VOLUME 5:

DEMAND-SIDE RESOURCE ANALYSIS

KCP&L GREATER MISSOURI OPERATIONS COMPANY (GMO)

INTEGRATED RESOURCE PLAN

4 CSR 240-22.050

CASE NO. EO-2012-0324

APRIL, 2012

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VOLUME 5: DEMAND-SIDE RESOURCE ANALYSIS

PURPOSE: *This rule specifies the principles by which potential demand-side resource options shall be developed and analyzed for cost effectiveness, with the goal of achieving all cost-effective demand-side savings. It also requires the selection of demand-side candidate resource options that are passed on to integrated resource analysis in 4 CSR 240-22.060 and an assessment of their maximum achievable potentials, technical potentials, and realistic achievable potentials*

SECTION 1: POTENTIAL DEMAND-SIDE RESOURCES

(1) The utility shall identify a set of potential demand-side resources from which demand-side candidate resource options will be identified for the purposes of developing the alternative resource plans required by 4 CSR 240-22.060(3). A potential demand-side resource consists of a demand-side program designed to deliver one (1) or more energy efficiency and energy management measures or a demand-side rate. The utility shall select the set of potential demand-side resources and describe and document its selection—

1.1 DESCRIBE AND DOCUMENT SELECTIONS

(A) To provide broad coverage of—

1.1.1 MARKET SEGMENTS COVERAGE

1. Appropriate market segments within each major class;

Market segments are identified in Section 3.2.

1.1.2 DECISION-MAKER COVERAGE

2. All significant decision-makers, including at least those who choose building design features and thermal integrity levels, equipment and

appliance efficiency levels, and utilization levels of the energy-using capital stock; and

GMO staff meets regularly with customer groups, architects, engineers, trade representatives, contractors, distributors, public agency staff and others to discuss opportunities to discuss energy usage issues, review GMO's energy plan, discuss energy efficiency and demand response programs, and illicit feedback and suggestions.

Table 1: List of Group Meetings Held in 2011

2011 Calendar						
JANUARY	Energy Efficiency 4th Grade Pilot Launched	MPower Appreciation	HEI / AWG Seminar	Energy Savings Store		
FEBRUARY	Lankford & Assoc.	Ivanhoe Community Group	Hunt Midwest	Control Service Company		
MARCH	MO Valley Ice Makers - Arctic Glacier	Local and Nationwide Ice Companies Seminar	MoKan Coin Laundry Association	Consumption Auditors	Cresent Electric Supply - Seminar	Introduction to LEED- Customer Seminar
APRIL	NKC Hospital Sustainability Fair	Fike Corp Employee Event	Hallmark Earth Day Event	Department of Energy- Data Center Energy Efficiency Seminar	Green the Core Earth Day Event	Cerner Earth Day Event
	ACCA (Air Conditioning Contractors of America) Trade Show	NKCH Environmental	Science City Earth Day Event	Sprint Employee Earth Day Event	JC Penney Earth Day Event for Employees	
MAY	GSA tenant appreciation event	Building Operator Management Association-BOMA EXPO	Renson House - Lighting Vendors	Ingersoll & Rand - Vendors		
JUNE	H&R Block employee green event	Grubb & Ellis/Penntower tenant appreication event	Department of Energy- Fundamentals of Compressed Air Training			
JULY	Lake Village Sustainable Renovation	Commercial Rebate Seminar				
AUGUST	Shawnee Chamber event	KC International Facilities Mgmt Assoc (KCIFMA)	Department of Energy- Fan System Assessment Training			
SEPTEMBER	S&S Engineers	Performance Plus Homes	Updated: Guenther Mills Keating Architects			
OCTOBER	Swiss Re employee green event	AB May	O'Conner Co	Eastern Jackson County Builders & Developers Association Expo/Trade Show	M.D Management	NARI (North American Remodeling Industry) Association - Pres/Tabletop
	Shaw Supply	Graybar Electric	Department of Energy- Process Heating System Assessment Training			
NOVEMBER	Beacon Hill	KCHBA (Green Build)	Summit Custom Homes - St. Jude Dream Home	Homoly Construction Open House	ASHREA MO Meeting	MFSC Engineers
	Thompson Engineers					
DECEMBER	Hathmore Technologies	Briarcliff Development	LightWild			
Monthly	KCRAR (Kansas City Regional Association of REALTORS)	Lenexa Chamber - Power Lunch	One-on-one customer meetings by each Energy Consultant	Green Impact Zone Project meeting	BOMA Green Committee meeting	NARI (North American Remodeling Industry) Association
	Northland Chamber	Metropolitan Energy Center	One-on-One Trade Ally/Channels Meetings	Kansas City Home Builders Association	Green Build Steering Committee; through KCHBA	ACCA (Air Conditioning Contractors of America) Chapter
Quarterly events	Building Operators Course-BOC training	Missouri South KCHBA Council	Missouri North KCHBA Council	Kansas South KCHBA Council	Trade Ally Seminars	
Annual events - once a year	GSA Sustainability Forum	KCMO Green Solutions Event	Harrah's Employee Event	Cool Homes Contractor Kick-Off Event	KCRAR (KC Regional Association of REALTORS)	

Green = Trade Ally Events
Yellow = Energy Consultant Events

1.1.3 MAJOR END USES COVERAGE

3. All major end uses, including at least the end uses which are to be considered in the utility's load analysis as listed in 4 CSR 240-22.030(4)(A)1.; All significant decision-makers, including at least those who choose building design features and thermal integrity levels, equipment and appliance efficiency levels, and utilization levels of the energy-using capital stock; 22.050 (1) (A) 3.

GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

Supplier will be required to describe, analyze and document the historical use of energy by each major class per unit by end-use pursuant to current Missouri electric utility resource planning rules 4 CSR 240-22.030 (4) (A).

This will require that for each major class, use per unit shall be disaggregated, where information permits, by end-uses that contribute significantly to energy use, or peak demand.

At a minimum, the Supplier will assist GPES in developing information on at least the following loads:

• For the residential sector: lighting, space cooling, space heating, ventilation, water heating, refrigerators, freezers, cooking, clothes washers, clothes dryers, television, personal computers, furnace fans, plug loads, and other uses;

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• For the commercial sector: space heat, space cooling, ventilation, water heat, refrigeration, lighting, office equipment, cooking equipment, and other uses; and
• For the industrial sector: machine drives, space heat, space cooling, ventilation, lighting, process heating, and other uses

Supplier may remove or consolidate a specified end-use load if it determines that it not contributing, and is not likely to contribute in the future, significantly to energy use or peak demand in a major class.

Supplier shall add other potential end-use loads if it determines that and end-use load not currently specified is likely to contribute in the future, significantly to energy use or peak demand in a major class.

Supplier will present the list of end-use load recommendations to GPES before proceeding in developing information. GPES will be allowed two weeks to review the list of end-use load recommended and Supplier will be required accommodate suggested revisions or additions.

Significant Decision Makers were identified in the previous section.

1.2 DESIGNING EFFECTIVE POTENTIAL DEMAND-SIDE PROGRAMS

(B) To fulfill the goal of achieving all cost effective demand-side savings, the utility shall design highly effective potential demand-side programs consistent with subsection (1)(A) that broadly cover the full spectrum of cost-effective end-use measures for all customer market segments; 22.050 (1) (B)

GMO had developed demand-side and energy efficiency programs and had these approved by the Commission in its Comprehensive Energy Plan (CEP). These programs are shown below with detailed descriptions following. The proposed new programs are then listed with detailed descriptions following.

Existing Programs

Affordability – Residential

- Affordable New Homes (Discontinued due to a lack of participation)
- Low Income Weatherization

Energy Efficiency – Residential

- Home Energy Analyzer Program
- Home Performance With Energy Star® Program
- Cool Homes
- Energy Star® New Homes

Energy Efficiency – C&I

- Building Operator Certification
- Business Energy Analyzer

Demand Response - Residential

- Energy Optimizer

Demand Response – C&I

- MPower Rider

<u>Proposed New Programs</u>

Energy Efficiency -Residential

- Appliance Turn-in
- Residential Lighting and Appliance
- Cool Homes

- Home Performance with Energy Star®
- Residential Energy Reports Program
- Multi-Family Rebate Program

Energy Efficiency – C&I

- C&I Prescriptive Rebate Program
- C&I Rebate Program
    - Custom Retrofit
    - New Construction

EXISTING AFFORDABILITY PROGRAMS

Program Name	**Affordable New Homes (Discontinued due to lack of Participation)**
Objective	This voluntary program is intended to provide incentives to builders of qualified new homes for low-income customers for the installation of Energy Star® rated lighting fixtures, Energy Star® rated refrigerators, high-efficiency central cooling equipment, and increased R-factor insulation in the home's attic, floor, or crawlspace.
Target Market and Eligibility	This Program is available to builders of qualified new homes, within the GMO service territory, for persons having household earnings that meet designated income criteria.
Program Description	The Program will be administrated by GMO. Agreements will be established with builders of qualified homes, who will then invoice GMO for incentives and will be paid for installing Energy Star® rated lighting fixtures, an Energy Star® rated refrigerator, high efficiency central cooling equipment (14 SEER or greater), and for upgrading to at least one of the following: R42 attic insulation, R25 floor insulation, or R19 crawlspace insulation. Proof of installation will be required prior to payment of incentives.
Rebates and Incentives	▪ Up to $100 per home for installing Energy Star rated lighting fixtures ▪ Up to $200 per home for installing an Energy Star refrigerator ▪ Up to $800 per home for installing high-efficiency central cooling equipment (14 SEER or greater) ▪ Up to $400 per home for installing the following: R42 attic insulation or R25 floor insulation or R19 crawl space insulation
Channel Partner	
Tariff Approved Date	March 2008

Program Name	**Low-Income Weatherization**
Objective	Weatherization benefits low-income GMO customers by reducing heating and cooling bills by as much as 31% annually and by resolving energy efficiency concerns in their homes before their bills increase. Additionally, the money that customers save on their energy bill can be used for other critical household expenses.
Target Market and Eligibility	This Program is available to any Customer currently receiving service under any generally available residential rate schedule for a minimum of one year prior to completion of an application for weatherization assistance and who also meets the additional Customer eligibility requirements defined in the agreement between the Company and the Social Agency. The Social Agency will select Customers eligible for Low-Income Weatherization using the following criteria: The Customer's household earnings at or below 185% of the current year Federal Poverty Level guidelines or below 60% of the state median income, whichever is higher for the number of persons in the residence, the residence must have energy consumption greater than 3,000 kWh per year, the Customer has received electric service from the Company for a minimum of one year prior to completion of an application, and other eligibility requirements defined in the agreement between the Company and the Social Agency.
Program Description	Qualified lower income customers can get help managing their usage and bills through GMO's Low-Income Weatherization Program. The program works directly with local Community Action Program (CAP) agencies that already provide weatherization services to low-income customers. GMO provides supplemental funds to CAP Agencies to cover the costs of additional cost-effective weatherization measures. Typical services include installing insulation, calking windows, and repairing heating and central cooling systems.
Rebates and Incentives	The cost to the customer is free with the weatherization measures performed on the residence capping at $3,500 per residence.
Channel Partner	City of Kansas City, MO (KCMO), West Central MO Community Action Agency, MO Valley Community Action Agency, Central Missouri Community Action
Tariff Approved Date	March 2008

EXISTING ENERGY EFFICIENCY-RESIDENTIAL

Program Name	**Home Energy Analyzer Program Using** Aclara**® Residential Suite.**
Objective	This is a free, online tool to help residential customers understand how they use energy in their home. It allows customers to see where their energy dollars go by end use, see how they compare to similar houses in their area, and find ways they can improve their home's energy efficiency.
Target Market and Eligibility	This product is for residential customers with Internet access.
Program Description	The online energy information and analysis program allows all residential customers with Internet access to retrieve their billing information and comparisons of their usage on a daily, weekly, monthly or annual basis. This tool will analyze the end use make-up of their home displayed by percentages. It will provide information on ways to save energy by end use through a searchable resource center. This tool also allows the user to analyze why their bill may have changed from one month to another. A home comparison displays an evaluation of the customer's home versus an average similar home via an Energy guide label concept.
Rebates and Incentives	None
Channel Partner	Aclara Software (formerly Nexus)
Tariff Approved Date	October 2008

Program Name	**Home Performance With ENERGY STAR®**
Objective	Home Performance with Energy Star (HPwES) is a program designed for existing homes. This Program may be applied to any home where the current resident is receiving service under any generally available residential rate schedule offered by the Company. All Assessments must be requested by the owner of the home. Program rebates are limited to one rebate per Assessment.
Target Market and Eligibility	HPwES is an innovative program that strives to produce an economically sustainable model that captures significant energy savings by encouraging a whole-house approach to Energy Efficiency improvements in existing homes. The program begins with a whole-house energy assessment performed by trained and Building Performance Institute (BPI) certified contractors. The assessment is then provided to the homeowners to follow through and complete energy improvements to their homes. Quality Assurance is a primary function of this program. HPwES is a statewide approach coordinating efforts between the state sponsor, Missouri Department of Natural Resources' Energy Center (MODNR) and local partners. GMO will collaborate regionally with the Metropolitan Energy Center (MEC) to implement a successful program in the Kansas City area.
Program Description	GMO offers a Home Performance with Energy Star rebate of up to $600 for customers who implement at least one qualifying energy efficient improvement that is recommended by the Home Performance certified contractor or consultant.
Rebates and Incentives	Missouri Department of Natural Resources – Energy Center (MDNR), Metropolitan Energy Center (MEC)
Channel Partner	1/23/08
Tariff Approval Date	April 2008

Program Name	**Cool Homes**
Objective	Improve the operating efficiency of single and multi-family homes with central air cooling systems. Reduce energy consumption for single and multi-family homeowners through the tune-up and early replacement of working inefficient cooling equipment. Achieve market transformation through HVAC contractor training.
Target Market and Eligibility	The target market for the program includes both GMO residential customers who have working inefficient central air conditioners and the HVAC contractors that serve this market. Targeted market customers are identified through the integration of weather data and billing analysis and the use of property tax records.
Program Description	The Cool Homes program is a residential central air-conditioning rebate program designed to help reduce excess energy usage during the peak summer months and cut carbon dioxide emissions through the maintenance and early retirement of inefficient central air conditioning equipment. This program encourages residential customers to have existing cooling systems evaluated and if feasible, brought back to factory specifications (re-commissioned), or replace less efficient, working central cooling systems with high efficiency central cooling systems.
Rebates and Incentives	The Cool Homes program provides contractors incentives to provide recommissioning and quality installation practices and customer rebate incentives offered through participating HVAC contractors to help offset the early replacement equipment costs. Contractor Incentives: GMO pays a $35 incentive to the contractor for the unit testing which is typically 1/3 of the service visit. Contractors will receive $45 upon completion of proper airflow and coolant recharge if the system requires Proctor Engineering will complete the processing for incentives, and will certify the efficiency of the HVAC system. The Program Administrator will pay contractor incentives upon successful completion of program standards. Customer Incentives: GMO customers who use participating Cool Homes HVAC

	contractors to test, repair, and/or replace working A/C or heat pumps with high-efficiency equipment rated at 14 SEER or above may be eligible for a rebate. ($650 : 14/15 SEER or $850 : SEER +16). Rebates are applied, per system, toward the purchase of a high-efficiency A/C or heat pump through a Cool Homes HVAC service contractor. The program Administrator pays HVAC contractors for the customer incentives offered through the program.
Channel Partner	Conservation Services Group (CSG), Proctor Engineering Group (PEG) and GMO service area HVAC contractors
Tariff Approval Date	October 2008

ENERGY EFFICIENCY-C&I

Program Name	**Building Operator Certification (BOC)**
Objective	Building Operator Certification is a market transformation effort to train facility operators in efficient building operations and management (O&M), establish recognition of and value for certified operators, support the adoption of resource-efficient O&M as the standard in building operations, and create a self-sustaining entity for administering and marketing the training. The program is a cost effective way to educate and encourage change leading to reduced energy consumption.
Target Market and Eligibility	This program is targeted to Commercial and Industrial building operator professionals interested in learning techniques to improve the energy efficiency of the facilities they manage. The certification courses funded by this program will be available through MDNR for any building operator employed by a company having at least one Missouri or Kansas commercial property receiving electrical service from GMO. Reimbursements for the successful completion of the certifications are available to any building operator associated with at least one Missouri commercial property receiving electrical service from GMO.
Program Description	BOC is a professional development program for building operators and maintenance staff. Level I training consists of a series of seven courses, 56 hours of instruction total, normally completed in seven months and five projects on energy and resource efficient operation of buildings. Level II training consists of six courses, 49 hours of instruction total, normally completed in six months and three projects. The goal of the program is to achieve measurable energy savings in the operation of buildings by training individuals responsible for day-to-day operations.
Rebates and Incentives	GMO will reimburse the MDNR for the amount paid annually to license the Level 1 and Level 2 curriculums for the GMO area, currently $25,000 per certification class (about 20 students per class). Tuition reimbursements of $575 per certification level will be paid to the sponsor or individual paying the tuition. To receive the reimbursement, qualified Building Operators must complete a reimbursement request and submit it to GMO. The reimbursement form is available by contacting GMO directly.
Channel Partner	Missouri Department of Natural Resources (MDNR)
Tariff Approval Date	March 2008

Business Energy Analyzer Program

A. PURPOSE:

This Program allows customers with access to the Internet to retrieve their billing information, make comparisons of electric usage on a monthly or yearly basis, analyze electric usage on an end use basis, and research energy savings by end use through a searchable resource center. Customers can also compare their bills to analyze changes from one month to another. Business customers can also compare their business to a similar business in terms of average energy usage using the Energy Guide label concept. This Program is offered in accordance with Section 393.1075, RSMo. Supp. 2009 (the Missouri Energy Efficiency Investment Act).

B. AVAILABILITY:

This Program is available to any Customer currently receiving service under GS, SGS, LGS, or LPS rate schedule. Customer participation is limited to fund availability and the Company reserves the right to modify or terminate this Program at any time, subject to Commission approval.

Demand Response-Residential

Program Name	**Energy Optimizer**
Objective	Residential and small commercial Air Conditioning (A/C) cycling program designed to reduce peak system electric demand requirements.
Target Market and Eligibility	All residential, and some small commercial GMO customers with an eligible central a/c system, This program does not include chillers.
Program Description	Optimizer participants receive a free web-programmable thermostat when they sign up for the program. Installation and maintenance of the thermostat is also free to the customer. The thermostat is equipped to receive a radio frequency signal, which allows GMO to cycle the customer's central a/c system during times of peak demand.
Rebates and Incentives	The customer owns the thermostat after three years.
Channel Partner	Honeywell
Tariff Approval Date	October 2008

DEMAND RESPONSE-C&I

Program Name	**MPower**
Objective	A commercial and industrial load curtailment program focused on reducing electrical demand during peak requirements.
Target Market and Eligibility	Current GMO electric customers on a non-residential rate, who are able to provide a minimum seasonal reduction of 25kW.
Program Description	MPower is a commercial and industrial Demand Response program, whereby customers are paid for reducing demand upon GMO request. The program is used by GMO to help manage its peak load.Customers pick the maximum number of events for which they are willing to commit (from one to ten) and payouts increase linearly based on the number of events chosen. The curtailment season runs from June through September.
Rebates and Incentives	Customer compensation shall be defined within each Customer contract and will be based on contract term, Maximum Number of Curtailment Events and the number of actual Curtailment Events per Curtailment Season. Timing of all payments/credits shall be specified in the curtailment contract with each Customer. Payments shall be paid to the Customer in the form of a check or bill credit as specified in the contract. The credits shall be applied before any applicable taxes. All other billing, operational, and related provisions of other applicable rate schedules shall remain in effect. Compensation will include: PROGRAM PARTICIPATION PAYMENT: For each Curtailment Season, Customer shall receive a payment/credit based upon the contract term, the number of consecutive years under contract, and the Maximum Number of Curtailment Events. The Program Participation Payment for a Curtailment Season is equal to the per kilowatt of Curtailable Load rate as defined in the table below multiplied by the Maximum Number of Curtailment Events stated in the Customer's contract.

CONTRACT TERM	# OF CONSECUTIVE YEARS UNDER CONTRACT	$/KW OF CURTAILABLE LOAD
One year	1	$2.50
One year	2	$2.50
One year	3	$3.25
One year	4	$3.25
One year	5	$4.50

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<tr><td>Three years</td><td>1</td><td>$3.25</td></tr>
<tr><td>Three years</td><td>4</td><td>$3.25</td></tr>
<tr><td>Three years</td><td>5</td><td>$4.50</td></tr>
<tr><td>Five years</td><td>Any</td><td>$4.50</td></tr>
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The Program Participation Payment will be divided by the number of months in the Curtailment Season and applied as bill credits equally for each month of the Curtailment Season.
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<tr><td>Channel Partner</td><td>Energy Curtailment Specialists (ECS)</td></tr>
<tr><td>Tariff Approval Date</td><td>October 2008</td></tr>
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PROPOSED NEW PROGRAMS

ENERGY EFFICIENCY-RESIDENTIAL

Program Name	**Cool Homes - Enhanced**
Objective	Assist single and multi-family homeowners with central air cooling systems to upgrade the efficiency of their systems. Reduce energy consumption for single and multi-family homeowners through the tune-up and early replacement of working, inefficient cooling equipment. Achieve market transformation through HVAC contractor training.
Target Market and Eligibility	The target market for the program includes both GMO residential customers who have working inefficient central air conditioners and the HVAC contractor market. Targeted market customers are identified through the integration of weather data and billing analysis and the use of property tax records.
Program Description	The Cool Homes program is a residential central air-conditioning rebate program designed to help reduce excess energy usage during the peak summer months and cut carbon dioxide emissions through the maintenance and early retirement of inefficient central air conditioning equipment. This program encourages residential customers to have existing cooling systems evaluated and if feasible, brought back to factory specifications (re-commissioned), or replace less efficient, working central cooling systems with high efficiency central cooling systems.
Rebates and Incentives	The Cool Homes program provides contractor incentives to provide for quality installation practices and customer rebate incentives offered through participating HVAC contractors to help offset customer equipment costs. Contractor Incentives: GMO pays a $35 incentive to the contractor for the unit testing which is typically 1/3 of the service visit. Contractors will receive $45 upon completion of proper airflow and coolant recharge if the system requires. Proctor Engineering will complete the processing for incentives, as they are responsible for the software

	and technical information needed to certify the efficiency of the HVAC system. The program Administrator will pay contractor incentives upon successful completion of program standards. Customer Incentives: GMO customers who use participating Cool Homes HVAC contractors to test, repair, and/or replace working A/C or heat pumps with high-efficiency equipment rated at 14 SEER or above may be eligible for an instant rebate. (14/15 SEER: $650 or 16+ SEER: $850). Rebates are applied, per system, toward the purchase of a high-efficiency A/C or heat pump through a Cool Homes HVAC service contractor. The program Administrator pays HVAC contractors for the customer incentives offered through the program.
Enhancement	GMO will work with market channels to increase participation.

Program Name	**Home Performance with Energy Star Program**
Objective	The program offers a comprehensive approach to home improvement, remodeling, and renovation that will make homes more efficient, reduce energy costs, while improving indoor air quality, and create a more comfortable, healthy home while protecting the environment through energy conservation.
Target Market and Eligibility	HPwES is a program designed for existing homes of all ages. This Program may be applied to any home where the current resident is receiving service under any generally available residential rate schedule offered by the Company. All Assessments must be requested by the owner of the home. Program rebates are limited to one rebate per Assessment.
Program Description	Home Performance with Energy Star (HPwES) is an innovative program that strives to produce an economically sustainable model that captures significant energy savings by encouraging a whole-house approach to Energy Efficiency improvements in existing homes. The program begins with a whole-house energy assessment performed by trained and Building Performance Institute (BPI) certified contractors. The infrastructure is then provided for homeowners to follow through and complete energy improvements to their homes. Quality Assurance is a primary function of this program. HPwES is a statewide approach coordinating efforts between the state sponsor, Missouri Department of Natural Resources' Energy Center (MODNR) and local partners. GMO will collaborate regionally with the Metropolitan Energy Center (MEC) to implement a successful program in the Kansas City area.
Rebates and Incentives	GMO offers a Home Performance with Energy Star rebate of up to $600 for customers who implement at least one qualifying energy efficient improvement that is recommended by the Home Performance certified contractor or consultant.
Enhancement	The primary objective of the program is to increase the adoption of high efficient Energy Star products through retail markets. The theory is that through market support of retailers, these products will have more exposure to customers and better placement in the store. The sales force will also be more aware of the product and promote it more often. Customers will then try the product and increase use of these products. It is expected that as the product is more widely accepted and prices are reduced, that GMO may reduce or drop the incentives and consumers will commonly adopt the measures. The enhancements will be designed to: ❖ Provide retail or distribution incentives to residential

	customers for the installation of measures to reduce energy use in the home and information about other programs that encourage the installation of high-efficiency lighting, heating and cooling systems and appliances. ❖ Provide a marketing mechanism for retailer and high efficiency product suppliers to promote energy efficient equipment and products to end users.

Program Name	**Appliance Turn-in Program**
Objective	The primary objective of the program is to incent customers to remove improperly operating, inefficient appliances, secondary appliances. The secondary purpose is to raise awareness of the energy benefits of Energy Star appliances. Provide a marketing mechanism for retail stores to promote energy efficient appliances to residential customers.
Target Market and Eligibility	Residential customers throughout the GMO territory are eligible for the program. The main target markets are: Customers with working second and third refrigerators and freezers, inefficient room air conditioners and inefficient dehumidifiers.
Program Description	Older vintage room air conditioners (room AC), refrigerators, freezers and dehumidifiers can be some of the least efficient electrical appliances in the home. Often these old units are used when they are not functioning properly and as a result use electricity very inefficiently. To encourage customers to dispose of their old appliances and purchase efficient Energy Star models, GMO proposes an appliance turn-in program. Located at retailer locations during special promotions, participants would receive coupons towards more efficient units if they turn in an old unit or arrange to have the old unit picked up. Units received will be recycled through a certified recycling agency. The program includes customer educational and promotional pieces designed to assist residential customers with the information necessary to improve the energy efficiency of their entire home. The program also includes customer and trade ally education to assist with understanding the technologies and applications that are being promoted, the incentives that are offered, and how the program functions.
Rebates and Incentives	Incentives will be provided on two levels, first an incentive to turn in or have picked up the old unit and the second an additional incentive to upgrade to an Energy Star appliance.

RESIDENTIAL ENERGY REPORTS

Program Description

The Residential Energy Reports provides residential customers with an Energy Report that provides a comparison of the household energy usage information with similar type customers or “neighbors.” The intention of the Energy Report is to provide information that will influence customers’ behavior in such a way that they lower their energy usage. This is a behavioral modification program.

This program element will operate as an opt-out only program, which means GMO will select customers for participation in the program. Program participants will be mailed an energy usage report on how energy is used by their households on a monthly basis. The customer’s home energy usage is compared to the average usage of households that are geographically located in close approximation of one another and have similar characteristics such as dwelling size and heating type. The report displays a monthly neighbor comparison, a 12-month neighbor comparison, a personal comparison of this year’s usage versus last year and specific energy tips that are based on the characteristics and usage of the household.

MULTI-FAMILY REBATE PROGRAM

Program Description

The Multi-family Rebate Program advances comprehensive energy efficiency measures, including: whole house solutions, plug load efficiency, visual monitoring and displays, performance standards, local government opportunities and DSM integration

Multi-family property owners and managers have been historically less responsive to energy efficiency efforts than have residential customers. This unique customer segment warrants additional attention and effort to motivate property owners and managers to actively participate in energy efficiency programs. The Multi-family Rebate Program proposes a series of comprehensive measures designed to address systems within multi-family housing establishments.

The Multi-family Rebate Program offers prescribed rebates for energy efficient products to motivate the multi-family property owners/managers to install energy efficient products in both common and dwelling areas of multi-family complexes and common areas of mobile home parks and condominiums. An additional objective is to heighten property owners/managers and tenants awareness and knowledge of energy efficiency.

Residential Lighting and Appliance Program

The Residential Lighting and Appliance Program promote ENERGY STAR® appliances,
lighting and home electronics. The program also promotes several products that are energy efficient, for which there are not yet ENERGY STAR labels, such as solid state lighting and light emitting diode technologies.

GMO conducted residential market research aimed at providing technical, market, and economic analyses that would be specific to the GMO service area, with the goal of identifying key characteristics for energy efficiency opportunities. The research was conducted by RLW Analytics and a report11 on March 13, 2007. The study was designed to provide GMO with technical, economic, and market potential for building measures, appliances, and lighting of single-family residential homes. The overarching goals of this assessment were to calculate and present technical, economic, and market potential analyses for energy efficiency opportunities to help target future programs that will have the largest and/or most cost. GMO used the results of this study to estimate the average annual program energy and demand savings of this program. The metric for this program is the estimated average annual energy and demand savings of 150 kWh and 0.08 kW per participant.

