 sq. ft.	820	$945
19		R-38				856	$1,159
20		R-49				874	$1,373
21	Wall Insulation	R-11	R5	ROF	990 sq. ft.	971	$1,613
22	LEDs (4 Bulbs)	10.1 Watt	43 Watt	ROF	N/A	93	$20
23	Air-Source Heat Pump	15 SEER	Electric Resistance Furnace: HVAC	ER	3 ton	10,749	$7,632
24			Electric Resistance with ASHP: HVAC	ER	3 ton	4,221	$7,632
26				ROF		820	$7,632
27		16 SEER	Electric Resistance Furnace: HVAC	ER	3 ton	12,449	$9,360
28			Electric Resistance with ASHP: HVAC	ER	3 ton t	5,406	$9,360
30				ROF		1,587	$9,360
32	Ductless Heat Pump	Not specified	Electric Resistance ER: HVAC	ER	3 ton	6,204	$6,188
33				ROF		5,438	$6,188
35	Ground-Source Heat Pump	23 EER	Assumed CAC	ER	3 ton	7,953	$11,871
36				ROF		3,646	$11,871
37	ECM Auto Fan	Not AHRI	90%	ER	Not specified	807	$293
38				ROF		793	$388
39	Whole-Home Package	See individual measures	See individual measures	ROF	See individual measures	2,971	$9,449
40				ER		12,900	$9,449
41	Ouachita Package	Not specified	Not specified	ER	Not specified	3,593	$5,773

Using the measure specific costs and savings database, Cadmus calculated the percentage funding of an individual measure's cost using the maximum tariff (80% of the average monthly savings) allowed under PAYS requirements. We calculated the funding amount as the present value of the sum of the maximum tariff amount paid monthly over 80% of the measure EUL, discounted at a 5.95% interest rate. The measure cost included a 5% nonpayment loss reserve fee, and was net of available Ameren Missouri rebates.[16] Ameren Missouri offers rebates ranging from $50 to $900 for ASHPs, smart thermostats, heat pump water heaters, ground-source heat pumps, central air conditioners, and ECM auto fans.

We found that the maximum tariff did not allow for the full measure cost to be funded in most cases. For 17 of the 34 measures and three packages we analyzed, less than 50% of the measure cost could be funded through a PAYS program. For these measures, the average copayment (portion of the upfront cost not covered by PAYS funding) required was $3,651. The estimated savings, costs, and potential

[16] See the ***Error! Reference source not found.*** section for an explanation of the interest rate and the loss reserve fee.

[redacted]

PAYS funding for these measures is shown in Table 13 (ordered from lowest percentage of cost funded to highest).

Most measures that achieved less than 50% funding assumed an ROF scenario, except for the central air conditioner and two ASHP scenarios. This group also included all the home appliances (refrigerators and clothes washers). Notably, this group also included the Ouachita Package. The Ouachita package is an unspecified package of upgrades based on the average cost per project an average savings from a PAYS program offered by the Ouachita Electric Cooperative in Ouachita, Arkansas. A post-retrofit billing analysis found that of 65 projects in all-electric homes, average cost was $5,773, and average savings were 3,593 kWh.[17] Most projects included an ASHP and weatherization, similar to the whole-home package used in this study. Assuming an EUL of 17 years, an Ameren Missouri PAYS program was nevertheless able to finance only 43% of the measure cost at that level of savings, while the Ouachita program had a co-pay of only about $1,000 on average. The different funding amounts in the two territories may be in part due to a difference in electric retail rates between the Ouachita Electric Cooperative and Ameren Missouri, and to differences in the climate of the two territories. However, it may also reflect a difference between the savings and costs in the TRM sources, which represent an average Ameren Missouri customer, and the savings and costs for a typical low-income customer.

[17] OptiMiser, LLC. *Ouachita HELP PAYS Residential Energy Efficiency Program Evaluation.* February 2018.

[redacted]