ENERGY EFFICIENCY PROGRAMS – C&I

Program Name	**Commercial and Industrial Rebate (Custom Incentives)**
Objective	The primary goal of the program is to encourage GMO's C&I customers to install energy efficient process, refrigeration, and other efficient equipment & controls in existing facilities. More specifically, the program is designed to: • Provide incentives to facility owners and operators for the installation of high-efficiency process, refrigeration and other equipment and controls. • Provide a marketing mechanism for consulting engineers, process and equipment contractors and distributors to promote energy-efficient equipment to end users.
Target Market and Eligibility	All GMO commercial and industrial retail customers are eligible for the program. However, the main target markets are customers in existing buildings. The separate New Construction program covers new construction design applications. Industrial customers, grocery stores, and other large commercial customers are expected to be the primary target markets for this program.
Program Description	The Commercial and Industrial Custom Incentive Program provides custom incentives to C&I customers for the installation of innovative and non-standard energy-efficiency equipment and controls. This program will pertain to existing facilities only. The separate Prescriptive Incentive program covers standard high-efficiency measures. The separate C&I New Construction Program will cover new construction design measures. The program includes customer educational and promotional pieces designed to assist facility owners, operators and decision makers with the information necessary to improve the energy efficiency of the process, refrigeration and other energy using systems in their facilities. The program also includes customer and trade ally education to assist with understanding the technologies that are being promoted, the incentives that are offered, and how the program functions.
Rebates and Incentives	The C&I Custom Incentive Program is a financial assistance and education program that provides incentives for the installation of energy efficiency measures in existing non-residential facilities. Customers/Contractors will submit their project savings estimates during the planning process prior to project initiation. GMO staff

	or its subcontractor will review these savings estimates and confirm the savings prior to committing to the incentive levels. This check on the savings analysis helps assure that GMO funds are being cost effectively used to promote efficiency. Incentives will be set using a "per saved kWh" and "per saved kW" basis so that both energy and demand savings will be rewarded. Levels of incentives will vary over time based on costs and market need but will typically be established in one-year increments. GMO will use a two-tier custom incentive approach. The first tier is at a lower rate for technologies that are established and known in the market but need financial help to get them implemented. The second tier will be technologies that are newer to the market or have risk that is more significant or other barriers that need higher stimulation and awareness. Most new technologies will start at the second higher incentive tier and migrate to the first lower incentive tier over time as they are accepted within the market. This approach gives appropriate signals to the market about new technologies or riskier technologies that have significant savings potential. Other guidelines to reduce free ridership will also be established. These include years of payback, total incentive dollars per customer per year and percent of total project cost. One barrier to getting measures identified and installed is getting customers to spend funds to analyze the opportunity and savings. To help address this issue, assessment/audit grants will be available to customers for up to 25% of the analysis cost not to exceed $300 for facilities less than 25,000 square feet and not to exceed $500 for larger facilities. If the customer implements that project, an additional bonus will be included in the incentive to cover an additional 25% of the assessment cost using the same caps.
Enhancement	Certain key customer segments will be targeted based on energy savings potential and technology. Initial market segments will include hospitality, food service, health care, grocery, large industrial and large office. The strategy will also include outreach to key equipment partners and trade allies including consulting architects and engineering firms, process and refrigeration contractors and distributors, relevant professional and trade associations and other parties of interest in the market. An important part of the marketing plan will be content and functionality on the GMO website, which will direct customers to information about the program. More specifically, the marketing and communications plan will include: Education seminars implemented in each market to provide details about how to participate in the Program. The seminars will

	be tailored to the needs of business owners, building managers, architects, engineers, vendors, and contractors; A combination of strategies including major media advertising, outreach and presentations at professional and community forums and events, and through direct outreach to key customers and customer representatives. Marketing activities will include: Brochures that describe the benefits and features of the program including program application forms and worksheets. The brochures will be mailed upon demand and distributed through the call center and www.GMO.com and will be available for various public awareness events (presentations, seminars etc). Targeted direct mailings used to educate customers on the benefits of the program and explaining how they can apply. Customer and trade partner outreach and presentations (e.g. Restaurant Association, BOMA and other customer organizations) informing interested parties about the benefits of the program and how to participate. Print advertisements to promote the program placed in selected local media including the Kansas City area newspapers and trade publications. GMO website content providing program information resources, contact information, downloadable application forms and worksheets, and links to other relevant service and information resources. GMO customer account representatives trained to promote the program to their customers.

Program Name	**Commercial and Industrial Rebate (New Construction)**
Objective	The primary goal of the program is to encourage GMO's C&I customers to install energy efficient measures in existing facilities. More specifically, the program is designed to: Provide incentives to facility owners and operators for the installation of high-efficiency equipment and controls. Provide a marketing mechanism for electrical contractors, mechanical contractors, and their distributors to promote energy efficient equipment to end users.
Target Market and Eligibility	All GMO commercial and industrial retail customers are eligible for the program. However, the main target markets are: Customers in both existing buildings and new construction depending on the technology and code requirements. New construction design incentives are covered by the separate New Construction program. Other utilities have found that the following types of larger commercial customers participate with the highest frequency in their C&I EE programs: large office buildings, education facilities, grocery stores, health care facilities, and warehouses. Small business customers are the most difficult market segment to reach with EE programs in general, but such customers tend to more readily participate in the lighting EE programs than other types of EE programs.
Program Description	C&I Prescriptive Incentive Program provides prescriptive incentives to C&I customers for the installation of energy-efficiency equipment for numerous applications including lighting equipment, controls, heating, ventilation and air conditioning (HVAC) equipment, motors, refrigeration, and food service equipment. Prescriptive incentives are offered for a schedule of measures in each of these categories. Innovative energy efficiency measures or measures with large variability in application will be covered as part of the separate Custom Rebate Program. Application to existing facilities and/or new facilities will vary by measure depending on the codes and standards within new construction. New construction design assistance will be covered by the separate C&I New Construction Program. The key to program success is the engagement of the market actors throughout the delivery channel that currently exists. These actors include manufacturers, distributors, consultants, engineers and contractors. The program will have staff specifically dedicated to educating, collaborating and engaging

	these important players in the program. Through these existing market actors who have relationships with C&I customers, the new high efficient technology will be offered to customers as a viable option. To support the market actors, the program also includes customer educational and promotional pieces designed to assist facility owners, operators and decision makers with the information necessary to improve the energy efficiency of the systems in their facilities.
Rebates and Incentives	Incentives for each technology will vary based on cost effectiveness and market response. The program strives to cover at least 50% of the incremental cost of the measure to stimulate the market if it is cost effective. Additional guidelines may be established such as total incentives available per customer per year to assure that funds are allocated across all customer opportunities.
Enhancement	The primary goal of the program is to encourage GMO's C&I customers to build more efficient new buildings and to install energy efficient lighting, HVAC, building envelope, refrigeration, and controls measures in new buildings. More specifically, the program is designed to: • Provide design assistance to the architects and engineers that are designing new buildings. The key design assistance tool is building simulation modeling of more efficient building designs. • Provide incentives to new facility owners for the installation of high-efficiency lighting, HVAC, building envelope, refrigeration and other equipment and controls. Standard high efficiency equipment will be covered through the Prescriptive Program when no modeling is completed. When modeling is completed, they will be considered within the total savings percent and provided incentives as a total package. • Provide a marketing mechanism for architects and engineers to promote energy efficient new buildings and equipment to end users. • Overcome market barriers, including: Customers' lack of awareness and knowledge about the benefits and costs of energy efficiency improvements. Performance uncertainty associated with energy efficiency projects. Additional first costs for energy efficient measures. Lack of time, resources and motivation by the designer/engineer to consider efficient alternatives and model these results for the owner's consideration. • Ensure that the participation process is clear, easy to understand and simple.

	Certain barriers exist to the adoption of energy efficiency measures, including lack of investment capital, competition for funds with other capital improvements, lack of awareness/knowledge about the benefits and costs of energy efficiency measures, high transaction and information search costs, and technology performance uncertainties This program is designed to help overcome these market barriers and encourage greater adoption of energy efficiency measures in the new construction C&I market.

Program Name	**C&I Prescriptive Rebate Program**
Objective	The primary goal of the program is to encourage GMO's C&I customers to install energy efficient measures in existing facilities. More specifically, the program is designed to: Provide incentives to facility owners and operators for the installation of high-efficiency equipment and controls. Provide a marketing mechanism for electrical contractors, mechanical contractors, and their distributors to promote energy efficient equipment to end users.
Target Market and Eligibility	All GMO commercial and industrial retail customers are eligible for the program. The main target markets are: large office buildings, education facilities, grocery stores, health care facilities, and warehouses.
Program Description	C&I Prescriptive Incentive Program provides prescriptive incentives to C&I customers for the installation of energy-efficiency equipment for numerous applications including lighting equipment, controls, heating, ventilation and air conditioning (HVAC) equipment, motors, refrigeration, and food service equipment. Prescriptive incentives are offered for a schedule of measures in each of these categories. Innovative energy efficiency measures or measures with large variability in application will be covered as part of the separate Custom Rebate Program. Application to existing facilities and/or new facilities will vary by measure depending on the codes and standards within new construction. New construction design assistance will be

	covered by the separate C&I New Construction Program.
Rebates and Incentives	Incentives for each technology will vary based on cost effectiveness and market response. The program strives to cover at least 50% of the incremental cost of the measure to stimulate the market if it is cost effective. Additional guidelines may be established such as total incentives available per customer per year to assure that funds are allocated across all customer opportunities.

1.3 DEMAND-SIDE RATES

(C) To include demand-side rates for all customer market segments; 22.050 (1) (C)

Demand-Side rates are addressed in section 4.

1.4 MULTIPLE DESIGNS

(D) To consider and assess multiple designs for demand-side programs and demand-side rates, selecting the optimal designs for implementation, and modifying them as necessary to enhance their performance; and 22.050 (1) (D)

GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A

Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

Navigant will consider and assess multiple designs for demand-side programs and recommend an optimal design for implementation.

1.5 EFFECTS OF IMPROVED TECHNOLOGIES

(E) To include the effects of improved technologies expected over the planning horizon to—

Addressed below in the response to rule (1) (E) 2.

1. Reduce or manage energy use;

Addressed below in the response to rule (1) (E) 2.

2. Improve the delivery of demand-side programs or demand-side rates.

GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

The selection of potential demand-side resources will be required to fulfill the goal of achieving all cost-effective demand-side savings and facilitate the design of highly effective potential demand-side programs.

To include the effects of improved technologies expected over the planning horizon to—

• Reduce or manage energy use; or

• Improve the delivery of demand-side programs or demand-side rates.

- Include demand response resources.
- Include on-site combined heat and power as a resource.

SECTION 2: DEMAND-SIDE RESEARCH

(2) The utility shall conduct, describe, and document market research studies, customer surveys, pilot demand-side programs, pilot demand-side rates, test marketing programs, and other activities as necessary to estimate the maximum achievable potential, technical potential, and realistic achievable potential of potential demand-side resource options for the utility and to develop the information necessary to design and implement cost-effective demand-side programs and demand-side rates. These research activities shall be designed to provide a solid foundation of information applicable to the utility about how and by whom energy-related decisions are made and about the most appropriate and cost-effective methods of influencing these decisions in favor of greater long-run energy efficiency and energy management impacts. The utility may compile existing data or adopt data developed by other entities, including government agencies and other utilities, as long as the utility verifies the applicability of the adopted data to its service territory. The utility shall provide copies of completed market research studies, pilot programs, pilot rates, test marketing programs, and other studies as required by this rule and descriptions of those studies that are planned or in progress and the scheduled completion dates.

2.1 CONSULTING ENGAGEMENT WITH NAVIGANT

GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. The scope of work and project schedule are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf".

2.2 JD POWER CUSTOMER SATISIFACTION

Established in 1968, J.D. Power and Associates is a global marketing information company that conducts independent and unbiased surveys of customer satisfaction, product quality and buyer behavior. J.D. Power and Associates is best known for its work in the automotive industry. However, in recent years, the company has expanded to serve a number of other industries, including telecommunications, travel and hotels, marine, utilities, healthcare, homebuilder, consumer electronics and financial services.

The electric utility study measures customer satisfaction by examining six key factors: power quality and reliability; price; billing and payment; corporate citizenship; communications; and customer service. The study ranks large and midsize utility companies in four geographic regions: East, Midwest, South and West. Companies in the midsize utility segments serve between 125,000 and 499,999 residential customers, while companies in the large utility segment serve 500,000 or more residential customers. The 2012 Electric Residential Customer Satisfaction Study is being conducted from the 3rd quarter of 2011 through the 2nd quarter of 2012 in four waves, with the final report scheduled for release in July of 2012. Both GMO and KCP&L customers were included in the survey sample.

KCP&L and GMO utilize the JD Power studies to measure customer satisfaction and has established indicators to measure success. There are several benefits to participating utilities in the JD Power studies including the following:

- Access to the data for internal company use
- Full report with benchmarking data on all utilities
- Annual presentations from JD Power representative to discuss findings
- Increased sample sizes for participating utilities

- Network of contacts throughout participating utilities

2.3 COMMUNICATIONS TRACKING (JD POWER)

KCP&L and GMO communications are being tracked within the JD Power study. Customers are asked the number of communications recalled and the main topic of the communication. In addition, they rate the company on key measures such as keeping you informed, usefulness of suggestions, getting your attention, how to be safe and communicating changes that impact customers. Results are tracked and reported each quarter of the year.

2.4 ACCOUNTLINK

AccountLink is a free, account management tool designed to allow customers to view and pay their bills online, look up and track payments, view daily energy usage, historical energy usage and generally manage their relationship with GMO in a self-service environment.

Prior to launching AccountLink in the GMO territory Account Inquiry users were surveyed to establish a base read of customer satisfaction to compare against post launch. Future surveys will be conducted to track success and customer satisfaction over time.

2.5 CUSTOMER SOLUTIONS

GMO will be conducting a survey to measure customer satisfaction with Tier 1 and Tier 2A business customers in order to develop account management plans and improve performance. Objectives of this research include the following.

- Collect and report as indicator
- Use general research findings to apply across all business customers

2.6 PRODUCT AND SERVICES AWARENESS / INTEREST

Product and service saturation is highly dependent on two key factors of awareness and interest. If customer awareness is low and interest is high, the product has typically not reached saturation. However, if awareness is high and interest is low, you might not want to spend a lot of money marketing the product.

GMO has utilized several different channels of marketing including direct mail, bill inserts, tele-marketing, media, and local events. They have estimated customer awareness and interest based on available information but do not truly know by product. GMO is planning on conducting a research study designed to capture customer awareness of products and services along with interest levels based on the program description. The objective of this research will be to better understand the saturation levels of GMO's products and services.

2.7 COOL HOMES

The Cool Homes program offers GMO customers with inefficient home cooling systems an evaluation to determine if their old equipment qualifies for an instant rebate up to $850 towards the purchase of a new high efficiency air conditioner or heat pump rated at SEER 14.0 and above. There is no cost for the initial evaluation.

Participating customers in GMO's Cool Homes program are given the opportunity to provide feedback on their experience with the contractor and their initial evaluation through a survey.

Please share with us your level of satisfaction. Using a scale of "1" to "5" where "1" means "Strongly disagree" and "5" means "Strongly agree," please rate these statements.	**Strongly agree**	**Somewhat agree**	**Neither disagree nor agree**	**Somewhat disagree**	**Strongly disagree**
The information explaining the KCP&L Cool Homes program was helpful.	55.2%	26.0%	10.1%	4.6%	4.0%
The information answered your questions.	55.5%	24.0%	11.3%	4.9%	4.3%
The contractor was professional and courteous	76.0%	13.0%	3.2%	1.2%	6.6%
The overall service I received from the contractor was excellent.	74.0%	13.0%	5.5%	2.0%	5.5%

How would rate the following?	**Yes**	**No**
Did the contractor arrive on time?	98.8%	1.2%
Was the contractor's appearance acceptable?	99.7%	0.3%
Did the contractor communicate with you about options for repair or replacement of your equipment?	96.8%	3.2%
Based on your experience with this contractor, would you work with them again?	98.0%	2.0%

2.8 ENERGY OPTIMIZER

GMO's Energy Optimizer participants help control system peak demands during summer months. Each participating customer receives a FREE Honeywell programmable thermostat - a $300 value. On the hottest weekday afternoons from May through September, demands on GMO's system are the highest. At these times, we may either raise your temperature a few degrees, or cycle the air conditioning compressor off and on for 15-minute increments for no more than 4 hours.

2.9 CHARTWELL

Chartwell is a leading facilitator of knowledge exchange within the utility industry; providing best practices case studies, analysis and networking opportunities through an integrated, trusted and unrivaled approach. Chartwell is another well known and respected source of utility information and reports that leading utilities use throughout the United States. Our membership allows us access to industry reports, white papers, and webinars (2 seats included for webinars), consulting, utility contacts, discounts on all Chartwell conferences. This information is very useful in keeping up with industry updates including technology, program/services, and industry best practices. In addition, membership provides great networking opportunities with other utility employees to discuss various topics of interest to KCP&L and GMO.

2.10 ELECTRIC POWER RESEARCH INSTITUTE

GMO financially supports research conducted by the Electric Power Research Institute (EPRI). GMO has access to a the EPRI library of energy efficiency and demand response research and data that is available to program participants.

The electric utility industry launched a new initiative in 2007 to investigate, demonstrate, and assess application of efficient end-use technologies and demand response systems. This effort, the EPRI 2007 Energy Efficiency Initiative, reestablished the electric utility industry as a leader in energy efficiency RD&D. More than 40 utility companies including collaborated to identify cost-effective technology and system options for increasing efficiency and enabling dynamic energy management.

A Key Initiative accomplishment include the creation of a Living Laboratory to test energy efficiency and demand response technologies and their interoperability. Perhaps the single largest achievement has been establishment of a Living Laboratory dedicated to testing the functionality of products necessary to support energy efficiency and demand response in a smart grid environment—as well as in today's system infrastructure. Products ranging from dimmable advanced lighting systems to programmable communicating thermostats to plug load control to communication and control gateways have been assessed. Through bench tests and through "living" applications at EPRI staff offices, performance results have been documented, with emphasis on items that can lead to field tests and demonstrations—and system interoperability. The laboratory, located at EPRI facilities in Knoxville, Tennessee, has also served as an educational center, providing a venue for technology tours and demonstrations for utility representatives and the public.

Research results are available as a significant collection of reports and data on technology and program potential, including material related to influencing factors such as greenhouse gas emissions and smart grid development. Through EPRI research, the industry has developed information on load growth (which could potentially offset efficiency benefits) and the potential cost/benefit of energy efficiency and demand response. Major converging factors that affect efficiency and load management are addressed, such as greenhouse gas effects and integration with advanced metering infrastructure and smart grid deployment.

More information about the EPRI energy efficiency and demand response program research can be found on their website, www.epri.com.

2.11 MULTI-FAMILY RESIDENTIAL STUDY - MARKET SATURATION AND POTENTIAL ANALYSIS

GMO Engaged KEMA consulting to complete a Multifamily DSM Potential study. The final report is "Appendix 5B 2010 KCPL Multifamily Final Report.doc". Additional research conducted by the American Council for an Energy efficient Economy is included in "Appendix 5C ACEEE_MF_Study.pdf".

2.12 EVALUATE ADDITIONAL DEMAND RESPONSE PROGRAMS

Research was conducted to evaluate GMO's existing demand response programs, historical participation and potential for additional programs. A proposed new MPower program with opportunities for additional benefits is described in "Appendix 5D MPower2.pdf".

2.13 ANALYSIS OF ENERGY EFFICIENT STREET LIGHTING

Current Street Lighting KCP&L Missouri & GMO

In 2008, KCP&L Missouri and GMO had 352 street and area lighting (SAL) customers who use 103 million kWh annually. The customer's lighting tariff includes the installation and maintenance of the lighting, in addition to the energy cost. GMO previously determined that the most efficient available technology for area lighting was high pressure sodium lamps and virtually all of the existing installed lighting is of that type. High pressure sodium lamps produce the greatest lumens per watt of any of the alternatives.

Alternative Lighting

GMO's primary focus for alternative lighting is LED fixtures. These have advantages over traditional high-intensity discharge lamps of lower efficiency and shorter lamp life. Recent advances in LED technology have made LED-based lighting a possible alternative to HID lighting.

LED technology for street and area lighting has the Potential to:

- Lower energy consumption
- Provide high quality color rendition
- Lower maintenance costs
- Reduce light pollution

Case Studies

KCP&L is collaborating with The Electric Power Research Institute, as a host utility, to test and evaluate the potential of currently available LED lighting. The issues that need to be addressed are system compatibility, technology performance, validating industry performance claims and efficacy issues. In particular, assuming the lamps perform reliably, the efficacy of the lamps will determine the total energy savings possible. LED lamps have a higher color rendering index and this has the effect of increasing the amount of perceived light. Identifying the minimum amount of light output necessary to replace existing light sources will maximize the possible energy savings. To this end, the EPRI collaboration will take periodic readings of scotopic and photopic light measurements at test sites. If you match lumens, LED luminaries can't measure up to HPS lamps. However, if you measure the efficacy, using scotopic readings, LED fixtures can replace HPS fixtures with fewer lumens, therefore, fewer watts.

The EPRI LEDSAL collaboration project involves a test site, where HID lighting is being replaced with LED luminaries. A GMO participant is involved in the quarterly measurement process, using EPRI's Rover Light Measurement Tool, to take readings of the pre installation HID lighting, the post installation LED lighting, and quarterly readings, through the end of the project. In addition to testing the efficacy of the LED lighting, the quarterly observations will provide information about degradation, spectrum shift, and reliability and maintenance issues. A significant part of the savings from LED lighting comes from the reduced need for maintenance and monitoring.

EPRI has over 20 test sites nation wide where each of these case studies is taking place. The quarterly monitoring will continue until spring 2012, at which time the project will close and a final report will be produced. This report will address the many concerns surrounding the adoption of LEDSAL lighting:

Technology viability
Performance
Energy savings
Maintenance savings
Public acceptance
IES standards (currently no accepted standard)

DSM Potential

Prior to 2012 project close, as a collaborator, KCP&L can share in the findings of energy savings, performance and public perceptions at other sites. We can use this information to:

Identify viable manufacturers
Obtain product cost information
Estimate annual impacts
Identify life cycle costs
Complete economic benefit cost analysis
Calculate standard practice test results
Develop program recommendations and timeline

Additional information on the KCPL EPRI collaboration can be found in the "Appendix 5E EPRI EE Demonstration-T.Geist-For Electronic Distribution.pdf"

Additional LED Research

In addition to the EPRI collaboration, KCP&L and GMO are conducting an LED pilot with 5 area communities where similar test sites will be evaluated using various lighting manufacturers. GMO is evaluating LED tariffs being offered by other utilities and will be using the pilot sites to help determine the potential structure of LED lighting tariffs on our system. Refer to "Appendix 5F KCPL LED Initiatives.ppt".

SECTION 3: DEVELOPMENT OF POTENTIAL DEMAND-SIDE PROGRAMS

(3) The utility shall develop potential demand-side programs that are designed to deliver an appropriate selection of end-use measures to each market segment. The utility shall describe and document its potential demand-side program planning and design process which shall include at least the following activities and elements:

3.1 PREVIOUSLY IMPLEMENTED DEMAND-SIDE PROGRAMS FROM OTHER UTILITIES

(A) Review demand-side programs that have been implemented by other utilities with similar characteristics and identify programs that would be applicable for the utility; 22.050 (3) (A)

We reviewed programs offered by:

- Ameren
- OG&E
- Empire
- MidAmerican
- Westar

We identified programs that would be applicable for the utility such as:

- Appliance recycling
- HVAC upgrades
- Residential Lighting and Appliance
- Home Energy Audits and Upgrades (Home Performance with Energy Star)

- Prescriptive Rebates for C&I Customers

3.2 MARKET SEGMENT IDENTIFICATION

(B) Identify, describe, and document market segments that are numerous and diverse enough to provide relatively complete coverage of the major classes and decision-makers identified in subsection (1)(A) and that are specifically defined to reflect the primary market imperfections that are common to the members of the market segment;22.050 (3) (B)

Greater Missouri Operations (GMO) utilized historical customer class energy usage, revenue, and customer count data for the residential, commercial, industrial, and interruptible customer sectors.

The commercial and industrial (C&I) customer data was sub-classified by market sector. The stratified data included segmentation of historical energy sales, usage, and customer count by both geographic region and by commercial and industrial (C&I) market sector.

The commercial and industrial (C&I) sectors are listed in Table 2 below:

Table 2: C&I Sectors

The geographic regions were defined as being either the GMO eastern district service region formerly named Missouri Public Service, or the St. Joseph, MO service region formerly named St Joseph Power & Light.

The residential sector was defined as being either single-family or multi-family premises.

An analysis of the multi-family sector was completed. GMO engaged a consulting firm, RLW/ KEMA, inc. to conduct a multi-family appliance saturation study.

For the Commercial and Industrial (C&I) market, GMO has segmented the market based on industry classifications by kWh usage. The top ten segments identified are:

- Retail 8.9%
- Fabricated Metal Products 6.7%
- Education, Schools & Colleges 6.4%
- Small Office 6.3%
- Chemicals 5.7%
- Services 5.1%
- Church 4.2%
- Food 4.0%
- Plastics & Rubber Products 3.0%
- Computer & Electronic Products 2.9%

3.3 DEVELOPMENT OF END USE MEASURES

(C) Identify a comprehensive list of end-use measures and demand-side programs considered by the utility and develop menus of end-use measures for each demand-side program. The demand-side programs shall be appropriate to the shared characteristics of each market segment. The end-use measures shall reflect technological changes in end-uses that may be reasonably anticipated to occur during the planning horizon;
22.050 (3) (C)

The majority of the residential end-use measures identified were from the two residential appliance saturation studies that were prepared by RLW Analytics (RLW); 1) "2006 Missouri Statewide Residential Lighting And Appliance Efficiency Saturation Study, Final Report", dated Sept 15, 2006 and 2) "2007 Kansas City Power & Light Single-Family Residential Potential Analysis, Final Report" dated March 13, 2007.

Morgan Marketing Partners (MMP), a consulting firm specializing in the development, marketing, and implementation of demand-side energy programs reviewed these measures and expanded the list.

The major categories of residential end-use measures included:

- Lighting
- Space cooling
- Space heating
- Residential refrigeration
- Water heating
- Residential building structure improvements
- Energy Star residential appliances, including dish washers, and clothes washers.

The measures identified in the RLW studies are listed as measure R1 through R31 in Table 3 below. The measures identified by MMP are listed as R32 through R41 in Table 3 also.

Table 3 Residential End-Use Measures

Residential ID	Baseline measure	End-Use Improvement	End-Use Category
R1	AC Refrigerant under charged	Add refrigerant	Space Cooling
R2	AC Refrigerant over charged	Remove refrigerant	Space Cooling
R3	Low evaporator airflow A	Increase duct sizes or add new ducts	Space Cooling
R4	Low evaporator airflow B	Increase blower speed	Space Cooling
R5	High duct leakage (25%)	Reduce duct leakage to 5%	Space Heating & Cooling
R6	Oversized AC units A	Size AC units to 100% of Manual J	Space Cooling
R7	Oversized AC units B	Size AC units to 100% of Manual J	Space Cooling
R8	One inch insul. on ducts in attic	Add two more inches of insulation	Space Heating & Cooling
R9	Gas heat and 13 SEER AC	Install AC SEER = 16	Space Cooling
R10	Home has 13 SEER heat pump	Install Heat Pump SEER = 16	Space Heating & Cooling
R11	Home has electric strip heat	Install Heat Pump SEER = 16	Space Heating & Cooling
R12	Attic insulation = R-7	Add another R-23 attic insulation	Space Heating & Cooling
R13	Attic insulation = R-11	Add another R-19 attic insulation	Space Heating & Cooling
R14	Exposed walls not insulated	Add R-11 wall insulation	Space Heating & Cooling
R15	Floor over basement not insulated	Add R-19 Insulation to floor	Space Heating & Cooling
R16	House infiltration = 0.8 ACH	Reduce infiltration to 0.35 ACH	Space Heating & Cooling
R17	Single pane windows A	Add storm windows	Space Heating & Cooling
R18	Single pane windows B	Install Low E double pane window 2904	Space Heating & Cooling
R19	Standard double pane windows	Install Low E double pane window 2904	Space Heating & Cooling
R20	No E & W window shading A	Add solar screens to E & W glass	Space Heating & Cooling
R21	No E & W window shading B	Plant deciduous trees on E & W sides	Space Heating & Cooling
R22	No Compact Fluorescent Lamps	Use 10 more CFLs throughout house	LIGHTING
R23	Refrigerator needs to be replaced	Purchase Energy Star refrigerator	REFRIGERATION
R24	Refrigerator early retirement	Removed unit uses no energy	REFRIGERATION
R25	Dishwasher to be replaced	Purchase Energy Star dishwasher	HOME APPLIANCE
R26	Clothes washer to be replaced	Purchase Energy Star clothes washer	HOME APPLIANCE
R27	No prgrammable thermostat	Install programmable thermostat	Space Heating & Cooling
R28	No faucet aerators	Install faucet aerators	Water Heating
R29	No low flow shower heads	Install low fow shower heads	Water Heating
R30	Hot water pipes not insulated	Insulate hot water pipes	Water Heating
R31	Electric water heater not wrapped	Wrap electric water heater	Water Heating
R32	Electric Meter	Energy Usage and Display Monitor	Usage Device
R33	Early Retirement of HVAC system, if SEER< 8.5	Install Heat Pump SEER = 16	Space Heating & Cooling
R34	Early Retirement of HVAC system, if SEER< 8.5	Install Heat Pump SEER = 14	Space Heating & Cooling
R35	Early Retirement of HVAC system, if SEER< 8.5	Install Heat Pump SEER = 15	Space Heating & Cooling
R36	De-humidifier early retirement	Removed unit uses no energy	HVAC
R37	Room A/C Unit early retirement	Removed unit uses no energy	HVAC
R38	Freezer early retirement	Removed unit uses no energy	REFRIGERATION
R39	Failure of HVAC system, Replace with 13 SEER	Replace with 14 SEER Unit	Space Cooling
R40	Failure of HVAC system, Replace with 13 SEER	Replace with 15 SEER Unit	Space Cooling
R41	Failure of HVAC system, Replace with 13 SEER	Replace with 16 SEER Unit	Space Cooling

The following are descriptions of each listed measure and improvement option, explanations of the assumptions made, and the technical approach to estimating impacts:

ID R1: Undercharged AC Systems

Published accounts from several other studies, including a New England HVAC study conducted by RLW in 2002, were used to estimate the technical potential percentages for AC systems. From these studies, about 36% of the measured systems are probably undercharged with refrigerant, which would be enough to exhibit recognizable symptoms. The average undercharged condition was modeled as a 20% reduction in both cooling capacity and efficiency. This 20% reduction represents a general consensus of the other studies.

In the baseline DOE2 models, the refrigerant charge factor was adjusted to 0.8 to reflect this 20% loss. In the retrofit models this factor was set to 1.00 to reflect a properly charged system. At this point the operating capacities and efficiencies were still slightly below rated values due to the fact that evaporator airflow is still a little low. This refrigerant charge correction resulted in an estimated annual savings of 689 kWh, and a peak demand reduction of 0.18 kW per application.

ID R2: Overcharged AC Systems

About 31% of the measured AC systems found in other studies were found to be overcharged with refrigerant. The average effect of this situation, however, is not nearly as dramatic, with only a 5% reduction in both cooling capacity and efficiency. This was represented in the models by a refrigerant charge factor of 0.95, which is in fact the average operating condition. The frequency, degree, and impact of overcharging are not as great as undercharging.

In the retrofit models the refrigerant charge factor was set to 1.00. This resulted in an estimated annual savings of 176 kWh, and a peak demand reduction of 0.12 kW.

IDs R3 and R4: AC Systems with Low Evaporator Air Flow

According to recent studies, about 70% of residential AC systems have a problem of significantly low evaporator airflow. The threshold for this performance characteristic is considered 350 CFM per ton, which is generally used as the lowest acceptable flow rate before capacity and efficiency are appreciably reduced. The average airflow for all those below the threshold was about 300 CFM per ton.

In the baseline DOE2 models the system airflow rate was set at 300 CFM per ton. In the retrofit models this was increased to 400 CFM per ton.

Two different approaches to the correction of a low airflow problem were examined because the associated costs and impacts of each are significantly different. The easiest, and least expensive, solution is to increase the blower speed whenever practical. In many cases, however, this will not be practical due to the presence of single speed blowers or a limited remaining blower capacity.

The other approach is to reduce airside system operating pressures by locating and removing restrictions or by increasing duct capacities. In an existing system the only practical ways to increase supply duct capacity are to replace existing ductwork with larger runouts to several rooms, or add more runouts at or near the supply plenum to new supply grilles.

In past studies, it was found that many return duct systems are simple but undersized. Return duct undersizing often occurs with systems in the attic that have one central return air filter grille in the ceiling of a corridor with one large flexible duct to a return plenum. In most, if not all, cases these can be replaced with larger ducts and return grilles, or new ducts and grilles can be added in parallel.

Any reliable and practical correction to the problem of low airflow would have to be determined by a careful on-site analysis of each problematic system. Often it may be necessary to combine fan speed corrections with increased supply and return duct capacities to obtain proper airflow at a reasonable cost.

The retrofit DOE2 model for increased duct capacity, ID 3, assumed that the total static pressure of the air distribution system could be reduced enough to allow the existing blower to deliver the required air flow without increasing the blower speed. The blower power was increased linearly with the increased airflow rate, and the system capacities and efficiencies were increased to rated conditions. This resulted in an estimated annual savings of 981 kWh, and a peak demand reduction of 0.82 kW.

The retrofit model for increasing blower speed, ID 4, required an increase in motor power equal to the square of the ratio of the flow rates. The increased fan power offset some of the energy savings due to increases in system capacity and efficiency. This resulted in an estimated annual savings of 807 kWh, and a peak demand reduction of 0.67 kW.

ID R5: AC Systems with High Duct Leakage

In the recent New England study that RLW conducted, it was found that about 73% of the AC systems had a problem of significantly high supply duct leakage to the outside. The threshold for supply air leakage was 15% of actual system airflow. The average leakage for all those above the threshold was 25 percent. The systems with high duct leakage do not seem to correlate at all with duct location or plenum static pressure. Based on field observation, however, these systems were characterized by poor installation workmanship, and they tended to be older than others.

The DOE2 model treats duct leakage as primary air delivered to and returning from unconditioned spaces such as attics and basements. About one third of the leakage was assigned to the unconditioned portion of the basement, and the remainder went to the first and second floor attic spaces. This leakage air actually tends to cool these spaces slightly, and they are modeled as buffer zones so that return leakage from them approximates the actual zone conditions. In this way, the primary effects of both supply and return air leakage to these spaces are captured in the model.

The baseline model used 25% duct leakage, and this was reduced to 5% in the retrofit case. This resulted in an estimated annual savings of 606 kWh, and a peak demand reduction of 0.45 kW.

In this analysis the inherent but small reduction in evaporator airflow was not modeled because an average value was not known. Many systems with leaky ductwork also suffer from insufficient airflow. In the New England study RLW found that about 79% of those with high duct leakage also had low airflow below 350 CFM per ton. Additionally, it was observed that 29% had a high blower motor power over 150 Watts per ton. The sealing of leaky ducts will tend to reduce air flow through the evaporator coil. In practice, therefore, it is necessary to measure the existing system airflow and blower motor power to determine if these other two potential problems need to be corrected before duct sealing is attempted.

IDs R6 and R7 Proper Sizing of AC Systems

An oversized system in this study is defined as having a rated cooling capacity greater than 100% of a valid Manual J cooling load estimate . Based on an average Manual J estimate of capacity in terms of square feet per ton and the individually observed home sizes and installed capacities, about 80% of the AC systems of this study are oversized relative to this criterion. It was found in the 2002 study by RLW that those that qualified as oversized averaged about 50% above the Manual J estimate.

The DOE2 models estimate the cooling system efficiency each hour as a function of a part load ratio. This is the ratio of system load and cooling capacity, and the function is empirically designed to approximate the efficiency penalty due to system cycling.

In the baseline model for ID 6 the systems were oversized by about 1.6 tons, and the retrofit was sized to 100% of Manual J, while the airflow and duct sizing was maintained at 360 CFM per ton. The rationale for maintaining this airflow rate is the probability that the same duct sizing practice will be applied by the contractor based on system size. This would be applicable to new AC systems that are installed where there is no existing ductwork. The estimated annual savings is 333 kWh, with a peak demand reduction of 0.27 kW.

On the other hand, if a new system is to be installed to replace an old system or with an existing forced air furnace that already has supply and return ductwork, the contractor may not install new ductwork. In this scenario, ID 7,

there is even more to gain by keeping the system size to a minimum. This is due to the fact that the existing ductwork would be able to deliver the same airflow in CFM as before with the same fan power (which would become a higher CFM per ton as the tons are reduced), thus reducing the system losses due to low airflow and excessive system cycling.

The retrofit DOE2 models for this case assume that the duct sizes, airflow rates, and fan static pressures remain unchanged. Even though the fan power is not increased, the annual fan energy consumption increases due to the fact that the system operates for longer periods of time, and this is accounted for in the models. The estimated annual savings for this scenario is 1046 kWh, with a peak demand reduction of 0.83 kW.

The advantages of reducing system size are all positive as long as the system capacity is sufficient to maintain acceptable comfort conditions about 97.5% of the time (which are all but a few hours of the typical cooling season). The smaller system will typically maintain better humidity control, last longer, make less noise, use less energy and cost less to install.

Most of the problems of low evaporator airflow in houses with evaporator coils added to existing forced air furnaces could be greatly reduced or avoided if the AC system is properly sized for the application. In recent studies, about 70% of the systems that are oversized also have evaporator airflow below 350 CFM per ton.

Unfortunately, downsizing is not a viable option after the system has been installed. Therefore, as an effective conservation program component, information and incentives will need to be presented to prospective homeowner participants before they even contact a contractor. Information and incentives should also be directed toward the contractors.

ID R8 Addition of Duct Insulation

It was observed that most ducts in the basements were not insulated, whereas nearly all ducts in the attics had at least one inch of insulation. The only appreciable savings available would be due to the addition of another inch or two of insulation to exposed ducts in the attic. Exact modeling of this was not within the scope of this project, but some assumptions were made regarding the duct heat gains due to conduction from a hot attic.

In the baseline DOE2 models it was assumed that 90% of the ducts were located in the attic and the product of U*A (i.e. thermal conduction coefficient times duct surface area) would be about 49.7, yielding an approximate peak air temperature rise of 1.0 degree Fahrenheit during the cooling cycle. In the retrofit case this U*A value was reduced to about 20.5. The estimated annual savings for this measure is 242 kWh, with a peak demand reduction of 0.24 kW.

ID R9 High Efficiency SEER 16 AC in Gas Heated Homes

Significant savings are potentially available for the installation of high efficiency AC systems instead of standard efficiency SEER 13 units. In the existing home retrofit market this might be applied to homes with old existing systems that are at the end of their useful operating lifetimes and need to be replaced. This might also apply to an existing home in which air conditioning was never before installed and the homeowner wants to install a new central AC system. Modeling the unit savings for this measure was straightforward. The baseline DOE2 model was assigned a rated efficiency of SEER 13, and the retrofit model used SEER 16. Additionally, the expansion device for both was changed from a capillary tube to a thermal expansion valve (TXV). All other conditions remained unchanged. The estimated annual savings for this measure is 921 kWh, with a peak demand reduction of -0.11 kW. The peak demand reduction is negative because a practical SEER 16 AC unit is achieved by applying a dual-speed compressor to an otherwise lower efficiency system. RLW found that a combination of an SEER 11 system and a dual speed compressor would yield a system that would be ARI rated at about SEER 16. The retrofit peak efficiency, however, is actually lower than the baseline peak efficiency.

IDs R10 and R11 High Efficiency SEER 16 Heat Pump

The installation of a high efficiency heat pump might be an option as a retrofit measure for existing homes with old heat pumps or with electric resistance heat.

The base case model for an old heat pump replacement, ID 10, assumed the baseline replacement heat pump would have been an SEER 13 heat pump. The retrofit model was similar to the SEER 16 AC, except it was equipped for reverse cycle operation. Potential savings for this option are about 1258 kWh and -0.52 kW for the average home.

The base case models for an electric resistance heat system replacement, ID 11, assumed the replacement equipment would be same as above. Potential savings calculated for this option were 3109 kWh and -0.48 kW. Average savings for electric strip heated homes is a little lower than anticipated due to the fact that the average electric strip heated home is slightly better insulated, and the occupants are more frugal in their energy usage practices (due to naturally reoccurring high heating costs). Additionally, there may be some significant "takeback" behavior involved. After upgrades are done, a homeowner would perceive heating bills are lower, and take some of the potential savings back in terms of increased comfort

IDs R12 and R13 Add Attic Insulation

Savings achievable for increasing attic insulation vary greatly with the amount of insulation already in place, as well as the amount of extra insulation added. Whether this is cost effective depends more on the amount of existing insulation. Two different baseline insulation values of R-7 and R-11 were assumed. In both retrofit scenarios the final R-value was R-30. Addition of any more than this is typically not cost-effective.

In the first scenario, ID R12, the baseline models were given an attic insulation value of R-7 with a retrofit to R-30. The calculated savings are 879 kWh and 0.54 kW. In the second scenario, ID R13, the base case was R-11 and the retrofit was R-30. Savings were estimated to be 541 kWh and 0.35 kW.

ID R14 Add Wall Insulation

Similar to attic insulation, achievable savings by increasing wall insulation vary greatly with the amount of insulation already in place, as well as the amount of extra insulation added. Whether this is cost effective depends more on the amount of existing insulation. RLW evaluated this measure with a baseline of no wall insulation, and added R-11 insulation to represent a realistic best-case scenario.

The calculated savings are 2634 kWh and 0.69 kW. Due to the high cost of adding insulation to existing walls, however, the simple payback for this measure based on kWh savings alone is relatively long at about 9.7 years. But this measure achieves some significant gas savings on average of about 360 Therms, and the simple payback to the average homeowner is only 2.8 years after rebate.

Although the potential savings are high, the long payback suggests that it would not be cost-effective to insulate existing walls with some insulation already in place. In fact, the existence of any batt insulation in existing walls renders it impractical to add more insulation by the normal method of blowing it through holes drilled into the stud cavities, because the batts would tend to block the flow of new insulation in many places.

ID R15 Add Insulation to Floor over Unheated Basement

Most basements are enclosed by thick masonry foundation walls and have direct contact with the earth. As such, they are naturally cooled by relatively low ground temperatures typical of Kansas City, where the averages are about 67 degrees Fahrenheit during the summer and about 43 during the winter.

As a result of the low ground temperatures, the savings are negative for most of the cooling season. The base case for this measure assumed no insulation and the retrofit provided for the addition of R-19 to the floors over the unconditioned basement areas. Calculated savings are -223 kWh and -0.12 kW. Due to differences in the costs of electricity and gas, the monetary savings from gas offset the increase in electricity usage, and the simple payback is about 7.5 years.

ID R16 Reduce Infiltration by Caulking and Weatherstripping

For this measure RLW assumed a baseline infiltration value of 0.8 ACH (Air Changes per Hour) and a retrofit of 0.35 ACH. RLW learned from several studies in different parts of the country that the average home infiltration rate is about 0.5 ACH. Calculated savings for weatherization measures are 1046 kWh, most of which (about 90%) is due to reduced heating requirements in electric heated homes, and 0.43 kW.

ID R17 Add Storm Windows to Standard Single Pane Windows

The average house in this study has about 240 square feet of window area. Less than 6% of the windows in this study were single pane, about 68% were double pane and 26%, were triple pane, counting those with storm windows. The overall average number of glass panes is 2.2, based on the study sample.

RLW used a typical single pane window with a U0 (thermal transmission coefficient) value of 1.09 and a SHGC (Solar Heat Gain Coefficient) of 0.81 for the base case, and applied storm windows in the retrofit case. The retrofit window structure had a U0 of 0.46 and a SHGC of 0.76, and the estimated savings were 908 kWh and 0.28 kW.

ID R18 Replace Standard Single Pane Windows

RLW used a typical single pane window with a U0 value of 1.09 and a SHGC of 0.81 for the base case, and applied a typical high performance double pane window in the retrofit case. The retrofit window had a U0 of 0.40 and a SHGC of 0.55, and the estimated savings were 1428 kWh and 0.54 kW.

ID R19 Replace Standard Double Pane Windows

RLW used a typical double pane window with a U0 (thermal transmission coefficient) value of 0.46 and a SHGC (Solar Heat Gain Coefficient) of 0.76 for the base case, and applied a typical high performance double pane window in the retrofit case. The retrofit window had a U0 of 0.40 and a SHGC of 0.55, and the estimated savings were 520 kWh and 0.26 kW.

IDs R20 and R21 Add Shading to East and West Facing Windows

Although external window shading might be added to all four faces of a house, the east and west faces offer the greatest potential savings. Also, to obtain maximum energy savings, the shade would have to be applied during the cooling season and removed during the heating season to avoid increasing the heating loads during the winter.

RLW considered and analyzed two different ways of shading east and west facing windows for this study, because one method will apply to some, while the other method is better for others. Neither alternative will be applicable to homes with significant east and west shading from existing trees or other things. To model these measures RLW removed all but about 5% of the external shading from the calibration models.

One practical method, ID R20, of shading windows from the exterior is the addition of solar screens that can be removed during the heating season. To model this retrofit, RLW increased the calibrated model east and west building shade transmissivities from about 0.7 to about 0.95 for the base case and the U0 value from 0.8 to 0.7 for the period of June 1 to October 31. To simulate the addition of solar screens, RLW reduced the SC of the east and west windows by half and the U0 value from 0.9 to 0.8 for July 1 through August 31. Estimated savings for this scenario are 172 kWh and 0.22 kW.

The other (and more desirable from both an aesthetic and practical perspective) method is the planting of deciduous trees in strategic locations to the east and west of the house. In this scenario, (ID R21) RLW assumed that three deciduous trees had been planted at about 20 feet from each side of the house (a total of six trees) to shade the windows as much as possible, and that they had grown to an effective height of 20 feet. Their solar transmissivities were changed from 0.1 during the summer (June 1 through October 31) to 0.9 during the winter. Resultant savings are 627 kWh, 0.18 kW. As these trees continue to grow, the savings will increase.

ID R22 Install Compact Fluorescent Lamps

Field data from the site visits indicated that the average home had about 9.7% CFL's (Compact Fluorescent Lamps) by bulb count. Hence, there is a high technical market potential for this measure. In the impact analysis RLW assumed that each program participant would install and use an average of ten 15-watt CFL's to replace ten 60-watt incandescent lamps, for a connected load reduction of about 450 Watts.

Lighting hourly usage patterns utilized in the models are based on actual measured hourly residential lighting usage patterns from a large number of long-term and short-term end-use studies RLW has performed or examined. Calculated savings amounted to 504 kWh and 0.05 kW. The peak heating load was not measurably affected because it occurred during the night when the lights are not being used.

One may note that the peak kW savings was 0.05 kW, or 50 Watts, whereas the reduction in connected load was 450 Watts. This is due to natural diversity in the lighting usage patterns so that all ten of these lamps are never on at the same time. These electric savings include both direct and indirect savings due to the reduction in internal heat gains that reduce the need for cooling.

IDs R23 and R24 Purchase Energy Star Labeled Refrigerator

Two options for replacing an existing refrigerator with an Energy Star certified unit were examined in this study. The first option assumes that an existing refrigerator is at the end of its functional life and the homeowner has already decided to replace it. The other option examines the potential of enticing a homeowner to retire an existing refrigerator before the end of its functional life.

For the firs option, ID R23, it was assumed that a standard new refrigerator on the market today uses about 564 kWh per year, and an Energy Star refrigerator will use about 432 kWh per year (10% below the 2001 federal standard average of about 480). The difference is 132 kWh per year. This direct energy reduction was modeled into the retrofit DOE2 models, and the resultant total interactive net savings are 152 kWh and 0.02 kW. Some secondary impacts are seen due to the fact that the refrigerator is in the conditioned spaces. Gas heated homes realize the full operating reduction of 132 kWh, but electrically heated homes pay a heating penalty due to the fact that savings inside the house increase the need for heat in the winter.

The baseline for the second option, ID R24, was 850 kWh per year. The resultant total interactive savings due to removal of this unit are 954 kWh and 0.12 kW. In addition to interactive effects, it was assumed that the primary refrigerator will be used more, thus adding slightly to its annual kWh usage.

ID R25 Purchase Energy Star Labeled Dishwasher

An average new dishwasher uses about 121 kWh per year directly, and an equivalent Energy Star dishwasher will use about only about 78 kWh per year. Estimated savings for a house with a weighted combination of electric and gas water heaters are 107 kWh and 0.01 kW, most of which is due to savings in weighted average electric hot water usage.

On the other hand, more substantial electric savings are possible if the water heater is electric. In this scenario, the savings would be about 240 kWh per year and 0.02 kW peak demand.

ID R26 Purchase Energy Star Labeled Clothes Washer

Maximum electric savings for high efficiency clothes washers can be achieved if both the water heater and dryer are electric, although by far most of the savings is due to the dryer. The most common home, however, uses natural gas for hot water. A significant number of homes had electric dryers (76%) and about 19% had electric water heaters.

For the typical home, RLW estimated annual savings to be about 110 kWh and 0.02 kW. The Energy Star clothes washer actually uses slightly more electric energy during the spin cycle to wring more water out, consequently reducing the time required for drying.

For the all-electric scenario, RLW estimated annual savings to be about 400 kWh and 0.04 kW.

<u>ID R27 Install Programmable Thermostat</u>

More than half of the homes visited already had programmable thermostats. RLW modeled the potential impacts of programmable thermostats by increasing the cooling setpoints 3.75 degrees F and decreasing the heating setpoints by 3.75 degrees F daily from 8AM to 3PM.

For this scenario RLW estimated annual savings to be about 666 kWh and -0.22 kW. Demand savings may actually be negative, as they are in this case, depending upon the setback schedule, the building mass and a thermal flywheel effect that causes the system to run longer to "make up" for the hours during which it was set back.

<u>ID R28 Install Faucet Aerators</u>

It was assumed, based on RLW's previous study for Missouri, that about 63% of all single family detached homes in Kansas City do not have a faucet aerator. RLW estimated the impacts of these by assuming that one faucet aerator would be installed on the kitchen sink, and that the energy savings would occur through a reduction in the use of hot water. The homes with gas water heaters will see no electric savings, but many of the homes in this study had electric water heaters.

The estimated savings for the typical home are 31 kWh and no measurable demand savings. For the 19% of homes with electric water heaters, the annual electric savings would be about 120 kWh and no peak demand. Actual demand savings may exist in some homes, but the schedule of kitchen faucet usage is small during the peak demand window.

Some homeowners may be willing to install and keep a faucet aerator in the bathroom. Although savings for these are not well defined, RLW has previously estimated that they might achieve about one tenth to one third the savings of the kitchen aerator. The reduced savings are, of course, due to the fact that the average bathroom sink utilizes significantly less hot water.

ID R29 Install Low Flow Showerheads

Field results of the previous study for Missouri indicate that about 40% of all single-family detached homes in Kansas City already use a low flow showerhead. RLW estimated the impacts of these by assuming that two low flow showerheads would be installed, and that the energy savings would occur through a reduction in the use of hot water. Again, the most common water heater is gas fired.

The estimated savings for the typical home are 174 kWh per year, and demand savings are negligible. For the 19% with electric water heaters the annual savings would be about 725 kWh and negligible coincident peak demand.

If there are more than two showers in a home, the low flow showerheads should be installed on the two most frequently used showers. If more than two devices are installed in a single home, the savings for the third one will probably be significantly less than those of the first two, but it will depend on how much the showers are actually used. On the other hand, if only one showerhead is installed because there is only one shower present, the savings for the one will probably be more than half the savings for two.

ID R30 Insulate Hot Water Pipes

All the audited homes of this study have hot water piping, but only portions of the pipes are easily accessible. RLW estimated conservation impacts by assuming that the exposed pipes could be insulated, and that the energy savings would occur through a reduction in the hot water standby losses. Again, the typical water heater is gas fired.

The estimated savings for the typical home are 80 kWh per year and negligible coincident peak demand. For the 19% with electric water heaters the annual electric savings would be about 355 kWh and negligible kW peak demand. Actual savings will vary significantly, depending on the amount and locations of exposed piping and the hot water usage patterns.

ID R31 Insulate Electric Water Heater Storage Tanks

RLW found that about 90% of the homes had electric water heaters that were not externally wrapped. The estimated savings for the typical home are 58 kWh per year and negligible kW. Savings for this measure will vary with the ambient temperatures surrounding the hot water tank.

ID R32 Install Energy Usage and Display Monitor Device

The Energy Use Monitor Tool (EUM) will provide the customer with a energy usage monitoring device aimed at helping them better manage their energy costs through real time feedback. With rising energy costs in all aspects of daily life, customers are looking for information they can act upon which will impact their monthly energy bill.

IDs R33, R34, R35 Early Retirement of residential HVAC SYSTEM

Energy efficiency gains of up to 100% can be obtained by replacing older HVAC units with a unit rated at a 14 SEER (ID R33), a unit rated at a 15 SEER (ID R34),

or a unit rated at a 16 SEER (ID R35). The base case assumption was that the existing HVAC unit was rated an 8 SEER.

ID R36, R37, R38 De-humidifier, Room A/C units and Freezers, early retirement

This measures offers a financial incentive to retire older de-humidifier units, old room A/C units and old freezers. The unit would be decommissioned and removed from the home.

<u>IDs R39, R40, R41 Upgrade failed HVAC System</u>

The baseline measure was a failed HVAC unit being replaced with a 13 SEER rated unit. A financial incentive would be provided to install a higher efficiency 14 seer unit, (ID R39) , a 15 SEER unit (ID R40), or a 16 SEER Unit (ID R41).

The major categories of commercial end-use measures included:

- Lighting systems – indoor, outdoor and traffic control
- Refrigeration and Food Service Equipment
- Heating, Ventilation, and Air Conditioning (HVAC)
- Motive power
- Commercial Energy Star Washing Machines
- Office equipment, both PC & Non-PC
- Thermal Storage

The major categories of industrial end-use measures included:

<u>Industrial</u>

- Lighting systems – indoor, outdoor and traffic control
- Refrigeration and Food Service Equipment
- Heating, Ventilation, and Air Conditioning (HVAC)
- Motive power
- Industrial process equipment

Lighting systems – indoor, outdoor and traffic control are listed in Table 4 and are described below.