Table 13. Measures that Allow for Less than 50% PAYS Funding

Item #	Measure	Baseline Equip	Scenario	Ameren Missouri Rebate	Funded Cost[a]	Max Monthly Tariff	PAYS Funding	PAYS Funding (% of funded cost)	Customer Copay
17	Window Replacement	N/A	N/A	$0	$6,540	$1	$86	1.0%	$6,455
8	Clothes Washer	Federal standard	ROF	$0	$837	$1	$63	8%	$773
9	Clothes Washer	Federal standard	ROF	$0	$1,123	$1	$86	8%	$1,036
10	Clothes Washer	Federal standard	ROF	$0	$1,186	$1	$97	8%	$1,088
26	Air-Source Heat Pump	Electric Resistance with ASHP: HVAC	ROF	$500	$7,489	$5	$622	8%	$6,867
2	Central Air Conditioner	Not specified	ROF	$300	$2,684	$2	$245	9%	$2,439
4	Central Air Conditioner	Not specified	ROF	$400	$2,692	$2	$259	10%	$2,433
6	Central Air Conditioner	Not specified	ROF	$500	$2,706	$2	$279	10%	$2,427
30	Air-Source Heat Pump	Electric Resistance with ASHP: HVAC	ROF	$650	$9,146	$10	$1,203	13%	$7,942
7	Clothes Dryer	Federal standard	ROF	$0	$520	$1	$103	20%	$417
36	Ground Source Heat Pump	Assumed CAC	ROF	$800	$11,625	$24	$2,765	24%	$8,860
39	Whole-Home Package	See individual measures	ROF	$950	$8,924	$19	$2,232	25%	$6,692
24	Air Source Heat Pump	Electric Resistance with ASHP: HVAC	ER	$500	$7,489	$28	$3,201	43%	$4,288
41	Ouachita Package	Not specified		$0	$6,062	$24	$2,626	43%	$3,435
28	Air-Source Heat Pump	Electric Resistance with ASHP: HVAC	ER	$650	$9,146	$35	$4,099	45%	$5,046
1	Central Air Conditioner	Not specified	ER	$300	$2,684	$11	$1,238	46%	$1,446
11	Refrigerator	N/A	N/A	$0	$832	$5	$403	48%	$429

[a]Funded cost is the full measure cost, less any available rebate, plus the 5% nonpayment loss fee, which is included in the funded amount.

[redacted]

Table 14 shows those measures where our analysis found that the maximum PAYS tariff covered most or all of the full upfront cost, including the loss reserve fee. In some cases, the maximum tariff recovered more than the full cost of the measure, and therefore could be reduced or collected over a slightly shorter duration. This group of measures includes building shell improvements, whole-home packages and both replace-on-failure and early replacement scenarios. For the most expensive measures, even the partial amount of funding provided by PAYS covers a significant portion of the upfront cost and represents an amount of money that might commonly be financed.

Table 14. Measures that Allow Majority or Full Funding with Maximum PAYS Tariff

Item #	Measure	Baseline Equipment	Scenario	Ameren Missouri Rebate	Funded Cost[a]	Max Monthly Tariff	PAYS Funding	PAYS Funding (% of funded cost)	Customer Copay
35	Ground-Source Heat Pump	Assumed CAC	ER	$800	$11,625	$52	$6,030	52%	$5,594
5	Central Air Conditioner	Not specified	ER	$500	$2,706	$13	$1,457	54%	$1,249
3	Central Air Conditioner	Not specified	ER	$400	$2,692	$13	$1,458	54%	$1,234
20	Ceiling Insulation	R5	N/A	$200	$1,232	$6	$801	65%	$431
21	Wall Insulation	R5	ROF	$345	$1,332	$6	$890	67%	$442
33	Ductless Heat Pump	Electric Resistance ER: HVAC	ROF	$500	$5,972	$36	$4,123	69%	$1,849
19	Ceiling Insulation	R5	N/A	$200	$1,007	$6	$785	78%	$222
32	Ductless Heat Pump	Electric Resistance ER: HVAC	ER	$500	$5,972	$41	$4,704	79%	$1,268
18	Ceiling Insulation	R5	N/A	$200	$782	$5	$752	96%	$30
27	Air-Source Heat Pump	Electric Resistance Furnace: HVAC	ER	$900	$8,883	$81	$9,439	Over 100%	$0
12	Thermostat (Learning)	Not specified	N/A	$50	$209	$3	$230	Over 100%	$0
40	Whole-Home Package	See individual measures	ER	$1,250	$8,609	$84	$9,761	Over 100%	$0
23	Air Source Heat Pump	Electric Resistance Furnace: HVAC	ER	$800	$7,174	$70	$8,150	Over 100%	$0

[a]Funded Cost is the full measure cost, less any available rebate, plus the 5% nonpayment loss fee, which is included in the funded amount.

For some early replacement measures, the maximum PAYS tariff recovered far more than the total upfront cost. For these measures, Cadmus assessed a tariff based on a duration of 10 years (in all cases,

shorter than 80% of the measure EUL). We selected the 10-year duration to reduce the total interest paid by the participant, while still allowing for a low monthly tariff charge. The four measures or packages where a 10-year tariff duration was possible are shown in Table 15, with additional information on the full measure cost, rebate, maximum monthly tariff (80% of monthly savings), and percentage of total cost funded. No co-payment is needed for these measures.