Table 4: C&I lighting measures

ID#	Potential Situation	Improvement	Quantity
C&I L1	T12 - 20W -2' 1 Lamp - Magnetic	T8 - 17W -2' 1 Lamp - Electronic	1 Fixture
C&I L2	T12 - 20W -2' 2 Lamp - Magnetic	T8 - 17W -2' 2 Lamp - Electronic	1 Fixture
C&I L3	T12 - 20W -2' 3 Lamp - Magnetic	T8 - 17W -2' 3 Lamp - Electronic	1 Fixture
C&I L4	T12 - 20W -2' 4 Lamp - Magnetic	T8 - 17W -2' 4 Lamp - Electronic	1 Fixture
C&I L5	T12 - 30W -3' 1 Lamp - Magnetic	T8 - 25W -3' 1 Lamp - Electronic	1 Fixture
C&I L6	T12 - 30W -3' 2 Lamp - Magnetic	T8 - 25W -3' 2 Lamp - Electronic	1 Fixture
C&I L7	T12 - 30W -3' 3 Lamp - Magnetic	T8 - 25W -3' 3 Lamp - Electronic	1 Fixture
C&I L8	T12 - 30W -3' 4 Lamp - Magnetic	T8 - 25W -3' 4 Lamp - Electronic	1 Fixture
C&I L9	T12- 34W - 4' 1 Lamp - Magnetic	T8 32W - 4' 1 Lamp - Electronic	1 Fixture
C&I L10	T12- 34W - 4' 2 Lamp - Magnetic	T8 32W - 4' 2 Lamp - Electronic	1 Fixture
C&I L11	T12- 34W - 4' 3 Lamp - Magnetic	T8 32W - 4' 3 Lamp - Electronic	1 Fixture
C&I L12	T12- 34W - 4' 4 Lamp - Magnetic	T8- 32W - 4' 4 Lamp - Electronic	1 Fixture
C&I L13	T12 - 60W - 8' 1 Lamp - Magnetic	T8 - 59W - 8' 1 Lamp - Electronic	1 Fixture
C&I L14	T12 - 60W - 8' 2 Lamp - Magnetic	T8 - 59W - 8' 2 Lamp - Electronic	1 Fixture
C&I L15	T12 - 95W - 8' 1 Lamp - Magnetic - HO	T8 - 86W - 8' 1 Lamp - HO - Electronic	1 Fixture
C&I L16	T12 - 95W - 8' 2 Lamp - Magnetic - HO	T8 - 86W - 8' 2 Lamp - HO - Electronic	1 Fixture
C&I L17	32 W T8 Lamp	Low Watt T8 Lamp	1 Lamp
C&I L18	T12- 34W - 4' 1 Lamp - Magnetic	T5 - 4' 1 Lamp - 28 watt	1 Fixture
C&I L19	T12- 34W - 4' 2 Lamp - Magnetic	T5 - 4' 2 Lamp - 28 watt	1 Fixture
C&I L20	T12- 34W - 4' 3 Lamp - Magnetic	T5 - 4' 3 Lamp - 28 watt	1 Fixture
C&I L21	T12- 34W - 4' 4 Lamp - Magnetic	T5 - 4' 4 Lamp - 28 watt	1 Fixture
C&I L22	T12- 34W - 4' 2 Lamp - Magnetic	T5 - 4' 1 Lamp HO - 54 watt	1 Fixture
C&I L23	T12 - 60W - 8' 2 Lamp - Magnetic	T5 - 4' 2 Lamp HO - 54 watt	1 Fixture
C&I L24	T12- 34W - 4' 4 Lamp - Magnetic	T5 - 4' 2 Lamp HO - 54 watt	1 Fixture
C&I L25	T12 - 8' and 4' Avg	T5 - 4' 2 Lamp HO - 54 watt	1 Fixture
C&I L26	T12 - 95W - 8' 2 Lamp - Magnetic - HO	T5 - 4' 3 Lamp HO - 54 watt	1 Fixture
C&I L27	T12 - 60W - 8' 4 Lamp - Magnetic	T5 - 4' 4 Lamp HO - 54 watt	1 Fixture
C&I L28	T12 - 95W - 8' 2 Lamp - Magnetic - HO	T5 - 4' 4 Lamp HO - 54 watt	1 Fixture
C&I L29	T12 - 95W - 8' 2 Lamp - Magnetic - VHO	T5 - 4' 4 Lamp HO - 54 watt	1 Fixture
C&I L30	T12 - 95W - 8' 2 Lamp - Magnetic - HO - VHO Avg	T5 - 4' 4 Lamp HO - 54 watt	1 Fixture
C&I L31	Hi-Bay 250 W Hi Intensity Discharge	Hi-Bay 3L T5 HO Fluorescents	1 Fixture
C&I L32	Hi-Bay 400 W Hi Intensity Discharge	Hi-Bay 4L T5 HO Fluorescents	1 Fixture
C&I L33	Hi-Bay 400W Hi Intensity Discharge	Hi-Bay 6L T5 HO Fluorescents	1 Fixture
C&I L34	Hi-Bay 1000W Hi Intensity Discharge	Hi-Bay 2-6L T5 HO Fluorescents	1 Fixture
C&I L35	Hi-Bay 250 W Hi Intensity Discharge	Hi-Bay 4L F32 T8 Fluorescents	1 Fixture
C&I L36	Hi-Bay 400 W Hi Intensity Discharge	Hi-Bay 6L F32 T8 Fluorescents	1 Fixture
C&I L37	Hi-Bay 400W Hi Intensity Discharge	Hi-Bay 8L F32 T8 Fluorescents	1 Fixture
C&I L38	Hi-Bay 1000W Hi Intensity Discharge	Hi-Bay 2-8L F32 T8 Fluorescents	1 Fixture
C&I L39	Hi-Bay 400 W Hi Intensity Discharge	Hi-Bay 8L 42W CFL	1 Fixture
C&I L40	Hi-Bay 400 W Hi Intensity Discharge	Hi-Bay 320 Watt Metal Halide - Pulse Start	1 Fixture
C&I L41	Hi-Bay 400 W Hi Intensity Discharge	Hi-Bay 350 Watt Metal Halide - Pulse Start	1 Fixture
C&I L42	Hi-Bay 400 W Hi Intensity Discharge	Hi-Bay 400 Watt Metal Halide - Pulse Start	1 Fixture
C&I L43	60W Inc	15W CFL	1 Lamp
C&I L44	2-60W Inc Fixture	2-13 W CFL Fixture	1 Fixture
C&I L45	Exit Signs have CFLs	Retrofit to LED EnergyStar Exit sign	1 Fixture
C&I L46	Standard lighting switch	Install Occupancy Sensor	1 switch
C&I L47	Traffic Signal, Incandescent	Install EnergyStar Rated LED Traffic Signal	1 Fixture
C&I L48	No Skylight or light tube	Install Light Tube Commercial Skylight	1 Fixture
C&I L49	No centralized lighting controls	Install centralized lighting controls	Per Sq. Ft
C&I L50	No lighting controls	Install Multilevel Lighting Controls	Per Sq. Ft
C&I L51	No lighting controls	Install Daylight Lighting Control Sensors	Per Sq. Ft

Description of C&I Lighting Measures

<u>ID: C&I L1 to C&I L17 Replace T12 or T12HOs Fixtures with T8 or T8HO Fixtures</u>

Technology Description

For this technology, we evaluated the replacement of energy efficient T12 lamps and T12 fixtures with magnetic ballasts with T8 lamps and T8 fixtures with electronic ballasts.

Methodology and Assumptions

A standard spreadsheet analysis was developed to evaluate the use of T8 lamps and fixtures with electronic ballasts versus the use of energy efficient T12 lamps and fixtures with magnetic ballasts. Also evaluated was the replacement of T12 HO lamps and fixtures with T8HO lamps and fixtures.

Key assumptions for both scenarios:

- Cost estimates include material costs only. Fixture replacement as well as fixture retrofit costs is provided. Installation costs and potential maintenance savings are not included.

- Secondary impacts for heating and cooling were not evaluated.

- Information regarding lamp and system wattages, lumens, and material pricing was developed from a combination of lighting suppliers and industrial supply houses.

- Potential lighting replacement scenarios were evaluated based on mean lumens. Lumen is the measure of the amount of light a lamp produces. Initial lumens are the lamps' approximate light output after 100 hours of operation, while mean lumens measures the light output at 40% of its rated life. A true measure of a lamps' efficacy is how well it maintains its' light output over time.

Results Summary

The results of the analysis are shown in CI – L1 T8 Replacement of T12s.

- Standard 2’ T8 17 watt lamps with electronic ballasts can be used to replace standard 2’ T12 20 watt lamps with magnetic ballasts on a one-for-one replacement schedule for 1, 2, 3 and 4 lamp configurations, with an average 10% increase in mean lumen output.

- Standard 3’ T8 25 watt lamps with electronic ballasts can be used to replace standard 3’ T12 30 watt lamps with magnetic ballasts on a one-for-one replacement schedule for 1, 2, 3 and 4 lamp configurations, with an average 3% increase in mean lumen output.

- Standard 4’ T12 34 watt lamps with magnetic ballasts can be replaced by 4’ T8 lamps with 28, 30, or 32 watt lamps with electronic ballasts on a one-for-one replacement schedule for 1, 2, 3 and 4 lamp configurations. Utilizing T8 28 watt lamps yield an average 13% increase in mean lumens output, the T8 30 watt lamps yield an average 16% increases in mean lumens output, while the T8 32 watt lamps yield an average 17% increase in mean lumens output.

- Standard 8’ T8 59 watt lamps with electronic ballasts can be used to replace standard 8’ T12 60 watt lamps with magnetic ballasts on a one-for-one replacement schedule for 1 and 2 lamp configurations, with an average 9% increase in mean lumen output. Although replacing T12 60W 8’ 1 and 2 lamp configurations with respective T8 59W 8’ 1 and 2 lamp configurations is an energy efficient solution, it isn’t very cost effective. A more cost effective option would be to replace T12 60W 8’ 1 lamp fixtures with T8 32 W 4’2 lamp fixtures and to replace T12 60W 8’ 2 lamp fixtures with T8 32 W 4’ 4 lamp fixtures. This option results in a 5% increase in mean lumen output.

- Standard 8’ T8 86 watt HO lamps with electronic ballasts can be used to replace standard 8’ T12 95 watt HO lamps with magnetic ballasts on a one-for-one replacement schedule for 1 and 2 lamp configurations, with an average 9% increase in mean lumen output.

- Standard 2’ T8 32W watt U-Bend lamps with electronic ballasts can be used to replace standard 2’ T12 34 watt U-Bend lamps with magnetic ballasts on a one-for-one replacement schedule for 1 and 2 lamp configurations, with an average 12% increase in mean lumen output.

Measure Life

Fixture and ballast life data range from 10 to 16 years, we recommend 10 years.

Initial One-Time Costs

A summary of costs are shown in CI – L1 T8 Replacement of T12s.

Existing Energy Standards

There are currently no standards for this technology.

Sources of Information

Center Point Energy lighting wattage table, manufacturers’ data, and utility data.

Energy savings and cost information are listed in Table 5 and in Table 6.

Table 5: Energy savings, T12s to T8 fixtures

Assumptions	
Minimum Operating Hours	1,800
Demonstration Operating Hours*	3,680

*** hours based on 16hrs/day, 5 days/week, 52 weeks/year**

ID	Energy Efficient Installation T 8 w/Electronic Ballast	Energy Efficient System Wattage	Standard Installation T12 w/Magnetic Ballast	Standard System Wattage	kW Savings	Demonstration Operating Hours	Energy Savings kWh/yr
C&I L1	T8 - 17W -2' 1 Lamp - Electronic	20	T12 - 20W -2' 1 Lamp - Magnetic	27.5	0.008	3,680	28
C&I L2	T8 - 17W -2' 2 Lamp - Electronic	33	T12 - 20W -2' 2 Lamp - Magnetic	43	0.010	3,680	35
C&I L3	T8 - 17W -2' 3 Lamp - Electronic	48	T12 - 20W -2' 3 Lamp - Magnetic	68	0.020	3,680	74
C&I L4	T8 - 17W -2' 4 Lamp - Electronic	63	T12 - 20W -2' 4 Lamp - Magnetic	85	0.022	3,680	81
C&I L5	T8 - 25W -3' 1 Lamp - Electronic	26	T12 - 30W -3' 1 Lamp - Magnetic	37	0.011	3,680	40
C&I L6	T8 - 25W -3' 2 Lamp - Electronic	43	T12 - 30W -3' 2 Lamp - Magnetic	53	0.010	3,680	37
C&I L7	T8 - 25W -3' 3 Lamp - Electronic	78	T12 - 30W -3' 3 Lamp - Magnetic	90	0.012	3,680	44
C&I L8	T8 - 25W -3' 4 Lamp - Electronic	86	T12 - 30W -3' 4 Lamp - Magnetic	106	0.020	3,680	74
C&I L9	T8 32W - 4' 1 Lamp - Electronic	30	T12- 34W - 4' 1 Lamp - Magnetic	44	0.014	3,680	52
C&I L10	T8 32W - 4' 2 Lamp - Electronic	60	T12- 34W - 4' 2 Lamp - Magnetic	77	0.017	3,680	63
C&I L11	T8 32W - 4' 3 Lamp - Electronic	88	T12- 34W - 4' 3 Lamp - Magnetic	120	0.032	3,680	118
C&I L12	T8- 32W - 4' 4 Lamp - Electronic	112	T12- 34W - 4' 4 Lamp - Magnetic	150	0.038	3,680	140
C&I L13	T8 - 59W - 8' 1 Lamp - Electronic	58	T12 - 60W - 8' 1 Lamp - Magnetic	69	0.011	3,680	40
C&I L14	T8 - 59W - 8' 2 Lamp - Electronic	112	T12 - 60W - 8' 2 Lamp - Magnetic	132	0.020	3,680	74
C&I L15	T8 - 86W - 8' 1 Lamp - HO - Electronic	80	T12 - 95W - 8' 1 Lamp - Magnetic - HO	105	0.025	3,680	92
C&I L16	T8 - 86W - 8' 2 Lamp - HO - Electronic	160	T12 - 95W - 8' 2 Lamp - Magnetic - HO	210	0.050	3,680	184
C&I L17	Low Watt T8	28	32 W T8	32	0.004	3,680	15

Table 6: Cost information, T12s to T8 fixtures

Product Description	Fixture Replacement Material Totals	Fixture Replacement Material Totals	Fixture Retrofit Material Totals
T8 - 17W -2' 1 Lamp - Electronic	$56.43	$56.43	$33.00
T8 - 17W -2' 2 Lamp - Electronic	$62.88	$62.88	$36.00
T8 - 17W -2' 3 Lamp - Electronic	$108.29	$108.29	$54.00
T8 - 17W -2' 4 Lamp - Electronic	$114.72	$114.72	$57.00
T8 - 25W -3' 1 Lamp - Electronic	$56.60	$56.60	$33.00
T8 - 25W -3' 2 Lamp - Electronic	$63.20	$63.20	$36.00
T8 - 25W -3' 3 Lamp - Electronic	$108.80	$108.80	$54.00
T8 - 25W -3' 4 Lamp - Electronic	$115.40	$115.40	$57.00
T8 32W - 4' 1 Lamp - Electronic	$63.10	$63.10	$33.00
T8 32W - 4' 2 Lamp - Electronic	$75.90	$75.90	$36.00
T8 32W - 4' 3 Lamp - Electronic	$80.15	$80.15	$54.00
T8- 32W - 4' 4 Lamp - Electronic	$144.55	$144.55	$57.00
T8 - 59W - 8' 1 Lamp - Electronic	$137.43	$137.43	$49.50
T8 - 59W - 8' 2 Lamp - Electronic	$146.56	$146.56	$54.00
T8 - 86W - 8' 1 Lamp - HO - Electronic	$146.55	$146.55	$66.00
T8 - 86W - 8' 2 Lamp - HO - Electronic	$164.80	$164.80	$72.00

ID: C&I L18 to C&I L30 Replace T12 or T12HOs fixtures with T5 or T5HO Fixtures

Technology Description

For this technology, we evaluated the replacement of energy efficient T12 lamps and T12 fixtures with magnetic ballasts with T5 lamps and T5 fixtures with electronic ballasts.

Methodology and Assumptions

A standard spreadsheet analysis was developed to evaluate the use of T5 lamps and fixtures with electronic ballasts versus the use of energy efficient T12 lamps and fixtures with magnetic ballasts. Also evaluated was the replacement of T12 HO lamps and fixtures with T5HO lamps and fixtures.

Key assumptions for both scenarios:

- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
- Secondary impacts for heating and cooling were not evaluated.
- Information regarding lamp and system wattages, lumens, and material pricing was developed from a combination of lighting suppliers and industrial supply houses.
- Potential lighting replacement scenarios were evaluated based on mean lumens. Lumen is the measure of the amount of light a lamp produces. Initial lumens are the lamps' approximate light output after 100 hours of operation, while mean lumens measures the light output at 40% of its rated life. A true measure of a lamps' efficacy is how well it maintains its' light output over time.

Results Summary

The results of the analysis are shown in CI – L2 T5s for T12s.

- Standard 4’ T5 28 watt lamps with electronic ballasts can be used to replace standard 4’ T12 34 watt lamps with magnetic ballasts on a one-for-one replacement schedule for 1, 2, 3 and 4 lamp configurations, with an average 20% increase in mean lumen output.

- T5 54W 4’ 1 lamp HO fixture can be utilized to replace a T12 34W 4’ 2 lamp fixture with a 3% increase in mean lumen output.

- T5 54W 4’ 2 lamp HO fixture can be utilized to replace a T12 60W 8’ 2 lamp fixture, but mean lumen output would decrease by 7%. The fixture can also be used to replace a T12 34W 4’ 4 lamp fixture with a 32% decrease in mean lumen output. Savings were determined for this fixture assuming an equal mix of these two replacements.

- T5 54W 4’ 3 lamp HO fixture can be utilized to replace a T12 95W 8’ 2 lamp HO fixture, with a 1% increase in mean lumen output.

- T5 54W 4’ 4 lamp HO fixture can be utilized to replace a T12 60W 8’ 4 lamp fixture, but mean lumen output would decrease by 6%. The fixture can also be used to replace a T12 95W 8’ 2 lamp HO or VHO fixture. Lumen output is 35% higher than the HO fixture and 28% lower than the VHO fixture. Savings were determined for this fixture assuming an equal mix of these three replacements.

Due to the high cost of the T5 fixtures, paybacks are generally not acceptable at lower operating hours. Some T5 options may be viable at higher operating hours, if substantial incentives are provided.

Due to the high lumen output, T5s may be too bright for low bay application and standard one-for-one T12 replacement. T5 technology may be better suited for high bay applications (ceiling heights > 15 feet) such as HID replacement.

Measure Life

Fixture and ballast life data range from 10 to 16 years, we recommend 10 years.

Initial One-Time Costs

A summary of costs are shown in CI – L2 T5s for T12s.

Suggested Incentives

T5 - 4' 1 Lamp - 28 watt $5.00

T5 - 4' 2 Lamp - 28 watt $8.00

T5 - 4' 3 Lamp - 28 watt $10.00

T5 - 4' 4 Lamp - 28 watt $12.00

T5 - 4' 1 Lamp HO - 54 watt $6.00

T5 - 4' 2 Lamp HO - 54 watt $9.00

T5 - 4' 3 Lamp HO - 54 watt $11.00

T5 - 4' 4 Lamp HO - 54 watt $13.00

Existing Energy Standards

There are currently no standards for this technology.

Sources of Information

Center Point Energy lighting wattage table, manufacturers' data, and utility data.

Energy savings and cost information are listed in **Error! Reference source not found.** and Table 8 below:

Table 7: Energy Savings - T12 to T5

Assumptions	
Demonstration Operating Hours	3,680

Measure ID	Energy Efficient Installation T 5 w/Electronic Ballast	Energy Efficient System Wattage	Standard Installation	Standard System Wattage	Watts Savings	kW Savings	Operating Hours	Energy Savings kWh/yr
C&I L18	T5 - 4' 1 Lamp - 28 watt	32	T12- 34W - 4' 1 Lamp - Magnetic	44	12	0.012	3,680	44
C&I L19	T5 - 4' 2 Lamp - 28 watt	65	T12- 34W - 4' 2 Lamp - Magnetic	77	12	0.012	3,680	44
C&I L20	T5 - 4' 3 Lamp - 28 watt	93	T12- 34W - 4' 3 Lamp - Magnetic	120	27	0.027	3,680	99
C&I L21	T5 - 4' 4 Lamp - 28 watt	126	T12- 34W - 4' 4 Lamp - Magnetic	150	24	0.024	3,680	88
C&I L22	T5 - 4' 1 Lamp HO - 54 watt	62	T12- 34W - 4' 2 Lamp - Magnetic	77	15	0.015	3,680	55
C&I L23	*T5 - 4' 2 Lamp HO - 54 watt*	*122*	*T12 - 60W - 8' 2 Lamp - Magnetic*	*132*	*10*	*0.010*	*3,680*	*37*
C&I L24	*T5 - 4' 2 Lamp HO - 54 watt*	*122*	*T12- 34W - 4' 4 Lamp - Magnetic*	*150*	*28*	*0.028*	*3,680*	*103*
C&I L25	T5 - 4' 2 Lamp HO - 54 watt	122	T12 - 8' and 4' Avg	141	19	0.019	3,680	70
C&I L26	T5 - 4' 3 Lamp HO - 54 watt	185	T12 - 95W - 8' 2 Lamp - Magnetic - HO	210	25	0.025	3,680	92
C&I L27	*T5 - 4' 4 Lamp HO - 54 watt*	*243*	*T12 - 60W - 8' 4 Lamp - Magnetic*	*264*	*21*	*0.021*	*3,680*	*77*
C&I L28	*T5 - 4' 4 Lamp HO - 54 watt*	*243*	*T12 - 95W - 8' 2 Lamp - Magnetic - HO*	*210*	*(33)*	*(0.033)*	*3,680*	*(121)*
C&I L29	*T5 - 4' 4 Lamp HO - 54 watt*	*243*	*T12 - 95W - 8' 2 Lamp - Magnetic - VHO*	*380*	*137*	*0.137*	*3,680*	*504*
	T5 - 4' 4 Lamp HO - 54 watt	243	T12 - 95W - 8' 2 Lamp - Magnetic - HO - VHO Avg	295	52	0.052	3,680	191

Table 8: Cost, T5 Fixture

Product Description	Material Totals
T5 - 4' 1 Lamp - 28 watt	$59.30
T5 - 4' 2 Lamp - 28 watt	$74.12
T5 - 4'3 Lamp - 28 watt	$78.60
T5 - 4'4 Lamp - 28 watt	$87.56
T5 - 4'1 Lamp HO - 54 watt	$120.00
T5 - 4'2 Lamp HO - 54 watt	$140.00
T5 - 4'3 Lamp HO - 54 watt	$175.00
T5 - 4' 4 Lamp HO - 54 watt	$223.88

ID: C&I L31 to C&I L42 High Bay Fluorescents and Pulse-Start HIDs

Technology Description

In high bay lighting applications (ceiling heights > 15 feet), high intensity discharge (HID) fixtures are typically utilized due to their high lumen output. Although high pressure sodium fixtures are energy efficient, they do not provide good color rending. Probe-start metal halide fixtures are typically installed for high bay lighting applications because they deliver crisp white light, even though they are not very energy efficient.

Traditional probe-start metal halide lamps have an internal starting electrode, or probe, powered by a high open circuit voltage (600v peak voltage) from the ballast to initiate an arc. The ballast starts the lamps as well as regulates the current through the lamp. The necessity of the probe-start mechanism and its' high open circuit voltage requirement contributes to shorter ballast and lamp life, poor lumen maintenance, and poor lamp efficacy.

Methodology and Assumptions

The analysis for this technology was performed to evaluate the use of high bay fluorescents and pulse-start metal halides versus traditional probe-start metal halides in high bay applications.

Ten high bay applications were evaluated:

1. T5 fixtures utilizing 3, 4, 6, and 12, high output lamps (T5HO), replacing, 250W, 400W, and 1000W metal halide fixtures.

2. T8 fixtures utilizing 4, 6, 8, and 16, 32 watt lamps (F32T8), replacing, 250W, 400W, and 1000W metal halide fixtures.

3. Compact fluorescent fixture utilizing eight (8) 42 watt c.f. lamps – 8L42WCF replacing a 400W metal halide fixture.

4. Pulse-Start metal halides at various wattages replacing 400W probe start metal halides. Pulse-start metal halide fixtures have an igniter incorporated in the pulse-start ballast which delivers a high voltage pulse to start the pulse-start lamp. The pulse-start ballast has a lower open circuit voltage requirement which contributes to lower ballast operating temperatures, resulting in longer ballast and lamp life, great lumen maintenance and lamp efficacy. Pulse-start metal halide fixtures have faster warm up times and quicker re-strike times compared to traditional probe-start metal halide fixtures.

Key assumptions:

a. Base case probe-start metal halide fixture as summarized above

b. Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

c. Information regarding lamp and system wattages, lumens, and material pricing was developed from a combination of lighting suppliers and industrial supply houses.

d. Secondary impacts for heating and cooling were not evaluated.

e. Potential lighting replacement scenarios were evaluated based on mean lumens. Lumen is the measure of the amount of light a lamp produces. Initial lumens are the lamps' approximate light output after 100 hours of operation, while mean lumens measures the light output at 40% of its rated life. A true measure of lamps' efficacy is how well it maintains its' light output over time.

Results Summary

The results of the analysis are shown in CI – L3 High Bay Fluorescents.

All T5HO fixtures are acceptable replacements for the metal halide fixtures they were compared to. Each result in a deviation in lumen output of 25% or less.

All F32T8 fixtures are acceptable replacements for the metal halide fixtures they were compared to. All but one result in a deviation in lumen output of 25% or less. The 2-8LT8 fixture replacement for a 1000W fixture results in a decrease in lumen output of 38%, but this is still a common fixture replacement.

The 8L42WCF fixtures may not be a cost effective option as cost is high compared to the above measures.

The 320WMH-PS fixtures deliver the same mean lumens as the standard system.

The 350WMH-PS fixtures result in a 12% increase in mean lumens, but have significantly lower savings.

The 400WMH-PS fixtures are not a cost effective option unless delamping scenarios are evaluated, as a one for one replacement results in savings.

Measure Life

Fixture and ballast life data range from 10 to 16 years, we recommend 10 years.

Initial One-Time Costs

A summary of costs are shown in CI – L3 High Bay Fluorescents.

Suggested Incentives

High Bay 3L T5HO	$	40.00
High Bay 4LT5HO	$	50.00
High Bay 6L T5HO (400W replacement)	$	40.00
High Bay 2 - 6L T5HO (1000W replacement)	$	120.00
High Bay Fluorescent 4LF32T8	$	40.00
High Bay Fluorescent 6LF32T8	$	50.00
High Bay Fluorescent 8LF32T8 (400 W replacement)	$	40.00
High Bay Fluorescent 8LF32T8 (1000 W replacement)	$	120.00
Pulse Start Metal Halide (retrofit only)	$	25.00
42W 8 Lamp Hi Bay CFL	$	50.00

Existing Energy Standards

There are currently no standards for this technology.

Sources of Information

Center Point Energy lighting wattage table, manufacturers' data, and utility data.

Energy savings and cost information is listed in Table 9 and Table 10 below:

Table 9: Energy savings, Hi-bay Fluorescent

	Assumptions								
	Operating Hours	4,160							
Measure ID	Energy Efficient Installation Hi Bay Fluorescents	Energy Efficient System Wattage	Standard Installation	Standard System Wattage	Watts Savings	kW Savings	Demonstration Operating Hours	Energy Savings kWh/yr
C&I L31	3L T5 HO	182	250 W HID	290	108	0.108	4,160	449
C&I L32	4L T5 HO	243	400 W HID	455	212	0.212	4,160	882
C&I L33	6L T5 HO	365	400W HID	455	90	0.09	4,160	374
C&I L34	2-6L T5 HO	730	1000W HID	1080	350	0.35	4,160	1,456
C&I L35	4L F32 T8	142	250 W HID	290	148	0.148	4,160	616
C&I L36	6L F32 T8	224	400 W HID	455	231	0.231	4,160	961
C&I L37	8L F32 T8	299	400W HID	455	156	0.156	4,160	649
C&I L38	2-8L F32 T8	598	1000W HID	1080	482	0.482	4,160	2,005
C&I L39	8L 42W CFL	372	400 W HID	455	83	0.083	4,160	345
C&I L40	320 Watt Metal Halide - Pulse Start	342	400 W HID	455	113	0.113	4,160	470
C&I L41	350 Watt Metal Halide - Pulse Start	375	400 W HID	455	80	0.08	4,160	333
C&I L42	400 Watt Metal Halide - Pulse Start	455	400 W HID	455	0	0	4,160	0

Table 10: Cost, Hi-bay Fluorescent

Fixture Installation	Material Cost
320 Watt Metal Halide - Pulse Start	$150.00
350 Watt Metal Halide - Pulse Start	$160.00
400 Watt Metal Halide - Pulse Start	$170.00
3L T5 HO	$180.00
4L T5 HO	$192.00
6L T5 HO	$350.00
4L F32 T8	$160.00
6L F32 T8	$160.00
8L F32 T8	$200.00
8L 42W CFL	$395.00

<u>ID: C&I L43 to C&I L44 Compact Fluorescent Lamps and Fixtures</u>

Technology Description

Compact fluorescent lamps were evaluated for the replacement of incandescent lamps. Hard-wired compact fluorescent fixtures were also evaluated in installations in lieu of incandescent fixtures.

Methodology and Assumptions

A spreadsheet calculation was performed with standard lighting wattages. Savings for typical conversions were calculated. Replacements were chosen to provide equivalent lumen output.

Key assumptions:

Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

Secondary impacts for heating and cooling were not evaluated.

Estimated Energy Savings – kWh

Screw based Compact Fluorescent Lamp annual savings 149 kWh/lamp. Assumes 1- 15W CFL replacing 60W incandescent lamp.

Compact Fluorescent Fixtures (hardwired) annual savings 308 kWh/fixture. Assumes 1 fixture with 2 -13W lamps (27W total) replacing 1 incandescent fixture with 2-60W lamps.

Assumptions include: 3,680 annual hours of operation (average of all commercial and industrial customers).

Summer Peak Savings

Screw based Compact Fluorescent Lamp – .0405 kW/lamp. Assumes 1- 15W CFL replacing 60W incandescent lamp.

Compact Fluorescent Fixtures (hardwired) - .0837 kW/fixture. Assumes 1 fixture with 2 -13W lamps (27W total) replacing 1 incandescent fixture with 2-60W lamps.

Assumes 90% of lighting is on during peak times.

Measure Life

Screw in Compact Fluorescent lamps 2 years (available with average rated life of 6,000 to 10,000 hours. Assumed mean life would be 8,000 hours for CFLs.)

Hardwired Compact Fluorescent fixtures: 12 years. Source: California Public Utilities Commission

Initial One-Time Cost

Screw in CFLs range in price from less than $3.00/lamp for shorter lifetime mainstream wattage lamps to over $20.00/lamp for specialty CFLs such as dimmable ballast reflector floods and other decorative styles.

Compact Fluorescent Fixtures are available for as little as $15.00/fixture for simple single lamp indoor or outdoor fixtures with magnetic ballasts, and over $200.00/fixture for commercial grade decorative fixtures with multiple lamps and electronic ballast. Median price range is $35.00-85.00/fixture for most common configurations.

Any Recurring Costs

Lamps will require replacement approximately every 2.5 years in a commercial building due to assumed average rated lamp life of 8,000 hours.

Suggested Incentives

CFL screw in lamps: $1.00 to $2.00 for standard units.

Hardwired new CFL fixtures: $10.00/fixture

Consideration of greater incentive for specialty items.

Requirements For Application

Compact fluorescent lamps must be replacing incandescent lamps. CFL fixtures should contain pin based lamps and be a hardwired installation. CFLs specified should be approximately ¼ of the wattage of the incandescent they are replacing.

Existing Energy Standards

Energy Star standards are available for both technologies for residential use. Considerations include rated lamp life, flicker free lamps, and descriptive information on packaging. Many commercial fixtures have not been evaluated for Energy Star residential list, but are appropriate replacements for incandescent and should not be excluded.

Sources of Information

Energy Star, Center Point Energy Lighting Wattage Table, lightsearch.com.

Energy savings information is listed in Table 11 below:

Table 11: Energy savings, CFLs

ID	C&I L43	C&I L44
EXISTING	Test	Test
Lighting Type	60W Inc	2-60W Inc Fixture
Number of Fixtures	1	1
Lamps per Fixture	1	2
Fixture Wattage	60	120
LF - Load Factor	0.9	0.9
Annual Operating Hours	3,680	3,680
Conversion Factor	1,000	1,000
kW	0.054	0.108
kWh/Yr Use	199	397
Average kWh Rate	$0.070	$0.070
Annual Energy Cost	$14	$28
PROPOSED		
Lighting Type	15W CFL	2-13 W CFL Fixture
Number of Fixtures	1	1
Lamps per Fixture	1	2
Fixture Wattage	15	27
Conversion Factor	1,000	1,000
kW	0.014	0.024
kWh/Yr Use	50	89
Gas Increase (th/yr)	NA	NA
Average therm Rate	$0.070	$0.070
Annual Energy Cost	$3	$6
SAVINGS		
kW	0.0405	0.0837
kWh/Yr Use	149	308
th/yr	NA	NA
Annual Energy Cost	$10	$22
Project cost Estimate	$3	$45
Simple Payback	0.3	2.1

ID: C&I L45 LED Exit Signs

Technology Description

Exit signs that have earned the ENERGY STAR label operate on five watts or less per sign, compared to standard signs, which use as much as 40 watts per sign.

Energy Savings – kWh and Summer Peak Savings

ENERGY STAR lists typical savings of 149 kWh and 31W. This assumes two CFL lamps in the base unit. As many existing fixtures have incandescent lamps these values are conservative.

Measure Life

15 years

Initial One-Time Cost

Material costs are found in the range of $20 - $40.

Suggested Incentive

A $10 incentive is recommended. Program incentives range from $5 to $35, or offer the fixtures at no cost.

Requirements

There are ENERGY STAR program requirements for LED Exit Signs. Signals must be less than 5W and have power factors above 0.7.

Existing Energy Standards, ENERGY STAR

Sources of Information

ENERGY STAR website

Manufacturers' website.

ID: C&I L46 Occupancy Sensors

Technology

Occupancy sensors represent an energy-efficient way to control lighting use in low occupancy areas such as halls, storage rooms, and restrooms. Instead of relying on people to remember to switch lights off when they leave a space, occupancy sensors perform this task. They measure the movement of people within a space. When movement is detected, the lights turn on automatically; they then shut off when they no longer sense movement. Each unit's shut-off time can be preset, given the needs of the space being controlled.

Estimated Energy Savings – kWh

Savings estimates vary by type of space and connected load. We are suggesting a two tier incentive based on square footage controlled. Larger square footages controlled will likely result in higher costs for multiple sensors, additional wiring, etc. We are not specifying savings or incentives by type of space assuming a natural mix in actual applications.

Industry Estimates of potential energy savings for occupancy sensors (%)

Space Type	CEC	Esource		EPRI	Novitas	Watt Stopper
Private office	25-50	13-50	30	40-55	15-70	
Open office	20-25	20-28	15	30-35	5-25	
Classroom	-	40-46	20-35	30-40	10-75	
Conference	45-65	22-65	35	45-65	20-65	
Restroom	30-75	30-90	40	45-65	30-75	
Warehouses	50-75	-	55	70-90	50-75	
Storage	45-65	45-80	-	-	45-65	

Assumed 3,680 annual hours of operation (average of all commercial and industrial customers), a 30% reduction in operating hours and 1.2 watts/square foot of lighting controlled.

Under 500 ft2 300 ft^2 average x 1.2 watt/ft^2 x 3680 hours x 30% = 397 kWh

1000 watts/kWh

Over 500 ft^2 750 ft^2 average x 1.2 watt/ft^2 x 3680 hours x 30% = 994 kWh

1000 watts/kWh

Summer Peak Savings

None – occupancy sensors may reduce load at peak but not for many applications. Average demand savings are 0.11 kW and 0.27 kW.

Measure Life

8-15 years listed in programs reviewed, DEER list 8 years, we recommend 8 years.

Initial One-Time Cost

Prices vary depending on sensor capability. Range from approximately $40 for low end or residential model to $200, not including installation. Assume $100 to $400/unit installed.

Any Recurring Costs

None.

Suggested Incentive

Under 500 ft^2 - $20/unit

Over 500 ft^2 - $40/unit

Incentive could be structured on wattage controlled or at a single incentive level for all installations.

Requirements For Application

Care should be taken when specifying occupancy sensors to ensure occupant satisfaction. Two main technologies used for occupancy sensors are passive infrared (PIR) and ultrasonic. PIR sensors react to body heat and sense occupancy by detecting the difference in heat from a body and the background. Ultrasonic sensors use volumetric detectors and broadcast sounds above the range of human hearing, then measure the time it takes the waves to return and can detect persons behind obstructions.

Both types of sensors feature a delay adjustment which sets the time that lights are on after no occupancy is detected and a sensitivity adjustment which makes the unit either more or less sensitive to motion. Delays should not be set for less than 10 minutes so that lamp life is not affected or make sure that programmed start ballasts are specified with fluorescent lamps.

Ultrasonic sensors are sensitive to air movement from HVAC diffusers and should be adjusted to a point at which they are not sensing air movement.

Existing Energy Standards

There are currently no Energy Star standards for this technology.

Sources of Information

FEMP, LRC; Green Seal Report, manufacturer's web sites Novitas, Leviton, Watt Stopper, Pass & Seymour Legrand

ID C&I L47 LED Traffic Lights

Technology Description

ENERGY STAR labeled signals perform better than incandescent models and are a better value. Compared to standard incandescents, ENERGY STAR labeled traffic signals use 80 - 90% less energy, and have lower maintenance costs because they need to be replaced less frequently.

Energy Savings – kWh

The energy savings varies for red, green and yellow signals. Savings also varies for round lamps, arrows and pedestrian signals. Reviewing details on California, Wisconsin and Texan programs, the savings below are typical.

In general savings are greater on car traffic signals and costs for the lamps are generally less than for pedestrian signals. The recommendations include a breakdown between the two types of signals.

Traffic signal (per lamp average) 275 kWh

Pedestrian signal 150 kWh

Summer Peak Savings

Traffic signal (per lamp average) 0.085 KW

Pedestrian signal 0.044 KW

Measure Life

Lamps rated for 30,000 to 40,000 hours which would provide for a 10 to 15 year life on traffic signal lights. We have seen municipalities plan for a 5 to 7 year change out schedule. Assume 6 to 8 years.

Initial One-Time Cost

Lamp costs vary significantly. Green generally cost 50% more than yellow or red. Pedestrian lamps generally 50% to 100% more expansive than traffic lamps.

Traffic Signals $50/lamp

Pedestrian $100/lamp

Suggested Incentive

Traffic Signals $12.50/lamp

Pedestrian $25/lamp

Incentives have been recently noted as high as $35/lamp (even higher when technology first became available) but feel lower incentives are adequate.

Requirements

There are Energy Star Program Requirements for LED Traffic Signals. Signals must be connected to a metered electric service. Some utilities charge municipalities per fixture or per intersection for traffic lights.

Existing Energy Standards

Energy Star

Sources of Information

LED Traffic signal programs from Texas, California and Wisconsin. Energy Star website. Manufacturers website.

CI – L48 Light Tube Commercial Skylight

Technology Description

This technology is essentially a 10” to 21” diameter skylight with a prismatic or translucent lens that reflects light captured from a roof opening through a highly specular reflective tube down to the mounted fixture height. When in use, a light tube fixture resembles a metal halide fixture. Uses include grocery, school, retail and other single story commercial buildings.

Estimated Energy Savings – kWh

As noted on the following table, the average savings is calculated to be 361 kWh. Please note, this assumes only 21” and 14” installations.

Brand/size	Lumen Output	Equivalent	KW	kWh
Solatube 21”	13,500-20,500	2-3LF32T8 172W	0.172	481.6
14”	6000-9100	1-3LF32T8	0.086	240.8
10”	3000-4600	3-18W quad	0.054	151.2
		AVERAGE	0.129	361.2

2800 hours per year used for savings calculations. Manufacturers maintain that light overcast conditions still allow for adequate output to offset electric light use.

Summer Peak Savings

There would be a fairly high correlation between sunlight available for the light tube and summer peak demand. Using 90% of the 0.129 KW average shown above results in a demand reduction estimate of 0.116 KW.

Measure Life

Warranty is 10 years. We have assumed a 14 year average life.

Initial One-Time Cost

Do it yourself kits range in price from approximately $300 to $500. Labor to install varies (approx. $200-$400) based on the type of roof deck. Average cost assumed to be on the low end, $500. Unless installations are easy and straightforward we don’t feel many customers will utilize this technology. New construction installations are less expensive, and likely more viable.

Any Recurring Costs

Flashing may need occasional maintenance and lens many need cleaning.

Suggested Incentive

California Commercial Skylight program offers $56 for each installed 21" Solatube skylight. California incentives tend to be fairly high on a cost per kWh basis. This technology appears to have a relatively low savings level compared to the cost thus an extensive incentive is difficult to justify. We recommend using $75 for the analysis. We see this as most cost effective in the new construction market where installation costs are lower and planning and design can maximize savings.

Requirements

Commercial and Industrial interior spaces that would otherwise require electric lighting between 1-4PM on weekdays during the summer to reduce peak demand.

Existing Energy Standards

There are currently no standards for this technology.

Sources of Information

California Energy Commission website www.energy.ca.gov, www.evsolar.com/daylighting.htm, www.elitesolarsystems.com, www.Solatube.com/solamaster.htm , www.dayliteco.com, PG&E Daylighting McDonald's case study, manufacturer's web sites,

ID: C&I L49 Centralized Lighting Control

Technology Description

Allow automated control of lighting systems. Included in this technology are simple time clocks, package programmable relay panels, and complete building automation systems. This type of control is most often used with programming schedules to light only areas that are occupied based on typical occupant schedules and utilize wall switches or occupancy sensors to determine when occupants are in a space at a non-typical time and allow adjustments to the lighting accordingly. Increased savings are possible by incorporating photosensors with a centralized lighting control system to indicate when it is appropriate to decrease the lighting level in perimeter building areas. Energy savings are maximized by integrating other systems such as security systems that detect employee keycards and can turn on or off lighting in office areas accordingly. Limitations include high initial and maintenance costs and compatibility of components. This technology is easiest to implement in new construction, however retrofit is a possibility.

Estimated Energy Savings – kWh

Timers 10-20% of lighting energy, Building Automation systems with photoelectric controls 20-30%

Key assumptions:

Lights on for an average of 3,680 hours, even though 3,956 annual hours of operation (average of all commercial and industrial customers). 1.25 Watts per square foot, average lighting level in space to be controlled, 15% savings on simple timer systems and 25% on more sophisticated building automation and controls. Estimated savings averages 1.15 kWh per square foot per year.

$(1.25\ W/ft^2 / 1000W/kW) \times (25\%\ savings) \times 3{,}680\ hrs = 1.15\ kWh/ft^2/yr$

Summer Peak Savings

Assumes at least 90% of lighting on during peak times. Assume peak savings is negligible. Average demand savings is 3.12 kW/10,000 ft_2.

Measure Life

DEER lists 16 years, programs reviewed show 10-15 years, we recommend 12 years.

Initial One-Time Cost

Simple time clocks are available for as little as $49.00 for an electronic 20A programmable 7 day timer. Building automation systems can be in the hundred thousands of dollars. The simple timeclock installed for $100 in a 150 square foot office will only cost about $0.67/square foot. Large systems could cost several dollars per square foot. This analysis assumes can average cost of $0.90 per square foot.

Any Recurring Costs

Requires regular maintenance and adjustments in scheduling due to changes in usage by occupants.

Suggested Incentive

We recommend a $.10/square foot assumption be used. Could consider adding to incentives if systems create other opportunities for daylighting and/or multilevel lighting.

Requirements

System should be automated and must consider occupant schedules and override for safety.

Existing Energy Standards

There are currently no standards for this technology.

Sources of Information

Lighting Research Center –"Controlling lighting with building automation systems", ACEEE Guide to Energy Efficient Commercial Equipment, FEMP, DEER

<u>ID: C&I L50 Multilevel Lighting Control</u>

Technology Description

Systems allow occupants or building control systems the ability to vary the amount of lighting in a space using multilevel switching to create different lighting schemes based on the task illumination requirements. Examples are: Conference rooms, auditoriums, classrooms and other multipurpose rooms where lighting needs may be at different levels for meetings, presentations, etc. Fluorescent fixtures with 3 lamps may be contain 2 ballasts to control inboard and outboard lamps to vary the amount of illumination generated by the fixture. Occupants can operate fixtures at 3 levels – 1 lamp, 2 lamps or all 3 lamps. Other examples are multiple fixture types, such as in a conference or multimedia room where occupants may choose to operate perimeter lights, accent lights or task lights separately from ambient lighting for multiple levels of lighting.

Another area where multilevel lighting might be used is in warehouse areas that are frequently unoccupied or are illuminated by skylights. In this situation, lighting with multilevel (high/low) capability can be switched to low output based on input from an occupancy or daylight sensor. A consideration for multilevel HID is that in many cases, the lamp loses efficacy at reduced power – for example at the high setting a 400W MH is operating at 100% input wattage and 100% lamp lumens, but at 50% power the lamp lumens are at approximately 23-30%. An option to operate lamps at 50% light level is also available, but the energy savings are not as great (approx 30% energy reduction).

Estimated Energy Savings – kWh

Savings varies by application and user preferences. Classrooms can take advantage of available daylight and switch lighting rows next to windows off to achieve savings (approx. 20-30% at perimeter). Savings for HID bi-level can be estimated at approximately 24% compared to single level HID fixtures. These savings are likely optimistic compared to the universe of potential applications. Average savings is estimated at 15-20%. Based on 3,680 burn hours per year savings should be about 0.8 kWh per square foot.

$(1.25 \text{ W/ft}^2 / 1000\text{W/kW}) \times (17.5\% \text{ savings}) \times 3{,}680 \text{ hrs} = 0.80 \text{ kWh/ft}^2\text{/yr}$

Summer Peak Savings

Assume peak demand impact is negligible. Average demand savings is 2.2 kW/10,000 ft^2.

Measure Life

DEER lists 16 years, programs reviewed show 10-15 years, we recommend 12 years.

Initial One-Time Cost

One time cost on new construction can be fairly minimal. Costs on retrofit will vary significantly with sophistication of the project. Assume $1/square foot for lack of substantial detail.

Any Recurring Costs

Commissioning to ensure proper performance of sensors if used.

Suggested Incentive

Minimal incentive based on savings potential and applications. Assumed to be $.05/square foot. Savings more reliable if multilevel lighting is part of a lighting automation or controlled daylighting strategy.

Requirements

Should be used with daylight or occupancy sensors to automate and maximize savings.

Existing Energy Standards

There are currently no Energy Star standards for this technology.

Sources of Information

PG&E, LRC, manufacturer websites.

ID: C&I L51 Daylight Sensor Lighting Control

Technology Description

Systems use photoelectric controls to take advantage of available daylight in perimeter building spaces (open spaces within 10' to 15' of windows) or other areas that have access to daylight infiltration. Photoelectric controls can be used to turn lights on or off, stepped dimming (high/low or inboard/outboard), or continuous dimming based on light level from available daylight. Especially useful in common spaces where task lighting is not critical (malls, warehouses, atriums, etc.).

Estimated Energy Savings – kWh

20-30+% for perimeter office and open spaces, up to 40% for sky lit common spaces.

Key assumptions:

Lighting on 3,680 hours per year. Assumes 1.3 watts per square foot, 30% savings in exterior (sun lit) spaces. Assume savings averages 1.43 kWh per square foot per year.

(1.3 W/ft^2 / 1000W/kW) x (30% savings) x 3,680 hrs = 1.43 kWh/ft^2/yr

Summer Peak Savings

The bulk of savings will occur during peak hours because this is exactly the time that maximum daylight is available.

1.3 watts/square foot x 1 square foot x .35 x 0.9 DF = 0.41 watts/ft^2

= .00041 KW/ft^2 or 4.1 KW/10,000ft^2

Measure Life

DEER lists 16 years, programs reviewed show 10-15 years, we recommend 12 years.

Initial One-Time Cost

Estimate $1/ft^2. Less expensive, and less refined, with multilevel lighting versus dimmable ballasts.

Any Recurring Costs

Occasional re-commissioning & adjustments, service calls due to occupant complaints.

Suggested Incentive

Suggest $.12/ft^2 of controlled space. Not entire facility square footage.

Requirements

Requires commissioning to calibrate sensors and ensure that energy savings and occupant comfort are realized. Incentive only for space with reasonable sun light exposure.

Existing Energy Standards

There are currently no standards for this technology.

Sources of Information

FEMP, ACEEE, Heschong Mahone Group, manufacturer websites, DEER.

Refrigeration and Food Service end-use measures are listed in Table 12 and described below.

Table 12: Refrigeration and food service measures

ID#	Potential Situation	Improvement	Quantity
C&I Refrig 1	No Controls on Vending Machine	Install Cold Beverage Vending Machine Controllers	1 each
C&I Refrig 2	No anti-sweat heater control	Install Anti-sweat heater controls	per door
C&I Refrig 3	Standard condenser	Install Efficient Refrigeration Condenser	40 Ton capacity
C&I Refrig 4	No covers on food cases	Install Night Covers for Food Cases	Per lineal Ft
C&I Refrig 5	No compressor head controls	Install compressor head controls	Per Ton
C&I Refrig 6	Standard Commercial Solid Door Refrigerators less than 20ft3	ENERGY STAR Commercial Solid Door Refrigerators less than 20ft3	per unit
C&I Refrig 7	Standard Commercial Solid Door Refrigerators 20-48 ft3	ENERGY STAR Commercial Solid Door Refrigerators 20-48 ft3	per unit
C&I Refrig 8	Standard Commercial Solid Door Refrigerators more than 48ft3	ENERGY STAR Commercial Solid Door Refrigerators more than 48ft3	per unit
C&I Refrig 9	Standard Commercial Solid Door Freezers less than 20ft3	ENERGY STAR Commercial Solid Door Freezers less than 20ft3	per unit
C&I Refrig 10	Standard Commercial Solid Door Freezers 20-48 ft3	ENERGY STAR Commercial Solid Door Freezers 20-48 ft3	per unit
C&I Refrig 11	Standard Commercial Solid Door Freezers more than 48ft3	ENERGY STAR Commercial Solid Door Freezers more than 48ft3	per unit
C&I Refrig 12	Standard Ice Machines less than 500 lbs	Energy Efficient Ice Machines less than 500 lbs	per unit
C&I Refrig 13	Standard Ice Machines 500-1000 lbs	Energy Efficient Ice Machines 500-1000 lbs	per unit
C&I Refrig 14	Standard Ice Machines more than 1000 lbs	Energy Efficient Ice Machines more than 1000 lbs	per unit

ID 52: C&I Refrigerator 1: Cold Beverage Vending Machine Controllers

Technology Description

Cold beverage vending machine controls reduce energy consumption between 30% and 50% on average by controlling the machine's lights and optimizing refrigeration to reduce energy while maintaining product quality. Additional yearly savings in maintenance can also be realized due to reduced running time of vendor components. The most prevalent and available control is Bayview Technologies' (owned by US Technologies, Inc) VendingMiser.

Methodology and Assumptions

Typical vending equipment consumes 7-14 kWh/day depending on size.

VendingMiser claims savings range is from 30%-50%. Potential annual energy saving calculate between 766.5 and 2,555 kWh per unit/year.

Tufts Climate initiative estimated 1752 kWh/year savings based on a very limited study. The Database for Energy Efficiency Resources (DEER) claims 1,612 kWh in annual savings.

Estimated Energy Savings – kWh

We have had experience with the installation of thousands of these units on programs over the last couple of years. We feel the units are effective in some applications but misapplications and persistency lead us to savings on the low end of expectations. We recommend a savings level of 800 kWh/year.

Summer Peak Savings

Typical peak use for a cold beverage machine: 700W – 1200 W. Assuming a 30% runtime reduction: 0.7 kW x 30% = 0.21 kW

Measure Life

Questions about persistence have been raised because the units are easily accessed and removed or unplugged. Position of sensor is also important for optimum performance. Although the quality of the product will allow for a longer life, we have assumed 5 years, as with other plug load technologies, analyzed, due to the persistency issue.

Initial One-Time Cost

Prices vary primarily due to institutional rates that are available to Utility and Government conservation programs. Identified costs vary from $140 to $180 per unit. Assume an average cost of $160/unit.

Any Recurring Costs

None.

Suggested Incentive

$50/unit

Requirements For Application

May need to move equipment away from the wall to access the outlet. Should follow placement of sensor directions closely

Existing Energy Standards

None for the controls. However, ENERGY STAR does have requirements for existing vending machines/rebuilt vending machines to be ENERGY STAR qualified. One of the methods of achieving the ENERGY STAR status is to install a vending machine controller to the existing machine.

Sources of Information

USA Technologies (usatech.com); EPA Energy Star; multiple utility/government program sites; Tufts University, E-Source, DEER database

ID 53: C&I Refrigerator 2: Anti-Sweat Heater Controls

Technology Description

Glass doors on refrigerator and freezer cases can have anti-sweat or anti-condensate heaters in the frames and mullions of the case. These heaters operate continuously in order to prevent condensation/frosting on the glass and frame that occurs when the surface temperature is below the dew point of the surrounding air. Anti-sweat heater controls control the operation of these heaters so that they do not run continuously when not needed (lower dew point in the air as typically occurs in winter). Anti-sweat heaters are only required to operate at full capacity when the space humidity is 55%. This results in energy savings due to reduce operation of the heater elements.

Methodology and Assumptions

Savings numbers were derived from a collection of supermarket studies identifying anti-sweat heaters as a potential energy efficiency measure. The study was completed by CDH Energy using the Supermarket Simulation Tool (SST) that they developed for the Electric Power Research Institute (EPRI).

The study simulated the potential impact of cycling anti-sweat heaters based on store humidity at eleven Wisconsin supermarkets. The control scheme assumes the heaters are on 100% of the time at store (indoor) relative humidity levels of 55%. The runtime drops linearly until the heaters are off at a store (indoor) humidity level of 22%. The savings determined is the average per door of the locations studied.

The savings at each store is driven by the hours at each humidity level – therefore the dryer the store the more savings. In addition, a reduction in refrigeration load due to less heat gain to the system from the heater operation is factored into the savings – therefore the less efficient the refrigeration system the more savings. Store humidity levels are dependent on outdoor humidity and the ventilation rate of the store.

Key assumptions:

Average power per door – 250 watts

3% savings in runtime of heater for a 1% drop in store (indoor) relative humidity.

Low temp rack efficiency of 1.8 kW/ton

75% of anti-sweat heater load contributes to total case load.

Estimated Energy Savings – kWh

1489 kWh savings per door.

Summer Peak Savings

No summer peak savings is claimed since the heaters typically must operate continuously through the summer in climates where summers are humid.

Measure Life

We recommend a 10 year life. This is consistent with what other programs use for other types of controls.

Initial One-Time Cost

The cost of controls can vary significantly per door depending on control type installed. One controller can operate as few as 1 door (when control is at the case) or an entire supermarket of doors when control is integrated into existing refrigeration control system. From our current observations of projects completed the average is $85 per door. A typical control is ~$250 to operate an average of 3 doors.

Suggested Incentive

$40 per door

Focus on Energy's incentive is $40 per door. Efficiency Vermont offers $15 for cooler doors and $30 for freezer doors.

Requirements For Application

Equipment must sense the relative humidity or dew point in the air outside of the display case and reduces or turns off the glass door (if applicable) and frame anti-sweat heaters at low humidity conditions. Measure not applicable for low or zero energy doors where there are no anti-sweat heaters. Incentive based on total number of doors and capped at 50% of project cost. New or retrofit applications are eligible.

Existing Energy Standards

None

Sources of Information

CDH Energy study, Other Efficiency Program Websites

ID 54: C&I Refrigerator 3: Efficient Refrigeration Condenser

Technology Description

This analysis evaluates the installation of oversized condensers for refrigeration systems. Increasing condenser size allows for reduced system head pressures. Reducing head pressure reduces the power consumption at the compressor.

Typical condenser designs provide for approaches (difference between entering air dry bulb temperature and refrigerant condensing temperature) as below:

Medium Temperature System = 15☐F design approach

Low Temperature System = 10☐F design approach

Reducing the approach lowers the head pressure and conserves compressor horsepower. Previous new construction programs in California offered prescriptive incentives that were based on the improvement in approach temperatures over those listed above.

Methodology and Assumptions

Averages of load and operating efficiency from an outside computer model are used in the calculation for energy savings.

- System capacity: 40 tons with full load kW/ton of 2.3 at 105°F saturated condensing temp.
- For the base, extrapolated from a computer model completed by an outside engineering firm, a system without efficient (oversized) condensers (10°F condenser approach) operating based on 82F ambient had an average load of 82% and average kW/ton of 1.92 and a similar system operating based on 70F ambient had an average load of 79% and average kW/ton of 1.85.
- For the proposed, extrapolated from the same computer model, a system with efficient (oversized) condensers (7°F condenser approach) operating based on 82F ambient had an average load of 83% and average kW/ton of 1.86 and a similar system operating based on 70F ambient had an average load of 80% and

average kW/ton of 1.78. Peak kW/ton of the proposed in the model was 2.18 kW/ton.

Due to savings for this measure occurring only in the warmer months, 4380 hours was used (1/2 a year).

Estimated Energy Savings – kWh

120 kWh per ton of refrigeration capacity

Summer Peak Savings

0.118 kW per ton of refrigeration capacity

Measure Life

Connecticut Light & Power uses a 15 year life. The DEER database indicates between 10 and 16 years.

Initial One-Time Cost

Per internet research, more recent analysis from projects completed in Oregon and California indicate $35 per ton of refrigeration cost for incremental. A new condenser when existing not failed would result in $350 per ton cost.

Suggested Incentive

$12 per ton of refrigeration capacity

Requirements For Application

Oversized Condenser Approach Requirements: Air cooled low temp 8°F, air cooled medium temp 13°F, evaporative-cooled 18°F. Condenser design temperature approach must be at or below the following parameters: Air-cooled condensers (exiting refrigerant vs. ambient dry bulb temperature): low temperature systems (8°F) and medium temperature systems (13°F). Evaporative-cooled condensers (exiting refrigerant vs. ambient wet bulb temperature: 18°F. Incentive is based on tons of refrigeration capacity of the system being affected. Capacity calculated at customer specific design conditions.

Existing Energy Standards

None

Sources of Information

California DSM programs, Connecticut Power & Light programs, Oregon Energy Smart Grocer project report.

Energy saving information is listed in Table 13 below:

Table 13: Energy savings, Efficient Condensers

EXISTING	82 Cond	70 Cond
Tons Capacity	40	40
Average Annual Load	82%	79%
Average kW/Ton	1.92	1.85
peak kW/ton	2.30	2.30
Hours	4,380	4,380
kW	92.000	92.000
kWh/Yr Use	**274,489**	**255,731**
PROPOSED		
Lighting Type	40	40
Average Annual Load	83%	80%
Ave kW/ton	1.86	1.78
peak kW/ton	2.18	2.18
Equiv Full Load Hours	4380	4380
kW	87.200	87.200
kWh/Yr Use	**271,126**	**249,485**
SAVINGS		
kW	4.8000	4.8000
kWh/Yr Use	**3,364**	**6,246**
kWh/Yr/Ton	84	156
kW/yr/ton	0.12	0.12
Project cost Estimate per Ton	$35	$35

Assumptions

System capacity: 40 tons with full load kW/ton of 2.3 at 105°F saturated condensing temp.

From a computer model completed by an outside engineering firm, a system without efficient (oversized) condensers (10°F condenser approach) operating based on 82F ambient had an average load of 82% and average kW/ton of 1.92 and a similar system operating based on 70F ambient had an average load of 79% and average kW/ton of 1.85.

From the same computer model, a system with efficient (oversized) condensers (7°F condenser approach) operating based on 82F ambient had an average load of 83% and average kW/ton of 1.86 and a similar system operating based on 70F ambient had an average load of 80% and average kW/ton of 1.78. Peak kW/ton of the proposed in the model was 2.18 kW/ton.