Table 15. Measures with 10-Year Funding Potential

Item #	Measure	Baseline Equipment	Scenario	Ameren Missouri Rebate	Funded Cost[a]	Adjusted Monthly Tariff	PAYS Funding	PAYS Funding (% of funded cost)	Customer Copay
13	Heat Pump Water Heater	Not specified	N/A	$500	$1,129	$13	$1,129	100%	$0
38	ECM Auto Fan	90%	ROF	$100	$302	$3	$302	100%	$0
14	Air Sealing	N/A	N/A	$200	$198	$2	$198	100%	$0
37	ECM Auto Fan	90%	ER	$100	$203	$2	$203	100%	$0

[a]Funded Cost is the full measure cost, less any available rebate, plus the 5% nonpayment loss fee, which is included in the funded amount.

Program Cost-Effectiveness Analysis

Cadmus tested the cost-effectiveness of a PAYS program by applying the TRC test to three program scenarios that incorporated one or more of three measures expected to be commonly installed through PAYS: an ASHP replacing a furnace and air conditioner, a whole-home package of upgrades, and an ASHP replacing an ASHP. In all cases, we assumed participant homes used electric heat, and the baseline heating and cooling equipment was working when it was replaced (i.e. early replacement).

The first scenario assumed a single-measure program allowing only an ASHP replacing a furnace and air conditioner. The second scenario again assumed a single measure program, allowing only the whole-home upgrade package. In the third program scenario, we assumed a program that included all three measures. (A single measure program based on the ASHP replacing ASHP measure is not cost-effective at any level of participation.)

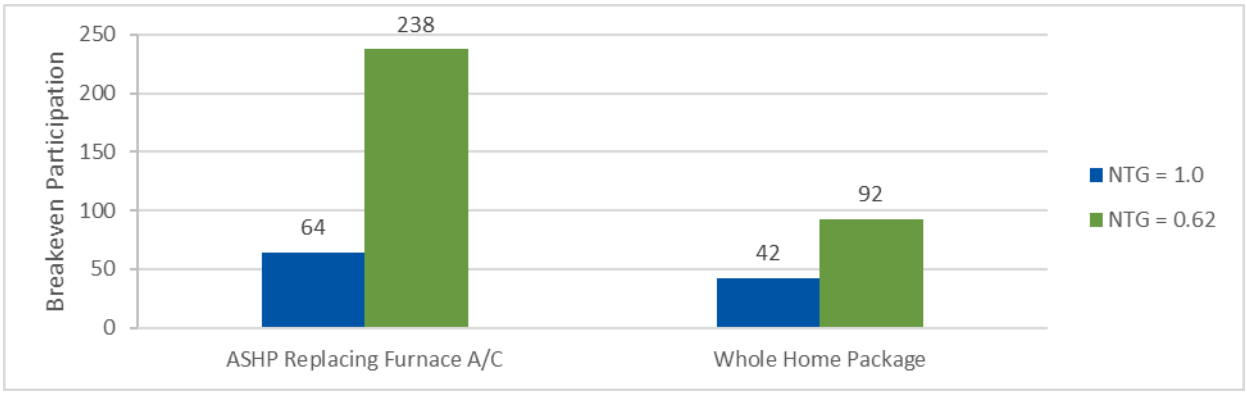
For each program scenario, we conducted a breakeven analysis to determine what level of participation was necessary for the program to have a benefit/cost ratio of 1.0. We also tested each scenario across a range of participation levels to illustrate sensitivity. Finally, we conducted all analyses first assuming an NTG of 1.00, and then assuming an NTG ratio of 0.62. (Scenarios are summarized in Table 7, above. See the *Methodology* section for more detail on each measure and the testing procedure.)

Single-Measure Program Cost-Effectiveness

Figure 2 shows the breakeven quantities for scenarios 1 and 2, the single-measure participation scenarios.

[redacted]

Figure 2. Scenario 1 and Scenario 2 Breakeven Participation



Combined-Measure Program Cost-Effectiveness

For the combined program scenario, Cadmus assumed a measure distribution of 45% ASHPs replacing furnace/air conditioners, 45% standard whole-home package, and 10% ASHPs replacing ASHPs. The breakeven participation level for this program scenario is 62 participants assuming an NTG ratio of 1.00, and 215 participants assuming an NTG ratio of 0.62.

Cadmus also tested cost-effectiveness at program participation levels of 50, 250, and 750 to assess the sensitivity of cost-effectiveness to different levels of participation, as shown in Figure 3. As evident by the breakeven participation, the program is not cost-effective for either NTG assumption at the 50 participant levels. The 250 and 750 participant levels are cost-effective for both NTG assumptions. However, sensitivity to participation is low. Increasing participation by 700% (from 50 participants to 750 participants) increased the benefit-cost ratio by only 35% (from benefits being 95% of costs to benefits being 129% of costs).