Due to savings for this measure occuring only in the warmer months,4380 hours was used (1/2 a year).

ID 55: C&I Refrigerator 4: Night Covers

Technology Description

Open refrigerated display cases in supermarkets have a continuous heat load due to losses to the surrounding environment. When store operations are not 24 hours per day, night covers (a film type perforated cover) can be utilized on the cases to minimize the losses to the ambient space during periods when the store is closed. The analysis is based on information extracted from documents describing past California utilities refrigeration efficiency improvement programs. This analysis relies on the assumptions from the California programs.

Thermal radiation and infiltration of warm air into cold, open display cases account for most of the refrigeration load for the displays. For supermarkets that do not operate for 24 hours, there is an energy reduction opportunity to cover the opening. The literature restricts its analysis to a case with a minimum of 6 hours per day of non-operating hours. It is recommended that the covers be perforated to decrease moisture buildup.

Test results reported by the SDG&E indicate a 9% reduction is compressor power during a 6 hour period with night covers in place. The uncovered usage reported by the California programs is 1168 kWh per linear foot.

Methodology and Assumptions

The analysis for this technology consists of simply clarifying the results of the test reports from the California utilities. Inherent in the acceptance of their energy estimates is acceptance of their testing and assumptions..

Estimated Energy Savings – kWh

KWh Savings = 1168 kWh/lineal foot x 9% = 105 per lineal foot

Summer Peak Savings

No summer peak savings due to covers installed at night. Average night demand savings based on 3500 hours of night application would be 0.03 kW.

Measure Life

The DEER database indicates a 5 year life for night covers. It does indicate a 16-year life for night shields – the savings would be the same for these but the likelihood of installation is low due to the covers being easier to use.

Initial One-Time Cost

Per internet research, more recent analysis from projects completed in Oregon indicate $35 per lineal foot cost.

Suggested Incentive

$10 per lineal foot

Requirements For Application

Store operation must allow covers to be covering cases at least 6 hours per 24 hour period.

Existing Energy Standards

None

Sources of Information

California DSM programs

ID 56 C&I Refrigerator 5: Head Pressure Control

Technology Description

Reducing the compressor discharge pressure reduces the pressure ratio across the compressor and improves the operating efficiency. Many systems have controls that maintain a minimum condensing pressure to ensure proper operation of all components. By letting the condensing pressure drop down at lower ambient temperatures with head pressure controls, energy savings can be achieved. The typical design target for refrigeration systems for head pressure is the equivalent of 100F to 105F saturated condensing temperature.

Previous programs in California offered prescriptive incentives that were based on ambient temperatures for the estimated savings as listed below:

82☐F = Base– No incentive

70☐F = 6% Savings

60☐F = 9.5% Savings

50☐F = 13% Savings

Methodology and Assumptions

Averages of load and operating efficiency from an outside computer model are used in the calculation for energy savings. The analysis is based on the estimated energy consumption of a low temperature system (-25☐F) operating 8760 hours per year. The base system is assumed to limit the condensing pressure to that corresponding to 82☐F ambient. The floating head pressure system is assumed to allow the equivalent condensing pressure to drop to a pressure corresponding 60☐F ambient. The average base load extrapolated from the model to be 82% with an average of 1.92 kW/ton operation. The proposed operation as extrapolated from the model is 78% with an average of 1.83 kW/ton.

Estimated Energy Savings – kWh

1264 per ton of refrigeration (based on original model output).

The calculation based on extrapolated data results in 1288 kWh/ton. A program simulation completed in Wisconsin of eleven stores demonstrated an average of 1226 kWh per ton.

Summer Peak Savings

Because the savings opportunity is based on colder ambient temperatures, there is no predictable demand savings for this technology.

Measure Life

The DEER database 2005 indicates a 16 year life

Initial One-Time Cost

Per internet research, more recent analysis from projects completed in Oregon indicated $80 per ton (mostly labor). The DEER database from California indicates between $30 & $50 per ton (mostly labor).

Suggested Incentive

$60 per ton of refrigeration

Requirements For Application

Controls must be installed that vary head pressure based on outdoor air temperature. At least a 20° minimum variance below design head pressure should be achieved during milder weather conditions. Qualifying systems use variable set-point floating head controls to adjust condensing temperatures in relation to outdoor air temperature. Incentive only available to assist with the purchase of hardware needed to achieve lowered head pressure (70F is a typical value). . Incentive is based on tons of refrigeration capacity that the control is applied to and is capped at 50% of project cost. Capacity calculated at customer specific design conditions.

Existing Energy Standards

None

Sources of Information

California DSM programs, CDH Energy Simulation report on Floating Head Pressure for 11 Wisconsin supermarkets

Energy savings information is listed in **Error! Reference source not found.** below:

Table 14: Head Pressure Controls

EXISTING	*Test*
Tons Capacity	*40*
Average Annual Load	*82%*
kW/Ton	*1.92*
Hours	*8,760*
kW	*0.000*
kWh/Yr Use	***551,670***
PROPOSED	
Tons Capacity	*40*
Average Annual Load	*78%*
Ave kW/ton	*1.83*
Equiv Full Load Hours	*8760*
kW	*0.000*
kWh/Yr Use	***500,161***
SAVINGS	
kW	*0.0000*
kWh/Yr Use	***51,509***
kWh/Yr/Ton	*1,288*
kW/yr/ton	*0.00*
Project cost Estimate per Ton	*$80*

Assumptions

System Capacity: 40 Tons with full load kW per ton at 105°F Saturated Condensing temp of 2.3 kW/Ton.

From a computer model completed by an outside engineering firm, a system without head pressure control down to 82F ambient had an average load of 82% in a year with an average kW/ton performance of 1.92.

From a computer model completed by an outside engineering firm, a system with head pressure control down to 60F ambient had an average load of 78% with an average kW/ton performance of 1.83.

ID 57 C&I Refrigerator 6 to C&I Refrigerator 11: ENERGY STAR Commercial Solid Door Refrigerators and Freezers

Technology Description

ENERGY STAR Commercial Solid Door Refrigerators and Freezers were evaluated in comparison to base models of comparable units.

Methodology and Assumptions

A spreadsheet calculation was performed comparing an equation for the base equipment energy usage (dependent on unit volume) to the ENERGY STAR specification (dependent on unit volume). Average sizes in three different size ranges were evaluated.

Key assumptions:

- Sizes Used for each range of unit is the average size of all units qualifying for ENERGY STAR in the size range.
- The energy per day for the existing unit is based on the equation 0.125*Volume+2.76 for refrigerators and 0.398*Volume+2.28 for freezers. (per Food Service Technology Center - pre-1996 standard)
- The energy per day for ENERGY STAR units is based on the qualifying specification 0.1*Volume+2.04 for refrigerators and 0.4*Volume+1.38 for freezers.
- The demand is assumed to be the average demand. (per Food Service Technology Center)
- Unit run continuously year round = 8760 hours/year
- Cost estimates are incremental based on data provided by the Food Service Technology Center.
- Secondary impacts for heating and cooling were not evaluated.

Estimated Energy Savings – kWh

(Based on using Food Service Technology Center Life Cycle Cost Calculator)

Refrigerators <20 ft^3 - 371 kWh/unit. Assumes 12 ft^3 average.

Refrigerators 20-48 ft^3 - 544 kWh/unit. Assumes 30 ft^3 average.

Refrigerators >48 ft^3 - 832 kWh/unit. Assumes 62 ft^3 average.

Freezers <20 ft^3 - 320 kWh/unit. Assumes 12 ft^3 average.

Freezers 20-48 ft^3 - 307 kWh/unit. Assumes 30 ft^3 average.

Freezers >48 ft^3 - 282 kWh/unit. Assumes 63 ft^3 average.

Summer Peak Savings

(Based on using Food Service Technology Center Life Cycle Cost Calculator)

Refrigerators <20 ft^3 - 0.042 kW/unit. Assumes 12 ft^3 average.

Refrigerators 20-48 ft^3 - 0.062 kW/unit. Assumes 30 ft^3 average.

Refrigerators >48 ft^3 - 0.095 kW/unit. Assumes 62 ft^3 average.

Freezers <20 ft^3 - 0.037 kW/unit. Assumes 12 ft^3 average.

Freezers 20-48 ft^3 - 0.035 kW/unit. Assumes 30 ft^3 average.

Freezers >48 ft^3 - 0.032 kW/unit. Assumes 63 ft^3 average.

Measure Life

The DEER database from California indicates a 12 year useful life.

Initial One-Time Cost

For qualifying refrigerators, research from the Food Service Technology Center indicates incremental costs of $250, $500 and $900 corresponding to the size ranges recommended from smallest to largest.

For qualifying freezers, research from the Food Service Technology Center indicates incremental costs of $150, $400 and $700 corresponding to the size ranges recommended from smallest to largest.

Suggested Incentive

$50 - $75 for $<48\ ft^3$ and $90 - $150 for $>48\ ft^3$.

Focus on Energy provides $75 and $150 respectively for these same groupings.

Efficiency Vermont's program incentive ranges from $75-$125 based on size and Rochester Public Utilities provides incentives ranging from $100 to $125 depending on size.

Requirements For Application

New units must be ENERGY STAR.

Existing Energy Standards

ENERGY STAR is the energy standard applicable to these units. The Consortium for Energy Efficiency also has more efficient tiers included in their specification.

Sources of Information

ENERGY STAR, Food Service Technology Center, Program websites for Efficiency Vermont and Rochester Public Utilities

Table 15: Energy savings, ENERGY STAR Commercial Solid Door Refrigerators and Freezers

	Refrigerator <20 ft^3	Refrigerator 20-48 ft^3	Refrigerator >48 ft^3	Freezer <20 ft^3	Freezer 20-48 ft^3	Freezer >48 ft^3
EXISTING						
Internal Volume	12	30	62	12	30	63
Number of Fixtures	1	1	1	1	1	1
Energy Per Day	4.26	6.51	10.51	7.06	14.22	27.35
Days per Year	365	365	365	365	365	365
kW	0.178	0.271	0.438	0.294	0.593	1.140
kWh/Yr Use	**1,555**	**2,376**	**3,836**	**2,575**	**5,190**	**9,984**
PROPOSED						
Internal Volume	12	30	62	12	30	63
Number of Fixtures	1	1	1	1	1	1
Energy per Day	3.24	5.04	8.24	6.18	13.38	26.58
Days per Year	365	365	365	365	365	365
kW	0.135	0.210	0.343	0.258	0.558	1.108
kWh/Yr Use	**1,183**	**1,840**	**3,008**	**2,256**	**4,884**	**9,702**
SAVINGS						
kW	0.043	0.061	0.095	0.036	0.035	0.032
kWh/Yr Use	**372**	**537**	**829**	**320**	**307**	**283**
kW using FSTC Life Cycle Calculator	**0.042**	**0.062**	**0.095**	**0.037**	**0.035**	**0.032**
kWh/Yr using FSTC Life Cycle Calculator	**371**	**544**	**832**	**320**	**307**	**282**
Project cost Estimate	$250	$500	$900	$150	$400	$700

Assumptions

Sizes Used for each range of unit is the average size of all units qualifying for ENERGY STAR in the size range.

The energy per day for the existing unit is based on the equation 0.125*Volume+2.76 for refrigerators and .398*Volume+2.28 for freezers. (per Food Service Technology Center - pre-1996 standard)

The energy per day for ENERGY STAR units is based on the qualifying specification 0.1*Volume+2.04 for refrigerators and 0.4*Volume+1.38 for freezers.

The demand is assumed to be the average demand. (per Food Service Technology Center).

ID 58 C&I Refrigerator 12 to C&I Refrigerator 14: Ice Machines

Technology Description

Ice machines (both air- and water-cooled) that are cube making machines were evaluated. These machines may be either an ice making head, remote condensing (air-cooled only) or a self-contained unit.

Methodology and Assumptions

A spreadsheet analysis of all equipment in the Air-conditioning & Refrigeration Institute (ARI) directory (the regulating agency that provides the testing standard for ice machines) was completed.

Data from the ARI directory (Ice Harvest Rate – lbs/24 hrs; Energy Consumption Rate – kWh/100 lbs) was separated into the categories used by the Consortium for Energy Efficiency (CEE) for their specification: air-cooled ice making head, air-cooled remote condensing unit, air-cooled self-contained unit, water-cooled ice making head and water-cooled self-contained unit.

Within each of these categories, an X-Y scatter diagram of energy vs harvest rate was created and a trend line was determined for the equipment that did not meet the CEE Tier 1 specification in order to set the base line for savings. (Note: the ARI directory only includes equipment currently available for sale) Savings (kWh/year) for each piece of qualifying equipment was calculated as compared to the base line determined for its category & size.

Calculation for kWh/year:

Annual kWh Savings per Unit =

$$\left(\frac{\text{kWh base}}{\text{100 lbs}} - \frac{\text{kWh prop}}{\text{100 lbs}}\right) \times \frac{\text{lbs/24 hrs}}{\text{100 lbs}} \times \text{365 days} \times \text{Load Factor}$$

Demand Savings = Annual kWh Savings per Unit / 3000 Equiv. Full Load Hours

All qualifying equipment was then grouped back together and sorted by size. This list was separated by size category (increments of 100 lbs of ice production per day). Total savings per year with a load factor was calculated as well as an estimated demand for each piece of equipment and the average in each size range was determined. After analyzing the different size categories it was determined that the equipment could be put into the larger groupings of <500 lbs, 500-1000 lbs and >1000 lbs.

Key assumptions:

75% load factor

Estimated 3000 hours per year equivalent full load.

Estimated Energy Savings – kWh

Ice Production <500 lbs/24 hrs - 1200 kWh/unit.

Ice Production 500-1000 lbs/24 hrs - 1750 kWh/unit.

Ice Production >1000 lbs/24 hrs - 4870 kWh/unit.

Summer Peak Savings

Ice Production <500 lbs/24 hrs – 0.32 kW/unit.

Ice Production 500-1000 lbs/24 hrs – 0.48 kW/unit.

Ice Production >1000 lbs/24 hrs – 1.28 kW/unit.

Measure Life

California's Southern California Edison program indicates a 12 year useful life for ice machines.

Initial One-Time Cost

The incremental cost was found in research completed by the Food Service Technology Center. Ice Production <500 lbs/24 hrs - $600; Ice Production 500-1000 lbs/24 hrs - $1500; Ice Production >1000 lbs/24 hrs - $2000

Suggested Incentive

Ice Production <500 lbs/24 hrs – $100.

Ice Production 500-1000 lbs/24 hrs – $150 - $200.

Ice Production >1000 lbs/24 hrs – $300 - $500

Focus on Energy's Incentives are $100, $200, and $500 for these categories.

California's Program's Incentives are $300, $400, and $500 for these categories.

Requirements For Application

New units must meet Consortium for Energy Efficiency's Tier 1 ice machine specification. Flake and nugget machines are not included.

Existing Energy Standards

Consortium for Energy Efficiency (CEE) Tier 1 is the standard. CEE also has more efficient tiers included in their specification.

Sources of Information

ARI, Consortium for Energy Efficiency, Food Service Technology Center working with the California DSM Programs, ASHRAE

Space heating, ventilation, and cooling end-use (HVAC) measures and descriptions are listed in Table 16 below.

Table 16: HVAC Measures

ID	Potential Situation	Improvement	Quantity
C&I HVAC 1	AC 65,000 1 Ph, 66 kWh/ton	AC 65,000 1 Ph, 59 kWh/ton	per Ton
C&I HVAC 2	AC 65,000 3 Ph, 49 kWh/ton	AC 65,000 3 Ph, 44 kWh/ton	per Ton
C&I HVAC 3	AC 65,000 - 135,000, 77 kWh/ton	AC 65,000 - 135,000, 60 kWh/ton	per Ton
C&I HVAC 4	AC 135,000 - 240,000, 120 kWh/ton	AC 135,000 - 240,000, 107 kWh/ton	per Ton
C&I HVAC 5	AC 240,000 - 760,000, 63 kWh/ton	AC 240,000 - 760,000, 56 kWh/ton	per Ton
C&I HVAC 6	AC >760,000, 93 kWh/ton	AC >760,000, 83 kWh/ton	per Ton
C&I HVAC 7	HP 65,000 1 Ph, 96 kWh/ton	HP 65,000 1 Ph, 99 kWh/ton	per Ton
C&I HVAC 8	HP 65,000 3 Ph, 58 kWh/ton	HP 65,000 3 Ph, 57 kWh/ton	per Ton
C&I HVAC 9	HP 65,000 - 135,000, 108 kWh/ton	HP 65,000 - 135,000, 108 kWh/ton	per Ton
C&I HVAC 10	HP 135,000 - 240,000, 119 kWh/ton	HP 135,000 - 240,000, 124 kWh/ton	per Ton
C&I HVAC 11	HP >240,000, 150 kWh/ton	HP >240,000, 153 kWh/ton	per Ton
C&I HVAC 12	Ground Source HP Closed Loop <135,000, 9 kWh/ton	Ground Source HP Closed Loop <135,000, 7 kWh/ton	per Ton
C&I HVAC 13	WLHP <17,000, 24 kWh/ton	WLHP <17,000, 22 kWh/ton	per Ton
C&I HVAC 14	WLHP 17,000-65,000, 21 kWh/ton	WLHP 17,000-65,000, 19 kWh/ton	per Ton
C&I HVAC 15	WLHP 65,000-135,000, 21 kWh/ton	WLHP 65,000-135,000, 19 kWh/ton	per Ton
C&I HVAC 16	PTAC, 28 kWh/ton	PTAC, 24 kWh/ton	per Ton
C&I HVAC 17	PTAC-HP, 45 kWh/ton	PTAC-HP, 48 kWh/ton	per Ton
C&I HVAC 18	Economizer, 159 kWh/ton	Economizer, 109 kWh/ton	per Ton
C&I HVAC 19	Tuneup - Refrigerant Charge, 145 kWh/ton	Tuneup - Refrigerant Charge, kWh/ton	per Ton
C&I HVAC 20	No ES Sleeve AC over 14,000 Btu hr	Install ES Sleeve AC over 14,000 Btu hr	1 Each
C&I HVAC 21	No ES Sleeve AC under 14,000 Btu hr	Install ES Sleeve AC under 14,000 Btu hr	1 Each
C&I HVAC 22	No Setback_Programmable Thermostat	Install Setback_Programmable Thermostat	1 Each
C&I HVAC 23	Chilled Water Reset Air Cooled 0-100 tons	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 24	Chilled Water Reset Air Cooled 100-200 tons	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 25	Chilled Water Reset Air Cooled 200-300 tons	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 26	Chilled Water Reset Air Cooled 300-400 tons	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 27	Chilled Water Reset Air Cooled 400-500 tons	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 28	Chilled Water Reset Water Cooled 0-1000 tons	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 29	Chilled Water Reset Water Cooled 1000-2000 tons	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 30	Chilled Water Reset Water Cooled 2000-3000 tons	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 31	Air Cooled Chillers	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 32	Water Cooled Chillers less than 150 ton	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 33	Water Cooled Chillers 150 - 300 ton	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 34	Water Cooled Chillers more than 300 ton	Replace with Min ARI rated Efficiency	per Ton
C&I HVAC 35	No Window Film	Install Window Film	per Sq. Ft.
C&I HVAC 36	Electric Water heater	HP Water Heater 500 gal_day	Gal per day
C&I HVAC 37	Electric Water heater	HP Water Heater 1000 gal_day	Gal per day
C&I HVAC 38	Electric Water heater	HP Water Heater 1500 gal_day	Gal per day

Description of HVAC measures

Weather Sensitive/ HVAC Measures

Study Methodology

HVAC measure energy and demand savings were established by using a set of prototypical building models developed for the DOE-2.2 building energy simulation program. DOE-2 is a widely used and accepted freeware building energy analysis program that can predict the energy use and cost for all types of buildings. DOE-2 uses a description of the building layout, constructions, operating schedules, conditioning systems (lighting, HVAC, etc.) and utility rates provided by the user, along with weather data, to perform an hourly simulation of the building and to estimate utility bills. Prototype models were developed for small retail, big-box retail, small office, large office, fast food restaurant, full service restaurant, school, assembly and light industrial buildings. These buildings represent the types of customers that are expected to participate in the program. The prototypes are based on the models used in the California DEER study, with appropriate modifications to adapt these models to local design practices and climate. Energy savings estimates were developed from the prototype models for entry into the DSMore Cost-Effectiveness_HC tool.

The HVAC measures for small commercial buildings include single package rooftop air conditioners and heat pumps, split system air conditioners and heat pumps, packaged terminal air conditioners and heat pumps, and ground source and water loop heat pumps. The HVAC measures for the large office building include air cooled chillers, water cooled chillers, variable frequency drives (VFD) applied to fans and pumps, and chilled water temperature reset controls. The program baseline is defined by the National Appliance Energy Conservation Act (NAECA) minimum efficiency for single phase equipment and ASHRAE 90.1 – 2004 minimum efficiency for three phase equipment. HVAC measures cover the upgrade of standard efficiency packaged HVAC systems with high efficiency versions of the same equipment. The calculations do not address HVAC system type changes (e.g. the energy savings from changing from a rooftop AC system to a ground-source heat pump system).

Measure Efficiency Assumptions

The equipment covered, the size ranges, and the program baseline and measure efficiency assumptions are shown in Table 17 and Table 18 below:

Table 17: HVAC Efficiency Assumptions

Equipment Category	Capacity Range Btu/hr	Baseline Efficiency Value	Baseline Efficiency Units	Source	Measure Efficiency Value	Measure Efficiency Units
Packaged Terminal A/C	All	8.9	EER	ASHRAE 90.1-2004	9.2	EER
Packaged Terminal HP	All	8.7	EER	ASHRAE 90.1-2004	9	EER
Rooftop A/C (1) phase	<65,000 1 Ph	13	SEER	NAECA	14	SEER
Rooftop A/C (3) phase	<65,000 3 Ph	12	SEER	ASHRAE 90.1-2004	13	SEER
Rooftop A/C (3) phase	65,000 - 135,000	10.1	EER	ASHRAE 90.1-2004	11	EER
Rooftop A/C (3) phase	135,000 - 240,000	9.5	EER	ASHRAE 90.1-2004	11	EER
Rooftop A/C (3) phase	240,000 - 760,000	9.3	EER	ASHRAE 90.1-2004	10	EER
Rooftop A/C (3) phase	>760,000	9	EER	ASHRAE 90.1-2004	10	EER
Rooftop HP (1) phase	<65,000 1 Ph	13	SEER	NAECA	14	SEER
Rooftop HP (3) phase	<65,000 3 Ph	12	SEER	ASHRAE 90.1-2004	13	SEER
Rooftop HP (3) phase	65,000 - 135,000	9.9	EER	ASHRAE 90.1-2004	11	EER
Rooftop HP (3) phase	135,000 - 240,000	9.1	EER	ASHRAE 90.1-2004	10	EER
Rooftop HP (3) phase	>240,000	8.8	EER	ASHRAE 90.1-2004	10	EER
Ground Source HP Closed Loop	<135,000 & 59 F EWT	16.2	EER	ASHRAE 90.1-2004	16.5	EER
Ground Source HP Closed Loop	<135,000 & 77 F EWT	13.4	EER	ASHRAE 90.1-2004	13.7	EER
Water Source Heat Pump	<17,000	11.2	EER	ASHRAE 90.1-2004	11.5	EER
Water Source Heat Pump	17,000 - 65,000	12	EER	ASHRAE 90.1-2004	12.3	EER
Water Source Heat Pump	65,000 - 135,000	12	EER	ASHRAE 90.1-2004	12.3	EER
Air Cooled Chillers	All	1.33	kW/ton	ASHRAE 90.1-2004	1.16	kW/ton
Water Cooled Chillers	< 150 ton	0.835	kW/ton	ASHRAE 90.1-2004	0.78	kW/ton
Water Cooled Chillers	150 - 300 ton	0.74	kW/ton	ASHRAE 90.1-2004	0.56	kW/ton
Water Cooled Chillers	> 300 ton	0.69	kW/ton	ASHRAE 90.1-2004	0.54	kW/ton

Additional measure modeling assumptions are summarized in Table 18.

Table 18: Measure Assumptions for Controls,Tune-up and Economizer Measures

Measure	Baseline Assumption	Measure Assumption	Comments
Economizer	Fixed outdoor air.	Dual sensor enthalpy economizer	Maximum efficiency economizer control strategy assumed.
AC tuneup	14% degradation in efficiency for un-tuned unit	Unit runs at rated efficiency (EER=8)	Tuneup applied to existing equipment only
VFD fan motor	Central VAV system with inlet vane air volume control	Central VAV system with VFD air volume control	Applied to large office prototype only
VFD pump control	Constant volume chilled water system with 3-way control valves at cooling coils	Variable volume chilled water system with 2 way control valves at cooling coils	Applied to chilled water pumps in large office prototype only
Chilled water reset control	Constant chilled water temperature setpoint control	Chilled water temperature controlled by coil demanding the most cooling	Applied to large office prototype only

SECONDARY RESEARCH REVIEW

Secondary research review was conducted to obtain estimates of engineering parameters used to develop the simulation models. The review incorporated research conducted in support of the California Database for Energy Efficiency Resources (DEER) study and the US Energy Information Agency (EIA) Commercial Building Energy Consumption Sudy (CBECS). Building characterstics data from the CBECS study for the West North Central census region were used to update the DEER prototype model. Insulation levels and glazing properties for existing buildings were set according the provisions of ASHRAE Standard 90A-1980. Insulation levels, glazing properties and lighting power densities for new construction were set according to ASHRAE Standard 90.1-2004. A description of each prototype simulation model follows.