Figure 3. Scenario 3 TRC Test Results at Different Participation Levels

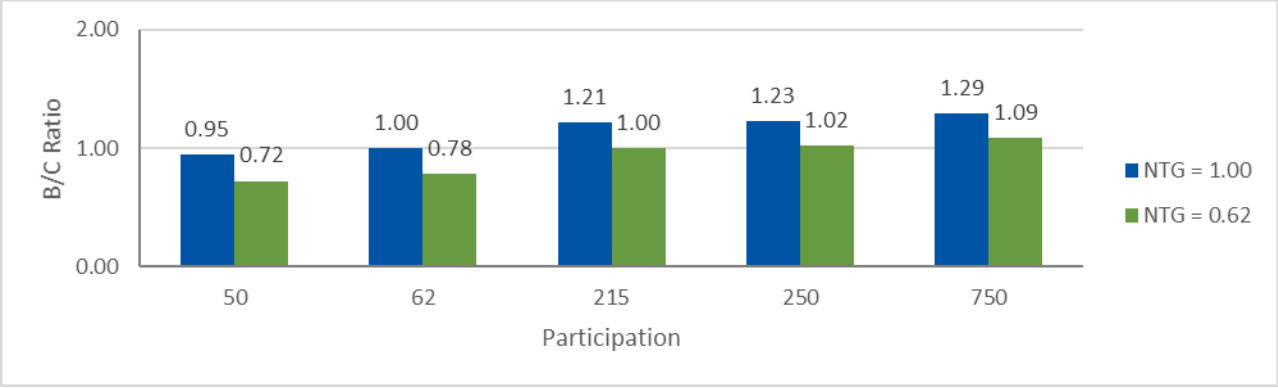


Table 16 shows detailed TRC test results for all three measures, individual and for the combined measure program, for both gross and net results.

[redacted]

Table 16. Detailed TRC Test Results

Participation	NTG = 1.00			NTG = 0.62		
	B/C Ratio	Benefits	Costs	B/C Ratio	Benefits	Costs
Scenario 1: ASHPs Replacing Furnace and Air Conditioners						
50	0.92	$582,028	$632,360	0.70	$360,857	$515,031
64	1.00	$744,921	$745,464	0.78	$461,851	$595,298
238	1.22	$2,764,711	$2,271,892	1.00	$1,714,121	$1,714,565
250	1.22	$2,910,140	$2,381,798	1.01	$1,804,287	$1,795,155
750	1.29	$8,730,420	$6,780,394	1.08	$5,412,860	$5,020,464
Scenario 2: Whole-Home Packages						
42	1.00	$593,576	$593,717	0.76	$368,017	$486,086
50	1.07	$708,144	$661,506	0.82	$439,049	$533,102
92	1.25	$1,309,090	$1,049,515	1.00	$811,636	$812,144
250	1.40	$3,540,719	$2,527,531	1.16	$2,195,246	$1,885,509
750	1.47	$10,622,157	$7,217,593	1.24	$6,585,737	$5,291,527
Scenario 3: Combined Measures						
50	0.95	$611,777	$647,300	0.72	$379,302	$524,294
62	1.00	$749,943	$746,547	0.78	$464,965	$593,983
215	1.21	$2,601,178	$2,142,866	1.00	$1,612,730	$1,612,619
250	1.23	$3,025,575	$2,456,865	1.02	$1,875,856	$1,841,696
750	1.29	$9,060,070	$7,005,779	1.09	$5,617,243	$5,160,203

Potential Market

Cadmus reviewed the current financing options available to Ameren Missouri customers, and demographic information about the service territory, to determine whether a PAYS program, as modeled in this study, would be necessary or appropriate to increase uptake of energy efficiency measures by Ameren Missouri residential customers.

Gap Analysis

Regardless of whether PAYS could be implemented cost-effectively, it is equally important that the program provide a necessary service that is not already provided by another program or the private sector. Cadmus reviewed available financing options in Ameren Missouri territory to identify whether there is a market need, and whether PAYS is the optimal design to meet that need.

Missourians have numerous private sector financing options. According to the Missouri Division of Finance, Missouri "ranks third in the nation in the number of state-chartered banks and fifth in the number of total banks with 253."[18] In addition to these traditional lenders, credit cards, contractor and

[18] Missouri Division of Finance website. Accessed online April 30, 2018: https://finance.mo.gov/banks/

manufacturer financing options are common means to finance an energy efficiency upgrade and are available through the state.

In Ameren Missouri territory, there are also three active energy efficiency financing programs – all property assessed clean energy (PACE) programs. PACE programs use a tax lien to secure financing for a property, and do not rely on the borrower's credit score. In general, any property with available equity could be eligible for PACE financing. Because its tied to the property, the financing can be extended over a long term, similar to a mortgage. Long financing terms result in high overall interest charges, but a much lower monthly payment. In addition, similar to the PAYS tariff, the PACE tax lien as a tax lien can be transferred to a new owner if the original borrower decides to sell. The lien must be disclosed at time of sale. PACE has been authorized by the state of Missouri, but to have an active program, cities or counties must decide to participate. Cities and counties can have multiple PACE programs; in Missouri, the MCED and Mo-ESP programs are both available in some parts of St. Louis County. Table 17 describes the three PACE programs available.

Table 17. Residential PACE Programs Active in Missouri

Program	Area	Terms
Missouri Clean Energy District/ HERO PACE (MCED)	Several municipalities in several counties around the state, including St. Louis County	Interest rates expected to be 6.5-6.75% plus fees; terms up to 20 years
Set the PACE St. Louis	City of St. Louis	Not published
Missouri Energy Savings Program (Mo-ESP)	St. Louis County	Not published

Cadmus compared key features across three common home upgrade financing mechanisms, two energy-efficiency program financing models, and PAYS, and then assessed each product's suitability to various market segments. Table 18 shows each product included in the analysis, and the specific representative example used. The analysis shown in the table is based on the actual features of the representative product in each product category, where details were available. In cases where the specific feature was not published, Cadmus based our assessment on typical features for that product type.

Table 18. Financing Products Considered in Financing Gap Analysis

Product type	Reference Example
Credit Card	**1 -** VISA Platinum Credit Card from Health Care Family Credit Union (HCFCU) (Richmond Heights, MO) **2 -** Bank of America Cash Rewards Card
Unsecured Personal Loan	United Credit Union Unsecured Loan (Columbia, MO)
Home Equity Line of Credit (HELOC)	Health Care Family Credit Union Home Equity Line of Credit (Richmond Heights, MO)
PACE	Missouri Clean Energy District/HERO PACE (multiple locations)
On-bill Financing	Illinois EELP (Illinois IOU territory)
PAYS	Ameren Missouri PAYS (as modeled in this study)

This section present summary results of the analysis below. Table 19 shows the summary results of the analysis of each product's suitability to a typical home energy improvement project (assumed to cost between $1,000 and $10,000) based on key features. Detailed analysis findings are provided in *Appendix A*.

Table 19. Summary Results of Feature Comparison

Feature	Credit Card	Unsecured Personal Loan	HELOC	PACE	On-bill Financing	PAYS
Overall Cost	Poor	Poor-Good	Good.	Okay	Excellent	Good
Monthly Affordability	Good	Poor	Good	Good	Good	Excellent
Available Loan Amounts	Okay.	Good.	Okay.	Good.	Excellent.	Poor-Okay.
Project Eligibility	Excellent.	Excellent.	Excellent.	Good.	Okay.	
Ease of Use	Excellent	Okay	Poor	Good	Okay	Okay-Good

The lowest-cost option is always to pay cash, but if financing is necessary, then the products that offer the best value over the life of the loan have the lowest interest rates and low or no fees. Term can also affect total cost, since longer terms result in larger amounts of interest paid. On-bill financing, with low rates, no fees, and short to moderate terms based on the participant's need, offers the best value.

Monthly affordability does not necessarily correspond with overall cost. The loan size and term length are the key drivers of low monthly payments. PAYS, which is designed for low-income participants that may have limited cash flow, ensures that the installed project will immediately provide a positive cash flow for the participant. However, most other financing products offer reasonable monthly payments.

This analysis assumes that the typical borrower needs between $1,000 and $10,000 for an energy-related home improvement project, and also assumes that borrowers prefer broad freedom to choose whatever measure they like. Some products have a high minimum amount, such as HELOCs and possibly PACE, and so are not well suited for small projects. Other products may not provide enough financing, such as credit cards for credit-stressed borrowers. PAYS severely limits the savings to cost ratio of eligible products, and provides limited funding for measures that do not provide high savings relative to total measure cost. As a result, this option is not well suited to the typical borrower. On-bill financing also severely restricts project eligibility to only those measures that the utility selects based on high benefit-cost ratios. Other financing options are generally well suited to most projects, in terms of amount of financing available and requirements for measures installed.