Small Retail

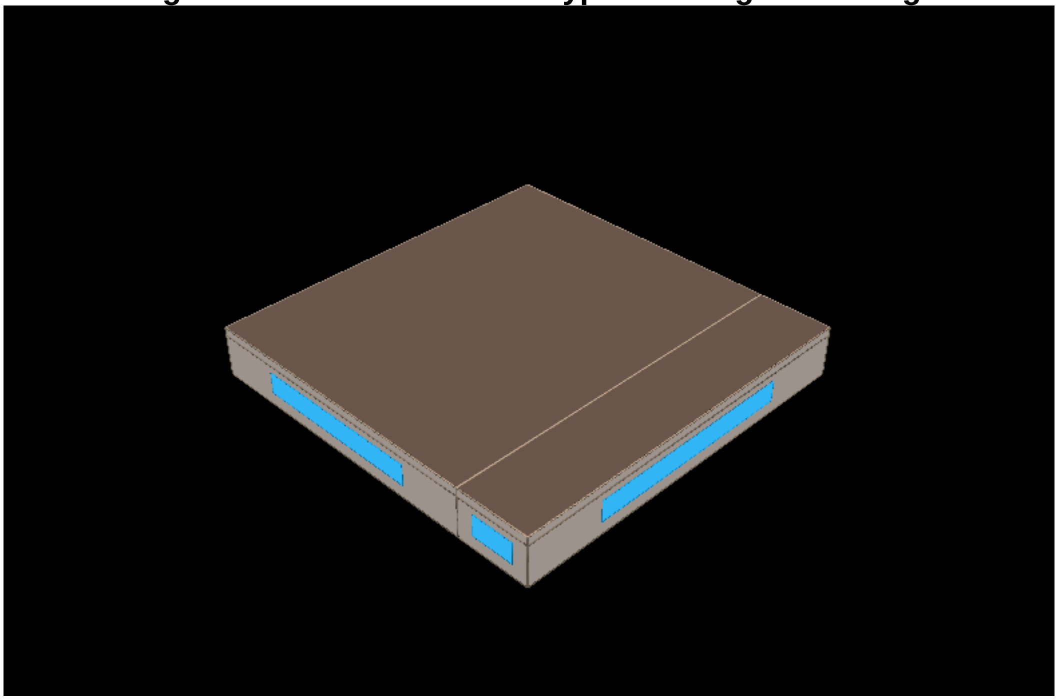
A prototypical building energy simulation model for a small retail building was developed using the DOE-2.2 building energy simulation program. The characteristics of the small retail building prototype are summarized in Table 19 below:

Table 19: Small Retail Prototype Description

Characteristic	**Value**
Vintage	Existing (1980s) vintage and new construction
Size	6400 square foot sales area 1600 square foot storage area 8000 square feet total
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer. Insulation R-value = 5.7
Roof construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Glazing type	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Lighting power density	Existing building: Sales area: 3.4 W/SF Storage area: 0.9 W/SF New construction: Sales area: 1.7 W/SF Storage area: 0.9 W/SF
Plug load density	Sales area: 1.2 W/SF Storage area: 0.2 W/SF
Operating hours	10 – 10 Monday-Saturday 10 – 8 Sunday
HVAC system type	Packaged single zone, no economizer
HVAC system size	Existing building: Sales floor: 221 SF/ton Storage area: 349 SF/ton New building Sales floor: 275 SF/ton Storage area: 460 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the small retail building prototype is shown in Figure 1 below:

Figure 1: Small Retail Prototype Building Rendering



Full-service Restaurant

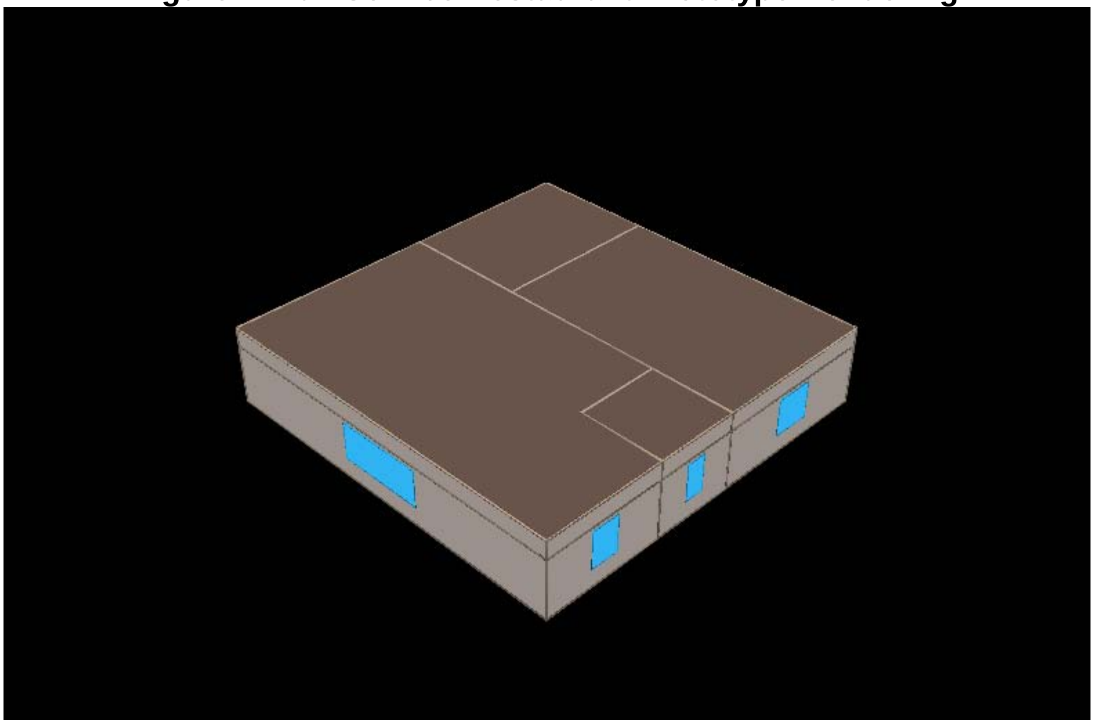
A prototypical building energy simulation model for a full-service restaurant was developed using the DOE-2.2 building energy simulation program. The characteristics of the full service restaurant prototype are summarized in Table 20 below:

Table 20: Full Service Restaurant Prototype Description

Characteristic	Value
Vintage	Existing (1980s) vintage and new construction
Size	2000 square foot dining area 600 square foot entry/reception area 1200 square foot kitchen 200 square foot restrooms
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer. Insulation R-value = 5.7
Roof construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Glazing type	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Lighting power density	Existing building: Dining area: 1.7 W/SF Entry area: 2.5 W/SF Kitchen: 4.3 W/SF Restrooms: 1.0 W/SF New construction: Dining area: 2.1 W/SF Entry area: 1.1 W/SF Kitchen: 1.2 W/SF Restrooms: 0.9 W/SF
Plug load density	Dining area: 0.6 W/SF Entry area: 0.6 W/SF Kitchen: 3.1 W/SF Restrooms: 0.2 W/SF
Operating hours	9am – 12am
HVAC system type	Packaged single zone, no economizer
HVAC system size	Existing building: Dining area: 136 SF/ton Entry area: 76 SF/ton Kitchen: 189 SF/ton Restrooms: 159 SF/ton New construction: Dining area: 144 SF/ton Entry area: 84 SF/ton Kitchen: 239 SF/ton Restrooms: 173 SF/ton
Thermostat setpoints	Occupied hours: 77 cooling, 72 heating Unoccupied hours: 82 cooling, 67 heating

A computer-generated sketch of the full-service restaurant prototype is shown in Figure 2 below:

Figure 2: Full Service Restaurant Prototype Rendering



Small Office

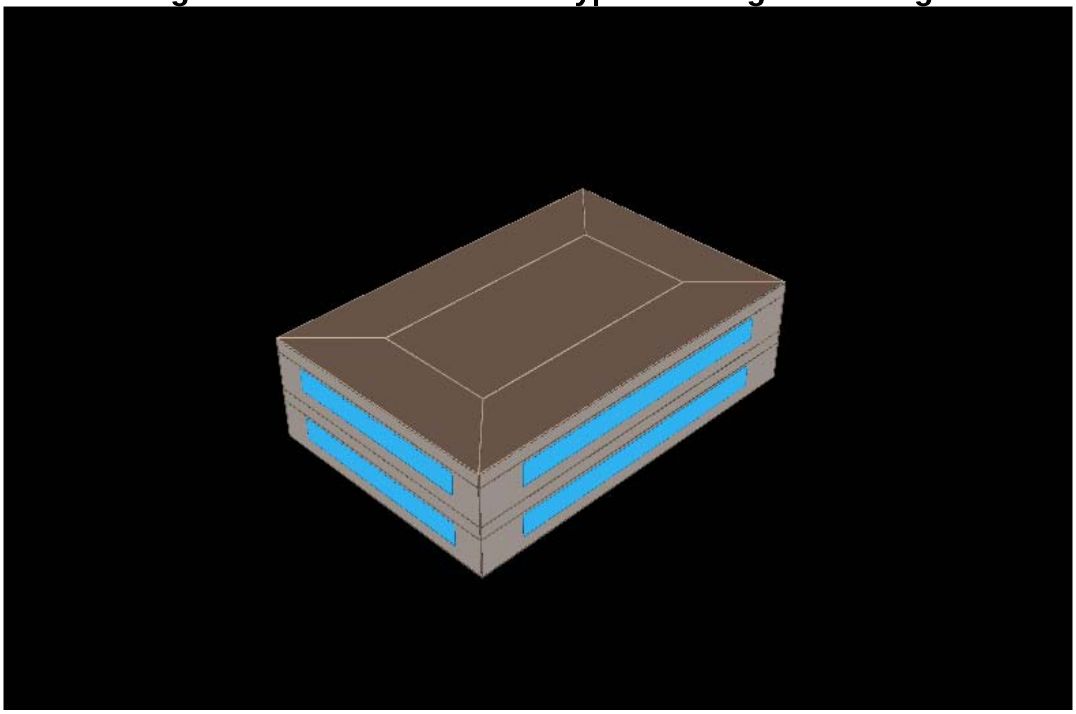
A prototypical building energy simulation model for a small office was developed using the DOE-2.2 building energy simulation program. The characteristics of the small office prototype are summarized in Table 21 below:

Table 21: Small Office Prototype Building Description

Characteristic	**Value**
Vintage	Existing (1980s) vintage and new construction
Size	10,000 square feet
Number of floors	2
Wall construction and R-value	Concrete block with brick veneer. Insulation R-value = 5.7
Roof construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Glazing type	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Lighting power density	Existing building: Perimeter offices: 2.2 W/SF Core offices: 1.5 W/SF New construction: Perimeter offices: 1.1 W/SF Core offices: 1.1 W/SF
Plug load density	Perimeter offices: 1.6 W/SF Core offices: 0.7 W/SF
Operating hours	Mon-Sat: 9am – 6pm Sun: Unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	Existing building: 171 SF/ton New construction: 236 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the small office prototype is shown in Figure 3 below:

Figure 3: Small Office Prototype Building Rendering



Light Industrial

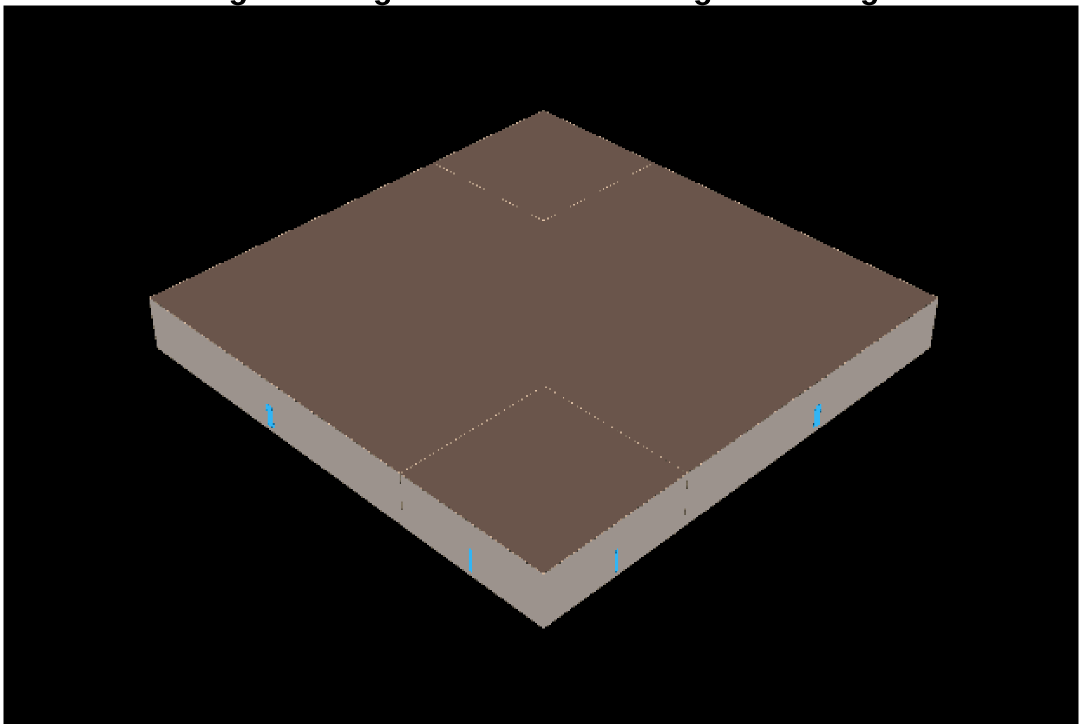
A prototypical building energy simulation model for a light industrial building was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in Table 22 below:

Table 22: Light Industrial Prototype Building Description

Characteristic	Value
Vintage	Existing (1980s) vintage and new construction
Size	100,000 square feet total 80,000 SF factory 20,000 SF warehouse
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer. Insulation R-value = 5.7
Roof construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Glazing type	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Lighting power density	Existing building: Factory – 2.1 W/SF Warehouse – 0.9 W/SF New construction: Factory – 1.7 W/SF Warehouse – 0.9 W/SF
Plug load density	Factory – 1.2 W/SF Warehouse – 0.2 W/SF
Operating hours	Mon-Fri: 6am – 6pm Sat Sun: Unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	Existing building: 478 SF/ton New construction: 523 SF/ton
Thermostat setpoints	Occupied hours: 78 cooling, 70 heating Unoccupied hours: 83 cooling, 65 heating

A computer-generated sketch of the prototype is shown in Figure 4 below:

Figure 4: Light Industrial Building Rendering



Big Box Retail

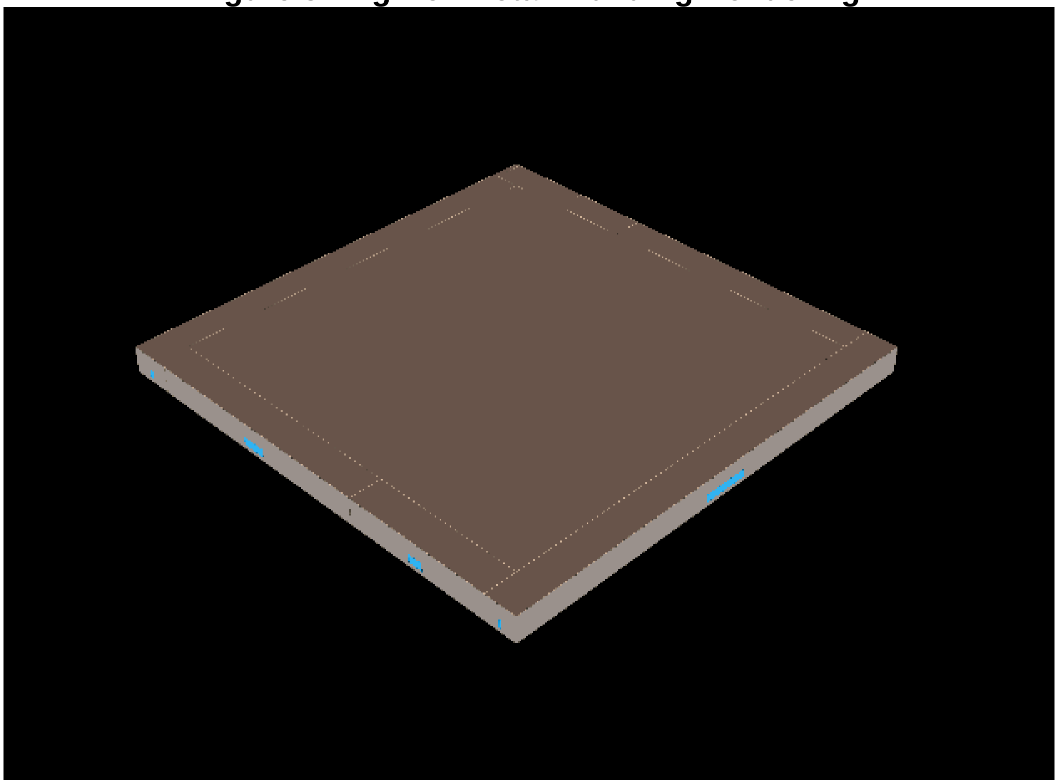
A prototypical building energy simulation model for a big box retail building was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in Table 23 below:

Table 23: Big Box Retail Prototype Building Description

Characteristic	Value
Vintage	Existing (1980s) vintage and new construction
Size	130,500 square feet Sales: 107,339 SF Storage: 11,870 SF Office: 4,683 SF Auto repair: 5,151 SF Kitchen: 1,459 SF
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer. Insulation R-value = 5.7
Roof construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Glazing type	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Lighting power density	Existing building: Sales: 3.36 W/SF Storage: 0.88 W/SF Office: 2.2 W/SF Auto repair: 2.15 W/SF Kitchen: 4.3 W/SF New construction: Sales: 1.7 W/SF Storage: 0.9 W/SF Office: 1.1 W/SF Auto repair: 0.7 W/SF Kitchen: 1.2 W/SF
Plug load density	Sales: 1.15 W/SF Storage: 0.23 W/SF Office: 1.73 W/SF Auto repair: 1.15 W/SF Kitchen: 3.23 W/SF
Operating hours	Mon-Sun: 10am – 9pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	Existing building: 256 SF/ton New construction: 309 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the prototype is shown in Figure 5 below:

Figure 5: Big Box Retail Building Rendering



FAST FOOD RESTAURANT

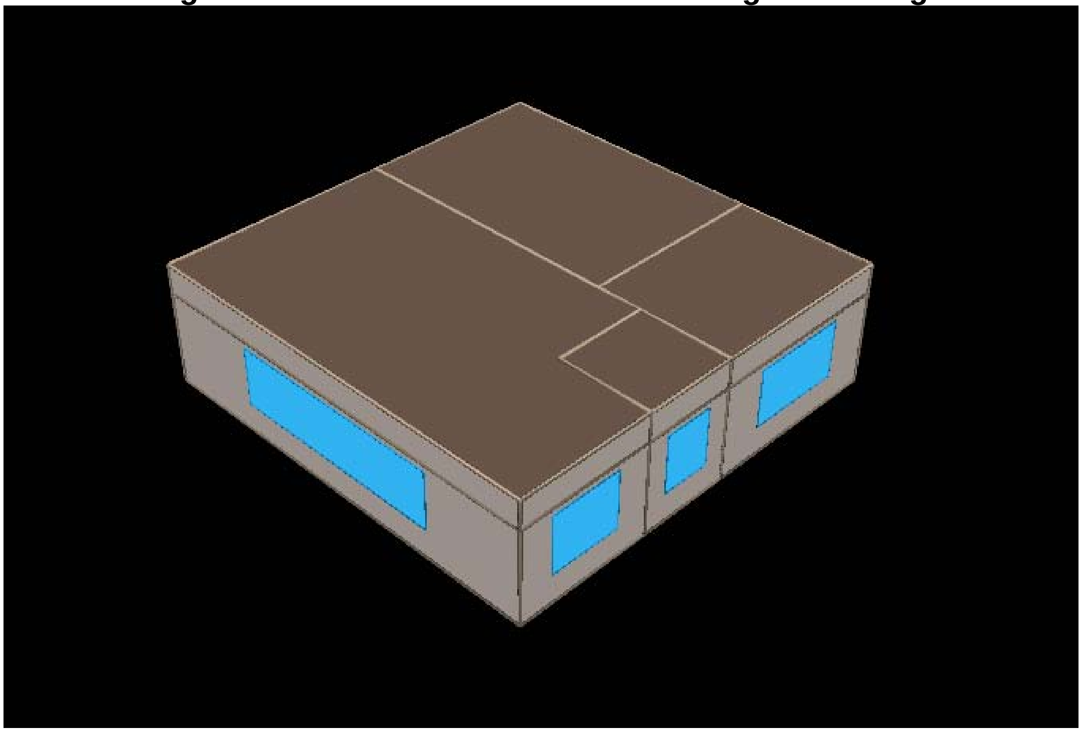
A prototypical building energy simulation model for a fast food restaurant was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in Table 24 below:

Table 24: Fast Food Restaurant Prototype Building Description

Characteristic	Value
Vintage	Existing (1980s) vintage and new construction
Size	2000 square feet 1000 SF dining 600 SF entry/lobby 300 SF kitchen 100 SF restroom
Number of floors	Concrete block with brick veneer. Insulation R-value = 5.7
Wall construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Roof construction and R-value	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Glazing type	Single pane clear
Lighting power density	Existing building: 1.7 W/SF dining 2.5 W/SF entry/lobby 4.3 W/SF kitchen 1.0 W/SF restroom New construction: 0.9 W/SF dining 1.1 W/SF entry/lobby 1.2 W/SF kitchen 0.9 W/SF restroom
Plug load density	0.6 W/SF dining 0.6 W/SF entry/lobby 4.3 W/SF kitchen 0.2 W/SF restroom
Operating hours	Mon-Sun: 6am – 11pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	Existing building: 89 SF/ton New construction: 105 SF/ton
Thermostat setpoints	Occupied hours: 77 cooling, 72 heating Unoccupied hours: 82 cooling, 67 heating

A computer-generated sketch of the prototype is shown in Figure 6 below:

Figure 6: Fast Food Restaurant Building Rendering



School

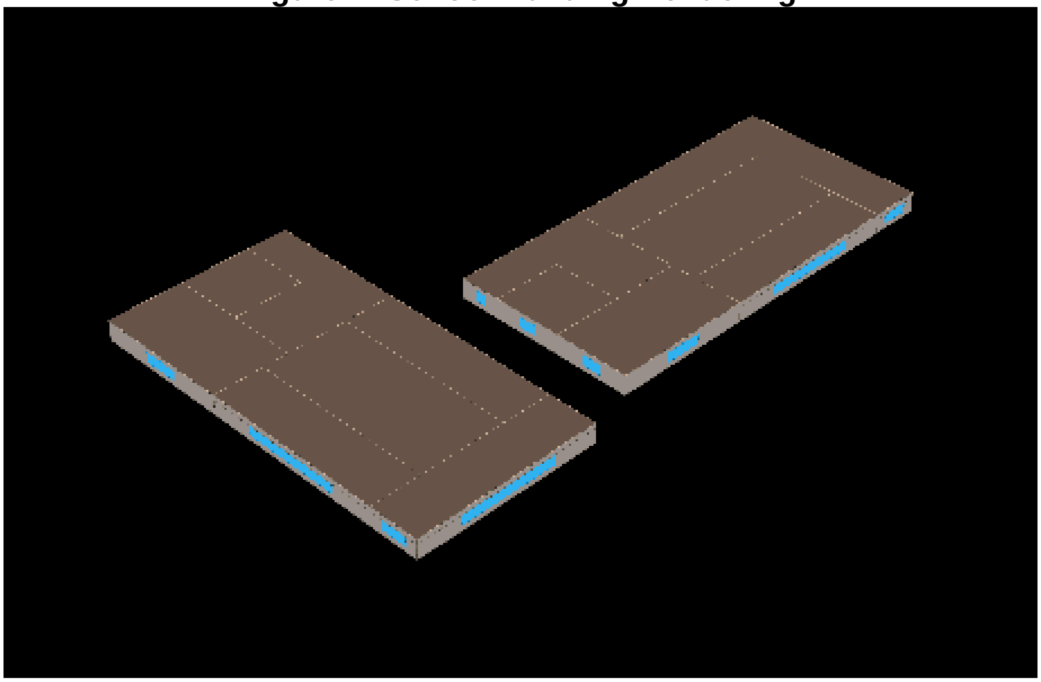
A prototypical building energy simulation model for an elementary school was developed using the DOE-2.2 building energy simulation program. The model is really of two identical buildings oriented in two different directions. The characteristics of the prototype are summarized in Table 25 below:

Table 25: Elementary School Prototype Building Description

Characteristic	Value
Vintage	Existing (1980s) vintage and new construction
Size	2 buildings, 25,000 square feet each; oriented 90° from each other Classroom: 15,750 SF Cafeteria: 3,750 SF Gymnasium: 3,750 SF Kitchen: 1,750 SF
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer. Insulation R-value = 5.7
Roof construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Glazing type	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Lighting power density	Existing building: Classroom: 4.4 W/SF Cafeteria: 1.7 W/SF Gymnasium: 2.1 W/SF Kitchen: 4.3 W/SF New construction: Classroom: 1.4 W/SF Cafeteria: 0.9 W/SF Gymnasium: 1.4 W/SF Kitchen: 1.2 W/SF
Plug load density	Classroom: 1.2 W/SF Cafeteria: 0.6 W/SF Gymnasium: 0.6 W/SF Kitchen: 4.2 W/SF
Operating hours	Mon-Fri: 8am – 6pm Sun: 8am – 4pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	Existing building: 195 SF/ton average New construction: 235 SF/ton average
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the prototype is shown in Figure 7 below:

Figure 7: School Building Rendering



Assembly

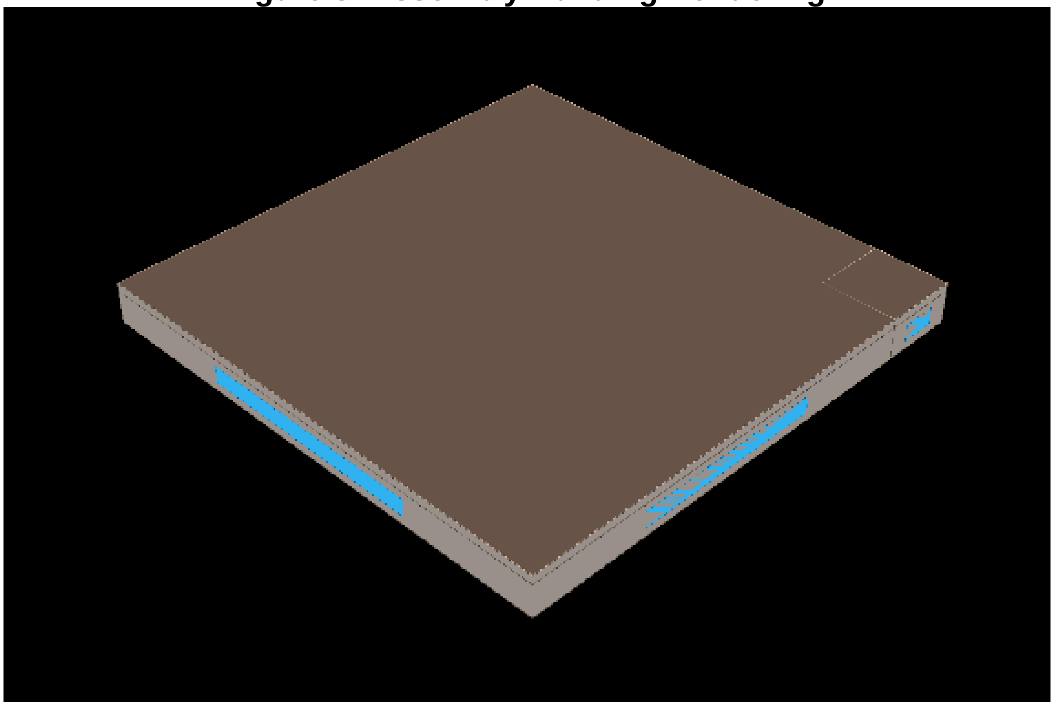
A prototypical building energy simulation model for an assembly building was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in Table 26 below:

Table 26: Assembly Prototype Building Description

Characteristic	Value
Vintage	Existing (1980s) vintage and new construction
Size	34,000 square feet Auditorium: 33,240 SF Office: 760 SF
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer. Insulation R-value = 5.7
Roof construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Glazing type	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Lighting power density	Existing building: Auditorium: 3.4 W/SF Office: 2.2 W/SF New construction: Auditorium: 1.7 W/SF Office: 1.1 W/SF
Plug load density	Auditorium: 1.2 W/SF Office: 1.7 W/SF
Operating hours	Mon-Sun: 8am – 9pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	Existing building: 91 SF/ton New construction: 98 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the prototype is shown in Figure 8 below:

Figure 8: Assembly Building Rendering



Large Office

A prototypical building energy simulation model for a small office was developed using the DOE-2.2 building energy simulation program. The characteristics of the large office prototype are summarized in Table 27 below:

Table 27: Large Office Prototype Building Description

Characteristic	Value
Vintage	Existing (1980s) vintage and new construction
Size	175,000 square feet
Number of floors	10
Wall construction and R-value	Concrete block with brick veneer. Insulation R-value = 5.7
Roof construction and R-value	Wood frame with built-up roof Existing building insulation: R- 8.4 New construction insulation R-15
Glazing type	Existing building: Double pane clear (SC=0.84, U-value=0.72) New construction: Double low-e tint (SC=0.45, U-value=0.57)
Lighting power density	Existing building: Perimeter offices: 2.2 W/SF Core offices: 1.5 W/SF New construction: Perimeter offices: 1.1 W/SF Core offices: 1.1 W/SF
Plug load density	Perimeter offices: 1.6 W/SF Core offices: 0.7 W/SF
Operating hours	Mon-Sat: 9am – 6pm Sun: Unoccupied
HVAC system type	Central built-up VAV system with water cooled centrifugal chiller and boiler.
HVAC system size	Existing building: 235 SF/ton New construction: 284 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

Energy and Peak Demand Savings Estimates

Energy and peak demand savings estimates were developed based on difference the simulated HVAC energy consumption and peak demand at the baseline and the measure efficiency levels. Energy and demand savings were normalized per ton of cooling capacity. The simulations used TMY2 long-term average weather data for Kansas City, Missouri. The results for each of the prototype building and HVAC system type and size combinations are shown in Table 28 through Table 36 below:

Table 28: Assembly Building HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.079	74	0.079	71
AC <65,000 3 Ph	0.059	56	0.059	53
AC 65,000 - 135,000	0.081	77	0.082	74
AC 135,000 - 240,000	0.144	136	0.144	130
AC 240,000 - 760,000	0.076	71	0.076	68
AC >760,000	0.112	105	0.112	101
HP <65,000 1 Ph	0.085	138	0.085	140
HP <65,000 3 Ph	0.059	77	0.059	77
HP 65,000 - 135,000	0.103	149	0.103	150
HP 135,000 - 240,000	0.101	175	0.101	179
HP >240,000	0.139	211	0.139	213
GSHP <135,000	0.009	7	0.009	6
WLHP <17,000	0.024	32	0.024	31
WLHP 17,000-65,000	0.021	28	0.021	27
WLHP 65,000-135,000	0.021	28	0.021	27
Economizer	0.081	96	0.000	13
AC Tuneup	0.175	165		

Table 29: . Big Box Retail HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.077	83	0.077	76
AC <65,000 3 Ph	0.058	62	0.058	56
AC 65,000 - 135,000	0.171	184	0.079	76
AC 135,000 - 240,000	0.141	152	0.140	135
AC 240,000 - 760,000	0.074	80	0.074	71
AC >760,000	0.109	117	0.109	105
HP <65,000 1 Ph	0.082	113	0.082	116
HP <65,000 3 Ph	0.058	71	0.058	69
HP 65,000 - 135,000	0.100	130	0.100	129
HP 135,000 - 240,000	0.098	140	0.098	145
HP >240,000	0.135	180	0.135	181
Economizer	0.080	166	0.079	118
Tuneup	0.171	184		