Ease of use is a critically important feature for financing in $1,000 to $10,000 range, which explains why credit card financing is the most commonly used of the products considered in this analysis.[19] Especially for wealthier borrowers, the relative costs of different products may be too low too matter. Credit cards are not only as fast as cash, utilization relies on a process that is familiar to nearly all borrowers. Other products may require different amounts of time and effort, but uninformed customers may be unable to make an informed choice if they are not sure what they would be required to do, or how long each process would take. PAYS requires several steps and limits choices, but does provide a turn-key process with an emphasis on information, and ample customer support.

Table 20 shows the general accessibility of each product, as well as accessibility to specific market segments: borrowers with good credit, credit-stressed borrowers (assumed to have a credit score below 660), and renters. Accessibility is a subjective judgment based on the minimum requirements and the relative cost as borrower credit or available equity, loan amount, or other circumstances, change. Our analysis also considers geographic availability, which is particularly limited for PACE. Because the on-bill program does not exist in Missouri, and the Ameren Missouri PAYS program is hypothetical, we do not consider geographic availability for those program types.

Table 20. Summary Results of Accessibility Comparison

Market Segment	Credit Card	Unsecured Personal Loan	HELOC	PACE	On-bill Financing	PAYS
General Eligibility	Good.	Okay.	Poor.	Okay-Good.	Good.	Good.
Customers with Good Credit	Excellent.	Good.	Okay.	Okay.	Good.	Good.
Credit-stressed Customers	Okay-Good.	Okay.	Poor.	Okay-Good.	Okay.	Excellent.
Renters	Okay.	Okay.	Poor.	Poor.	Poor.	Excellent.

Most financing products evaluated in this study are an okay or good option for most people. HELOCs, which are restricted to those with both a decent credit score and available home equity, are generally least accessible. Customer with good credit obviously have the most financing options available. For these customers, a credit card is likely the preferred choice, given its extreme flexibility and reasonable cost. For credit-stressed borrowers, HELOCs may not be accessible due to credit score, and PACE may

[19] In 2017, Cadmus conducted a survey of homeowners in a western state. Results indicated that for home improvement projects over $1,000 in the past year, 51% paid cash or cash equivalent, 29% used a credit card with intent to repay over time, 9% used secured financing such as a HELOC, 5% used contractor financing, 4% used a personal loan, 3% used manufacturer financing, and 1% used insurance reimbursements or some other method. N=476. Study is not publicly available.

not be accessible to due to geographic limits, a borrower's recent bankruptcy, or late mortgage or property tax payment. PAYS is the best option for this group. For renters, PACE and PAYS may be the only realistic options. While renters are free to use credit cards and personal loans, they have no motivation to make improvements to property they don't own and will likely not live in long term. Only PAYS helps address the fact that a renter is receiving the benefit from the savings, while the landlord owns the property and improvements, and is usually responsible for making the investment.

Ameren Missouri Demographics

Cadmus compiled demographic information on key market segments discussed in this study from Ameren Missouri's customer database, except where noted. Key market segments included all-electric homes, all electric homes that do not have high-efficiency heat pumps, low-income customers, home size, and renters.

Table 21. Key Demographics

Metric	Number of Customers	Percent of Total Customers
Number of residential customers	1,055,000	100%
Heating Fuel		
Homes with electric heat	335,833	32%
Homes with electric heat, excluding high-efficiency heat pumps[a]	326,950	31%
Income		
Annual income below $50,000[b]	559,150	53%
Number of customers receiving low-income assistance	35,212	3%
Home Size in Square Feet		
Up to 1,000	222,146	21%
1,001 to 1,500	303,967	29%
1,501 to 2000	210,049	20%
2,001 to 2500	132,827	13%
2,501 to 3000	185,680	18%
Homeownership[c]		
Homeowners	717,400	68%
Renters	337,600	32%

[a]Calculated as the number of homes with electric heat minus the number of heat pump rebate participants
[b]Source: Residential survey conducted for the Ameren Missouri Lighting Program PY17 Evaluation. N=160
[c]Source: Nonparticipant survey conducted for the Ameren Missouri Residential Portfolio PY17 Evaluation. N=2,410.

Cost-effectiveness tests showed that assuming the average costs and savings achieved by rebate participants, a PAYS program must have a minimum of 62 participants. The ratio of benefits to costs rises slowly as participation increases, so that if 38% of the measure savings are is allocated to free ridership or to a rebate program, the PAYS program is not cost-effective until it reaches 215 participants. In addition, the financing market gap analysis shows that PAYS is not likely to be well-suited to the general market, and that it should be targeted to low-income customers and renters to optimize its

success. As shown in Table 23, over 35,000 Ameren Missouri customers received low-income assistance in 2017. Less than 1% of these customers would need to participate in PAYS to achieve 215 participants. In addition, according to a residential survey conducted for the Ameren Missouri Lighting Program evaluation for 2017, over 50% of Ameren Missouri customers have incomes below $50,000, and may be considered low income. Thirty-two percent of Ameren Missouri customers are renters, and 31% live in homes with electric heat from equipment that is not a high-efficiency heat pump.

The cost-effectiveness results relied on savings estimates from the Ameren Missouri TRM. For full measure cost, Cadmus relied primarily on the Missouri TRM (draft), which in turn sourced information from the Ameren Missouri TRM. In general, these values represent the average Ameren Missouri rebate customer. Utility energy efficiency program participants tend to be wealthier and better educated than the general population, and to live in larger homes. The typical rebate participant does not represent the low-income or renter sub-sectors of Ameren Missouri's customer base. Both the savings and costs for low-income or renter participants could be lower than the estimates provided in the TRM, which could have either a positive or negative impact on the program cost-effectiveness.

Conclusions

Ameren Missouri must be able to offer risk mitigation to potential capital providers in order to implement any kind of on-bill financing program, regardless of the program design or target market. Nearly all on-bill programs that Cadmus reviewed for this study or other PAYS studies used multiple forms of credit enhancements to bring down the cost of third-party capital and protect the utility against having to absorb the cost of participant nonpayment. Potential partners informed Ameren Missouri that a program with an interest rate of more than 6% would not be competitive with the private sector products already available. This rate should be achievable for Ameren Missouri, if the utility can provide at least one substantial credit enhancement such as a loan loss reserve. Cadmus found the average interest rate for on-bill programs to be 5.74%.

Although a tariff on-bill program does have benefits in terms of reduced risk and transferability, a non-tariff program could serve a significant need among low-income homeowners. The tariff provides reassurance to investors by allowing the utility to shut off service for nonpayment of the tariff. It also allows the tariff to transfer to the next resident if the original borrower moves, making a program better able to serve renters. However, other financial risk mitigation strategies, including a loss reserve, can bring down the cost of capital. In addition, in active PAYS programs that do have a tariff, the number of renter participants appears to be a minority of total participation, based on the percentage of multifamily homes. A non-tariff program would still have many features beneficial to low-income or credit-stressed homeowners. Homeowners make up 68% of Ameren Missouri customers.

ASHPs, likely to be most common measure in an Ameren Missouri PAYS program, can generate enough savings for the program to be cost-effective. While some other measures produce greater saving as a percentage of the measure cost, ASHPs are among the measures that generate the most total savings. In addition, they are an expensive piece of equipment that serves a critical function, and likely to require financing for many homeowners. For these reasons, ASHPs are likely to be a high-participation measure in an Ameren Missouri PAYS program. If installed to replace a working electric furnace and air conditioner, this measure can generate enough savings for a PAYS program to be cost effective at around 200 participants, even with additional less cost-effective measures included in the measure mix. In addition, this measure can be supported with installation of other more cost-effective measures, such as heat pump water heaters.

The turnkey design and capped monthly payment make PAYS well suited for low-income customers, and not well suited for the general market. Although there are gaps in the market for financing for mid- and high-income customers, these customers in general have several options and only minor inconveniences from standard financial products. These customers are likely to prefer greater flexibility and convenience than the PAYS program would provide. For low-income customers, especially those with poor credit, the PAYS program could provide a more affordable alternative to available private sector options, both overall and from the perspective of the monthly payment. Where feasible, providing positive cash flow could help alleviate other financial pressures and reduce the utility's risk of nonpayment for service from these customers.

[redacted]

Appendix A. Detailed Financing Gap Analysis

[redacted]

Table 22. Detailed Results of Feature Comparison

Feature	Credit Card	Unsecured Personal Loan	HELOC	PACE	On-bill Financing	PAYS
Overall Cost	**Poor.** Interest rates from 9% APR to 24.5% APR; variable depending on amount borrowed and borrowers credit score.	**Good-Poor.** Starts at 7.5% APR for a credit score of 750 or higher, increasing to 21.5% APR for a credit score of 579 or lower.	**Good.** Fixed rate starts at 5.5% APR, increases with loan-to-value and credit score. Longer term will increase total interest paid.	**Okay.** MCED's forecast rate starts around 6.5%, not including fees. For some projects, interest may be tax deductible.	**Excellent.** Rate is flat [redacted] Program incorporates available rebates.	**Good**[redacted] interest rate, plus a 5% loss reserve fee.
Monthly Affordability	**Good.** Minimum payment of 2.5% of the balance due monthly (VISA Platinum Card).	**Poor.** Standard term is 35 months or less. Shorter terms results in higher monthly payments.	**Good.** Term up to 180 months allows for low monthly payments.	**Good.** Term is EUL of installed measures, up to 20 years.	**Good.** Terms up to 10 years.	**Excellent.** Payments are offset by monthly bill savings, making the investment cash flow positive for the participant.
Available Loan Amounts	**Okay.** Can finance up to card limit. Limits vary widely, and may be $5,000 or less for credit-stressed borrowers.	**Good.** Loan amounts not published, but typically finance from $500 to $15,000.	**Okay.** Minimum loan amount of $10,000; unused portion can be repaid. Can provide significantly more financing than most other options, with the exception of PACE.	**Good.** Varies based on property value and equity, typically very flexible. May have a minimum amount of up to $2,500 (not published.)	**Excellent.** Financing amounts from $500 to $20,000.	**Poor-Okay.** Subject to strict bill savings to cost requirements that protect the participant, but limit projects and amount of funding available.
Project Eligibility	**Excellent.** No restrictions on project.	**Good.** No project restrictions.	**Good.** No project restrictions.	**Good.** Nearly any efficient measure qualifies, includes water conservation measures.	**Okay.** Projects limited to utility-approved measures.	

[redacted]

Ease of Use	**Excellent.** Accepted by most installers. No application or closing paperwork. Transactions almost instant.	**Okay.** Requires an application (available online) and may take several days to receive approval. Borrower must sign closing documents.	**Poor.** Requires an application, and may require a home appraisal. Can take days to weeks to receive approval. Borrower may need to sign closing documents in person (closing process not published).	**Good.** Online application is approved within minutes. Contractor supports the customer to complete online closing documents.	**Okay.** Program requirements are complex. Application is available online but may take several days for approval. Process from application to funding may take from 30 to 60 days.	**Okay-Good.** Program provides a turn-key service, including energy audit, qualified installer, and quality control inspection. Requires significant time and attention from participants, but provides extensive support.

[redacted]

Table 23. Detailed Results of Market Segment Comparison

Market Segment	Credit Card	Unsecured Personal Loan	HELOC	PACE	On-bill Financing	PAYS
Customer Eligibility	**Good.** Available to almost any borrower, even those with poor credit or limited credit history. Costs increase for lower scores or those with no history.	**Okay.** Not limited to homeowners, and available to credit-stressed borrowers. However, costs increase sharply as credit score drops.	**Poor.** Limited to homeowners with available equity in their homes and acceptable credit.	**Okay - Good.** Limited to homeowners with available equity, but does not rely on credit score. Currently available in limited areas, but growing.	**Good.** Generally limited to homeowners, requires a minimum 640 credit score. Credit score does not impact interest rate.	**Excellent.** PAYS relies solely on bill payment history to qualify borrowers, and allows renters to participate (with the landlord's approval).
Accessibility to Customers with Good Credit	**Excellent.** Broadly available, multiple transactions from single application.	**Good.** Broadly available, requires new application for each transaction.	**Okay.** Limited to homeowners with available equity.	**Okay.** Limited to homeowners with available equity, not accepted by all mortgage insurers. Limited area.	**Good.** Limited to homeowners.	**Good.** Not as convenient or flexible as other options available to this segment.
Accessibility to Credit-stressed Customers	**Okay-Good.** Typically, costs more dependent on amount borrowed and delinquency, so may be a reasonable option for those who consistently make payments and pay down balance.	**Okay.** Available to credit-stressed borrowers but adds additional financial stress due to high rates.	**Poor.** Requires a minimum credit score (not published).	**Okay.** Does not rely on credit score, but borrowers with recent bankruptcies, defaults, late mortgage or property tax payments not eligible. Limited area.	**Okay.** Program allows a minimum 640 credit score. Rates do not change based on credit score.	**Excellent.** Credit score is not considered.
Accessibility to Renters	**Okay.** No restriction for homeownership, but no tools to overcome split-incentive.	**Okay.** No restriction for homeownership, but no tools to overcome split-incentive.	**Poor.** Renters are not eligible.	**Poor.** Renters are not eligible. Limited area.	**Poor.** Renters are generally not eligible.	**Excellent.** Renters are eligible and are not exposed to long-term costs.
Outcome When Borrower Moves	Borrower remains responsible for payments.	Borrower remains responsible for payments.	Borrower remains responsible for payments.	Obligation stays with home, payment of outstanding balance may be negotiated during sale.	Borrower remains responsible for payments.	Obligation stays with home, and is paid by new resident, or owner.