Table 30: Fast Food Restaurant HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.077	67	0.073	57
AC <65,000 3 Ph	0.058	50	0.058	44
AC 65,000 - 135,000	0.080	69	0.080	60
AC 135,000 - 240,000	0.141	122	0.141	106
AC 240,000 - 760,000	0.074	64	0.074	56
AC >760,000	0.109	94	0.109	82
HP <65,000 1 Ph	0.083	116	0.083	119
HP <65,000 3 Ph	0.058	66	0.058	64
HP 65,000 - 135,000	0.101	126	0.101	126
HP 135,000 - 240,000	0.098	146	0.099	151
HP >240,000	0.136	178	0.136	179
GSHP <135,000	0.009	10	0.008	8
Economizer	0.080	95	0.080	67
AC tuneup	0.171	148		

Table 31: Light Industrial HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.077	49	0.076	50
AC <65,000 3 Ph	0.058	37	0.057	37
AC 65,000 - 135,000	0.079	51	0.079	51
AC 135,000 - 240,000	0.140	90	0.140	91
AC 240,000 - 760,000	0.073	47	0.073	48
AC >760,000	0.108	69	0.108	70
HP <65,000 1 Ph	0.081	90	0.081	89
HP <65,000 3 Ph	0.057	51	0.057	50
HP 65,000 - 135,000	0.099	97	0.099	96
HP 135,000 - 240,000	0.097	114	0.097	113
HP >240,000	0.134	138	0.133	137
Economizer	0.079	75	0.079	77
AC tuneup	0.170	109		

Table 32: Nursing Home HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.077	67	0.076	59
AC <65,000 3 Ph	0.057	50	0.057	44
AC 65,000 - 135,000	0.079	69	0.079	60
AC 135,000 - 240,000	0.140	123	0.139	107
AC 240,000 - 760,000	0.073	64	0.073	56
AC >760,000	0.108	95	0.108	83
HP <65,000 1 Ph	0.082	121	0.082	129
HP <65,000 3 Ph	0.058	69	0.057	68
HP 65,000 - 135,000	0.100	131	0.100	135
HP 135,000 - 240,000	0.098	153	0.098	166
HP >240,000	0.135	186	0.135	194
Economizer	0.079	88	0.079	62
Tuneup	0.170	149		

Table 33: School HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.075	25	0.075	21
AC <65,000 3 Ph	0.056	18	0.056	16
AC 65,000 - 135,000	0.078	25	0.077	21
AC 135,000 - 240,000	0.138	45	0.137	38
AC 240,000 - 760,000	0.072	24	0.072	20
AC >760,000	0.106	35	0.106	29
HP <65,000 1 Ph	0.080	50	0.080	53
HP <65,000 3 Ph	0.056	27	0.056	27
HP 65,000 - 135,000	0.098	53	0.098	54
HP 135,000 - 240,000	0.096	64	0.096	68
HP >240,000	0.132	76	0.132	78
GSHP <135,000	0.009	3	0.009	2
WLHP <17,000	0.024	11	0.024	10
WLHP 17,000-65,000	0.021	10	0.021	9
WLHP 65,000-135,000	0.021	10	0.021	9
PTAC	0.006	13	0.006	11
PTAC-HP	0.007	28	0.007	30
Economizer	0.078	55	0.077	36
Tuneup	0.167	54		

Table 34: Full Service Restaurant HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.077	62	0.077	58
AC <65,000 3 Ph	0.058	46	0.058	43
AC 65,000 - 135,000	0.080	64	0.079	60
AC 135,000 - 240,000	0.141	113	0.140	105
AC 240,000 - 760,000	0.074	59	0.074	55
AC >760,000	0.109	88	0.109	82
HP <65,000 1 Ph	0.082	117	0.082	118
HP <65,000 3 Ph	0.058	65	0.058	64
HP 65,000 - 135,000	0.100	125	0.100	125
HP 135,000 - 240,000	0.098	148	0.098	151
HP >240,000	0.135	178	0.135	179
GSHP <135,000	0.009	9	0.009	8
Economizer	0.080	82	0.079	66
AC tuneup	0.171	137		

Table 35: Small Retail Building HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.078	82	0.077	71
AC <65,000 3 Ph	0.058	61	0.057	53
AC 65,000 - 135,000	0.080	84	0.079	73
AC 135,000 - 240,000	0.142	149	0.140	129
AC 240,000 - 760,000	0.075	78	0.073	68
AC >760,000	0.110	115	0.108	100
HP <65,000 1 Ph	0.083	120	0.082	123
HP <65,000 3 Ph	0.058	73	0.057	70
HP 65,000 - 135,000	0.101	135	0.100	134
HP 135,000 - 240,000	0.099	149	0.097	155
HP >240,000	0.136	188	0.134	189
GSHP <135,000	0.011	13	0.009	10
PTAC	0.006	40	0.006	35
PTAC-HP	0.006	63	0.007	67
Economizer	0.080	149	0.079	99
Tuneup	0.172	181		

Table 36: Small Office Building HVAC Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.072	62	0.072	55
AC <65,000 3 Ph	0.054	47	0.054	41
AC 65,000 - 135,000	0.074	64	0.074	57
AC 135,000 - 240,000	0.131	114	0.132	101
AC 240,000 - 760,000	0.069	60	0.069	53
AC >760,000	0.101	88	0.102	78
HP <65,000 1 Ph	0.076	83	0.076	86
HP <65,000 3 Ph	0.053	52	0.053	51
HP 65,000 - 135,000	0.092	95	0.093	96
HP 135,000 - 240,000	0.091	102	0.091	108
HP >240,000	0.125	131	0.125	134
GSHP <135,000	0.011	11	0.010	9
WLHP <17,000	0.025	29	0.024	25
WLHP 17,000-65,000	0.022	25	0.021	22
WLHP 65,000-135,000	0.022	25	0.021	22
PTAC	0.005	31	0.005	27
PTAC-HP	0.005	44	0.006	48
Economizer	0.074	189	0.074	134
Tuneup	0.159	138		

Weights were developed for each of the buildings above that utilize packaged HVAC systems from GMO customer data. The GMO data show number of accounts by building type. Weights for the buildings addressed by this study were derived from the GMO customer account data and are shown in

.

Table 37: Weights for Buildings with Packaged HVAC Systems

Building Type	Weight
Assembly	7.5%
Big Box Retail	10.5%
Fast Food	3.9%
Light Industrial	16.6%
Nursing Home	5.3%
School	14.6%
Full Service Restaurant	3.9%
Small Retail	17.7%
Small Office	19.9%

The weights were applied to the results for each of the prototypes to estimate the average savings for each packaged HVAC system measure. The average savings are shown in Table 38 below:

Table 38: Weighted Packaged HVAC System Measure Savings

	Existing		New	
	kW/ton	kWh/ton	kW/ton	kWh/ton
AC <65,000 1 Ph	0.076	62	0.075	56
AC <65,000 3 Ph	0.057	46	0.057	42
AC 65,000 - 135,000	0.088	74	0.078	57
AC 135,000 - 240,000	0.139	113	0.138	102
AC 240,000 - 760,000	0.073	59	0.072	53
AC >760,000	0.107	87	0.107	79
HP <65,000 1 Ph	0.081	98	0.081	100
HP <65,000 3 Ph	0.057	58	0.056	56
HP 65,000 - 135,000	0.098	108	0.098	108
HP 135,000 - 240,000	0.097	122	0.096	127
HP >240,000	0.133	152	0.132	154
GSHP <135,000	0.010	9	0.009	7
WLHP <17,000	0.024	23	0.024	21
WLHP 17,000-65,000	0.021	20	0.021	18
WLHP 65,000-135,000	0.021	20	0.021	18
PTAC	0.006	29	0.006	25
PTAC-HP	0.006	46	0.007	49
Economizer	0.079	104	0.071	72
Tuneup	0.171	136		

Energy and demand savings for built up HVAC system measures calculated from the large office building prototype are shown in Table 39.

Table 39: Large Office Building HVAC Measure Savings

	Existing		New	
Chillers and controls	kW/ton	kWh/ton	kW/ton	kWh/ton
Air-cooled Chiller	0.150	154	0.143	136
Water-Cooled Chiller < 150 ton	0.049	56	0.049	53
Water-Cooled Chiller 150-300 ton	0.158	187	0.159	177
Water-Cooled Chiller >300 ton	0.131	156	0.133	148
Chilled water reset	0.030	87	0.040	86
VFDs on HVAC motors	kW/hp	kWh/hp	kW/hp	kWh/hp
VFD Fan Motor (per hp)	0.001	868	0.005	969
VFD chilled water pump (per hp)	0.496	1430	0.615	1398

TYPICAL HVAC UNIT SIZES

For the DSMore runs, typical HVAC unit sizes were chosen from each of the unit size categories above to estimate a “per unit” savings. The typical unit size assumed in the DSMore runs is summarized in Table 40 below:

Table 40: Typical HVAC Unit Sizes by Type and Size

HVAC Measure Type and Size Category	Typical Unit Size
AC <65,000 1 Ph	5 ton
AC <65,000 3 Ph	5 ton
AC 65,000 - 135,000	10 ton
AC 135,000 - 240,000	20 ton
AC 240,000 - 760,000	25 ton
AC >760,000	65 ton
HP <65,000 1 Ph	5 ton
HP <65,000 3 Ph	5 ton
HP 65,000 - 135,000	10 ton
HP 135,000 - 240,000	20 ton
HP >240,000	65 ton
GSHP <135,000	10 ton
WLHP <17,000	1 ton
WLHP 17,000-65,000	3 ton
WLHP 65,000-135,000	7.5 ton
PTAC	1 ton
PTAC-HP	1 ton
Economizer	10 ton
Tuneup	10 ton
Air-cooled Chiller	200 ton
Water-Cooled Chiller < 150 ton	80 ton
Water-Cooled Chiller 150-300 ton	230 ton
Water-Cooled Chiller >300 ton	1000 ton

Motive power ~ Motors, Pumps and Variable Frequency Drive (VFD) end-use measures are listed in Table 41.

Table 41: Pumps and Variable Frequency Drive (VFD) measures

ID3	Potential Situation	Improvement	Quantity
CI Motive Power 1	Std. EPACT Motors 1-5 HP	NEMA Premium Motors 1-5 HP	per HP
CI Motive Power 2	Std. EPACT Motors 7.5-20 HP	NEMA Premium Motors 7.5-20 HP	per HP
CI Motive Power 3	Std. EPACT Motors 25-100 HP	NEMA Premium Motors 25-100 HP	per HP
CI Motive Power 4	Std. EPACT Motors 125-250 HP	NEMA Premium Motors 125-250 HP	per HP
CI Motive Power 5	Std. Pump HP 1.5	Hi Efficiency Pump HP 1.5	per HP
CI Motive Power 6	Std. Pump HP 2	Hi Efficiency Pump HP 2	per HP
CI Motive Power 7	Std. Pump HP 3	Hi Efficiency Pump HP 3	per HP
CI Motive Power 8	Std. Pump HP 5	Hi Efficiency Pump HP 5	per HP
CI Motive Power 9	Std. Pump HP 7.5	Hi Efficiency Pump HP 7.5	per HP
CI Motive Power 10	Std. Pump HP 10	Hi Efficiency Pump HP 10	per HP
CI Motive Power 11	Std. Pump HP 15	Hi Efficiency Pump HP 15	per HP
CI Motive Power 12	Std. Pump HP 20	Hi Efficiency Pump HP 20	per HP
CI Motive Power 13	No Variable Frequency Drive HP 1.5	Install Variable Frequency Drive HP 1.5	per HP
CI Motive Power 14	No Variable Frequency Drive HP 2	Install Variable Frequency Drive HP 2	per HP
CI Motive Power 15	No Variable Frequency Drive HP 3	Install Variable Frequency Drive HP 3	per HP
CI Motive Power 16	No Variable Frequency Drive HP 5	Install Variable Frequency Drive HP 5	per HP
CI Motive Power 17	No Variable Frequency Drive HP 7.5	Install Variable Frequency Drive HP 7.5	per HP
CI Motive Power 18	No Variable Frequency Drive HP 10	Install Variable Frequency Drive HP 10	per HP
CI Motive Power 19	No Variable Frequency Drive HP 15	Install Variable Frequency Drive HP 15	per HP
CI Motive Power 20	No Variable Frequency Drive HP 20	Install Variable Frequency Drive HP 20	per HP
CI Motive Power 21	No Variable Frequency Drive HP 25	Install Variable Frequency Drive HP 25	per HP
CI Motive Power 22	No Variable Frequency Drive HP 30	Install Variable Frequency Drive HP 30	per HP
CI Motive Power 23	No Variable Frequency Drive HP 40	Install Variable Frequency Drive HP 40	per HP
CI Motive Power 24	No Variable Frequency Drive HP 50	Install Variable Frequency Drive HP 50	per HP

ID: CI Motive Power 1 – 4 Premium Efficiency Motors

Technology Description

Considerable efficiency gains can be made by selecting NEMA Premium Efficiency motors over standard EPACT efficiency motors.

Methodology and Assumptions

The attached spreadsheet compares the efficiency gains from EPACT to NEMA Premium Efficiency for 6 of the more common motors from 1 to 300 HP. The motor types selected were ODP and TEFC in 1200, 1800, and 3600 RPM. (60 Hz 1, 2, and 3 poles)

Key assumptions:

Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

Energy savings are for new motors

Estimated Energy Savings

Size Category	kW	kWh
1-5 HP	0.03	110
7.5-20 HP	0.08	294
25-100 HP	0.29	1,067
125-250 HP	0.66	2,429

Assumptions include: 3,680 annual hours of operation (average of all commercial and industrial customers).

Measure Life

NEMA premium efficiency motors have a life of 15 years.

Suggested Incentive

Size Category	$/HP	
1-5 HP	$	10.00
7.5-20 HP	$	8.00
25-100 HP	$	5.00
125-250 HP	$	4.00

Requirements For Application

Copies of invoices that clearly show that the new motor is NEMA premium efficiency and the motor's size.

Cross Reference for Energy Calculations

Estimated Savings for Motors are within 8.5% of deemed savings by the Focus On Energy program.

Existing Energy Standards

NEMA Premium Efficiency, Epact 1992, Pre 1997

Sources of Information

EERE Industrial Technologies Program

Energy savings and cost information are listed in Table 42 and Table 43 below:.

Table 42: Energy savings, Premium Efficiency Motors

	1200 TEFC		1800 TEFC		3600 TEFC		1200 ODP		1800 ODP		3600 ODP		Overall		
Motor HP	Delta kW	Delta kWh/yr	Delta kW	Delta kWh/yr	Delta kW	Delta kWh/yr	Delta kW	Delta kWh/yr	Delta kW	Delta kWh/yr	Delta kW	Delta kWh/yr	Average 6 Categories Delta kW	Average 6 Categories Delta kWh/yr	Average per Size Category
1	0.02	67.59	0.02	75.89	0.01	46.04	0.02	67.59	0.02	75.89	NA	NA	0.02	67	**0.03079**
1.5	0.02	71.56	0.03	92.09	0.02	57.94	0.03	92.09	0.03	92.09	0.02	57.94	0.02	77	
2	0.03	93.24	0.03	122.79	0.02	74.54	0.03	95.41	0.03	122.79	0.02	74.54	0.03	97	
3	0.04	136.72	0.04	136.72	0.02	72.38	0.04	139.86	0.06	207.45	0.03	111.81	0.04	134	
5	0.06	227.86	0.06	227.86	0.03	115.22	0.06	227.86	0.06	227.86	0.03	120.64	0.05	191	
7.5	0.07	246.48	0.10	358.75	0.05	168.96	0.08	285.01	0.11	415.45	0.05	172.83	0.07	275	**0.11099**
10	0.09	328.64	0.13	478.33	0.04	154.73	0.09	323.61	0.13	478.33	0.06	225.29	0.09	331	
15	0.13	485.41	0.12	445.66	0.07	260.88	0.13	485.41	0.17	632.55	0.06	232.09	0.12	424	
20	0.18	647.21	0.23	843.40	0.09	347.83	0.16	594.22	0.23	843.40	0.09	347.83	0.16	604	
25	0.18	680.03	0.17	618.98	0.10	374.22	0.18	680.03	0.27	987.53	0.10	374.22	0.17	619	**0.28697**
30	0.22	816.04	0.20	742.77	0.12	449.06	0.20	742.77	0.28	1046.67	0.12	449.06	0.19	708	
40	0.24	897.18	0.24	897.18	0.16	589.68	0.24	897.18	0.24	897.18	0.16	598.04	0.22	796	
50	0.30	1121.48	0.41	1522.81	0.17	622.97	0.30	1121.48	0.41	1522.81	0.17	622.97	0.30	1,089	
60	0.30	1089.40	0.46	1685.70	0.20	737.98	0.30	1089.40	0.46	1685.70	0.20	737.98	0.32	1,171	
75	0.37	1361.75	0.53	1938.06	0.25	922.47	0.37	1361.75	0.37	1347.38	0.25	922.47	0.36	1,309	
100	0.49	1796.51	0.48	1781.40	0.28	1012.99	0.49	1796.51	0.70	2584.08	0.33	1229.96	0.46	1,700	
125	0.61	2245.64	0.61	2226.75	0.34	1242.29	0.61	2245.64	0.61	2226.75	0.34	1266.24	0.52	1,909	**0.67817**
150	0.64	2352.84	0.64	2352.84	0.41	1490.75	0.73	2672.11	0.64	2352.84	0.41	1519.48	0.58	2,123	
200	0.85	3137.12	1.27	4686.11	0.43	1575.14	0.97	3562.81	0.85	3137.12	0.54	1987.67	0.82	3,014	
250	1.07	3921.40	1.59	5857.64	0.53	1952.48	0.00	0.00	0.53	1952.48	0.68	2484.59	0.73	2,695	
300	1.28	4705.68	1.27	4666.46	0.64	2342.97	0.00	0.00	0.64	2342.97	0.64	2362.70	0.74	2,737	

Table 43: Cost, Premium Efficiency Motors

	1200 TEFC Added Cost	1800 TEFC Added Cost	3600 TEFC Added Cost	1200 ODP Added Cost	1800 ODP Added Cost	3600 ODP Added Cost	Avg Added Cost	Ac/hp Added Cost
1	40.3	84.5	58.5	37.7	66.3	22.75	51.68	51.68
1.5	81.9	91.65	33.15	43.55	66.95	32.5	58.28	38.86
2	61.75	86.45	9.1	55.9	70.2	51.35	55.79	27.90
3	50.05	43.55	33.8	99.45	73.45	41.6	56.98	18.99
5	87.75	37.7	39	169.65	78.65	59.8	78.76	15.75
7.5	250.25	50.05	54.6	141.05	127.4	148.2	128.59	17.15
10	306.8	81.25	48.75	187.85	150.15	130	150.80	15.08
15	193.05	130	114.4	281.45	233.35	167.7	186.66	12.44
20	419.9	160.55	125.45	334.1	200.2	130.65	228.48	11.42
25	355.55	276.9	194.35	183.95	249.6	150.15	235.08	9.40
30	299.65	335.4	204.75	174.85	198.9	295.1	251.44	8.38
40	696.15	412.1	285.35	178.75	293.15	257.4	353.82	8.85
50	684.45	555.1	596.7	232.7	220.35	357.5	441.13	8.82
60	657.8	624.65	605.8	516.75	320.45	253.5	496.49	8.27
75	914.55	889.2	556.4	346.45	393.9	583.05	613.93	8.19
100	1506.05	1201.85	1170.65	37.7	576.55	468	826.80	8.27
125	820.95	685.1	551.2	540.15	926.9	828.1	725.40	5.80
150	530.4	803.4	554.45	1085.5	427.7	644.8	674.38	4.50
200	1728.35	784.55	1365.65	1635.4	886.6	861.9	1,210.41	6.05
250	4026.75	1530.1	1556.75	0	1323	1326	1,627.10	6.51
300	5135	980.2	1686.1	0	1369.5	1547.25	1,786.34	5.95

ID: CI Motive Power 5 – 12 High Efficiency Pumps

Technology Description

Choosing the correct pump for the process can have a large impact on energy consumption. System efficiencies can be increased by 20% or more depending on pump selection. High efficiency pumps reach efficiencies of 75% or greater on the pump curve at the dominant operating conditions.

Methodology and Assumptions

A spreadsheet analysis was performed for the operation of a set of pumps from Bell-Gosset. For five flow increments and five pressure increments, pumps that could meet the operating conditions were compared. The savings listed are the average savings on a kilowatt per horsepower basis of high efficiency pumps over other pumps that could meet the load.

Key assumptions:

Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

New installations such that motor speed and impeller size could vary

Estimated Energy Savings – kWh

The high efficiency pumps are shown to save 236 kWh per year per horsepower of the pump.

Assumptions include: 3,680 annual hours of operation (average of all commercial and industrial customers).

Summer Peak Savings

The high efficiency pumps are shown to save .064 kW per horsepower of the pump.

Assumptions include: The average loading of the pumps analyzed was 76%. Pumps with varying loads should also be equipped a variable speed drive to ensure optimal performance.

Measure Life

Pumping systems are common listed with life spans of 15 years.

Suggested Incentive

Pumps HP 1.5	$	210.00
Pumps HP 2	$	220.00
Pumps HP 3	$	230.00
Pumps HP 5	$	240.00
Pumps HP 7.5	$	250.00
Pumps HP 10	$	260.00
Pumps HP 15	$	300.00
Pumps HP 20	$	400.00

Requirements For Application

Submittals for incentive should include a pump performance curve demonstrating that a pump efficiency of 75% or greater for the dominant operating conditions.

Existing Energy Standards

A premium quality pump can have a poor efficiency if it is not matched with the proper load. The best indicator of pump performance is the pump curve.

Sources of Information

EERE Industrial Technologies Program

Table 44: High Efficiency Pumps

Pump No	HP	Increase	Savings	Savings	Cost Index	Cost $	hp
1	1.5	5.66	0.55	1,991	1.47	$ 319	0.365
3	2.0	7.48	0.14	513	1.31	$ 467	0.070
8	3.0	7.19	0.16	573	1.28	$ 461	0.052
2	5.0	2.86	0.18	664	1.07	$ 75	0.036
4	5.0	21.3	2.54	9,232	1.29	$ 304	0.507
5	5.0	12.9	1.21	4,405	1.72	$ 754	0.242
11	5.0	13.75	0.43	1,569	1.19	$ 341	0.086
14	5.0	24.54	1.17	4,254	1.34	$ 610	0.234
6	7.5	7.48	0.51	1,840	1.38	$ 657	0.067
9	7.5	6.05	0.47	1,720	1.26	$ 498	0.063
7	10.0	2.96	0.28	1,026	1.06	$ 131	0.028
10	10.0	4.6	0.45	1,629	1.14	$ 332	0.045
12	10.0	12.25	1.11	4,043	1.06	$ 150	0.111
15	15.0	16.09	2.01	7,332	1.21	$ 585	0.134
13	20.0	2.45	0.35	1,267	1.32	$ 1,029	0.017
16	20.0	9.24	1.47	5,340	1.17	$ 498	0.073
17	20.0	4	0.94	3,409	1.29	$ 850	0.047

<u>ID: CI Motive Power 13 – 24 VFD's on Pumps</u>

Technology Description

Variable frequency drives physically slow the motors driving pumps in order to achieve reduced flow rates at considerable energy savings. Traditionally flow rates have been reduced by increasing the head and riding the pump curve back to a new flow rate (throttling control). Alternately some systems have bypasses that divert a portion of the flow back to the pump inlet to reduce system flow (bypass control).

Methodology and Assumptions

The attached spreadsheet analyzes three common load profiles utilizing data collected from simple VFD models. Since throttling valve control is more efficient than bypass control it was selected as the base case.

Key assumptions:

Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

Typical load profiles were assumed.

Estimated Energy Savings

0.26 kW/HP

957 kWh/HP

Assumptions include: 3,680 annual hours of operation (average of all commercial and industrial customers).

Measure Life

Variable Speed Drives have a life of 10 years.

Suggested Incentive

We recommend an incentive of $40 - $50/HP.

Requirements for Application

Copies of invoices that clearly show that the new motor is NEMA premium efficiency and the motor's size.

Cross Reference for Energy Calculations

Focus on Energy offers a hybrid rebate a prescriptive incentive of $50/hp that needs custom calculations to determine savings

Existing Energy Standards

None

Sources of Information

EERE Industrial Technologies Program

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Table 45: Energy savings estimate VFDs

Profile 1

Design Data & Flow Profile				Constant Speed Pump					Variable Speed Pump						
				(Rides the pump curve)									Curve Fit	1.1356800	
Design Head			80	Generic curve fits					Calculation	-1.212121	-0.464286		from EPRI	-3.189767	
Design GPM			500	-0.16832	-0.46429	Motor Eff.			of Static	2.187879	1.032857			3.035644	
Min. Static Head			16	-0.14027	1.03286	is almost			Pressure	0.013333	0.220000			-0.029156	
Nominal BHP			17.1	1.35963	0.22000	constant			on the						
Estimated Motor HP			20						Modulation						
% Motor Load at Design			85%						Curve			Motor Eff.	90%		
				Correction Factors			Motor Eff.				Corr. Fact.	VFD Eff.	98%		
				95.2%	75.0%		90%				75%	Corr.Fact.	1.05		
% Hours	**Hrs/yr**	**GPM**	**% flow**	**Head**	**Pump. Eff.**	**BHP**	**Cur. kW**	**kWh**	**Head**	**Eq. Flow**	**Pump Eff.**	**BHP**	**Comb. Eff.**	**Pro. kW**	**kWh**
5%	184	500	100%	80	59%	17.1	14.2	2,605	80.0	99%	59%	17.1	88%	14.5	2,662
15%	552	450	90%	84	58%	16.4	13.6	7,484	67.8	100%	59%	13.0	88%	11.1	6,119
20%	736	400	80%	87	56%	15.6	12.9	9,515	57.0	99%	59%	9.7	87%	8.4	6,150
25%	920	350	70%	90	54%	14.8	12.3	11,272	47.4	95%	59%	7.1	85%	6.2	5,732
18%	662	300	60%	92	50%	13.9	11.5	7,626	39.0	89%	58%	5.1	82%	4.6	3,067
8%	294	250	50%	95	47%	12.9	10.7	3,144	32.0	80%	56%	3.6	77%	3.5	1,022
6%	221	200	40%	97	42%	11.7	9.7	2,143	26.2	69%	54%	2.5	69%	2.7	589
3%	110	150	30%	99	37%	10.3	8.5	939	21.8	56%	49%	1.7	58%	2.2	239
0%	-	100	20%	101	31%	8.3	6.9	-	18.6	40%	42%	1.1	43%	2.0	-
0%	-	50	10%	102	24%	5.4	4.5	-	16.6	22%	32%	0.7	23%	2.2	-
0%	**3,680**							**44,727**							**25,581**
70%	**Avg Flow**														

Profile 2

Design Data & Flow Profile				Constant Speed Pump					Variable Speed Pump						
				(Rides the pump curve)									Curve Fit	1.1356800	
Design Head			80	Generic curve fits					Calculation	-1.212121	-0.464286		from EPRI	-3.189767	
Design GPM			500	-0.16832	-0.46429	Motor Eff.			of Static	2.187879	1.032857			3.035644	
Min. Static Head			16	-0.14027	1.03286	is almost			Pressure	0.013333	0.220000			-0.029156	
Nominal BHP			17.1	1.35963	0.22000	constant			on the						
Estimated Motor HP			20						Modulation						
% Motor Load at Design			85%						Curve			Motor Eff.	90%		
				Correction Factors			Motor Eff.				Corr. Fact.	VFD Eff.	98%		
				95.2%	75.0%		90%				75%	Corr.Fact.	1.05		
% Hours	**Hrs/yr**	**GPM**	**% flow**	**Head**	**Pump. Eff.**	**BHP**	**Cur. kW**	**kWh**	**Head**	**Eq. Flow**	**Pump Eff.**	**BHP**	**Comb. Eff.**	**Pro. kW**	**kWh**
0%	-	500	100%	80	59%	17.1	14.2	-	80.0	99%	59%	17.1	88%	14.5	-
2%	74	450	90%	84	58%	16.4	13.6	998	67.8	100%	59%	13.0	88%	11.1	816
10%	368	400	80%	87	56%	15.6	12.9	4,757	57.0	99%	59%	9.7	87%	8.4	3,075
20%	736	350	70%	90	54%	14.8	12.3	9,017	47.4	95%	59%	7.1	85%	6.2	4,586
35%	1,288	300	60%	92	50%	13.9	11.5	14,827	39.0	89%	58%	5.1	82%	4.6	5,964
20%	736	250	50%	95	47%	12.9	10.7	7,860	32.0	80%	56%	3.6	77%	3.5	2,554
10%	368	200	40%	97	42%	11.7	9.7	3,572	26.2	69%	54%	2.5	69%	2.7	982
3%	110	150	30%	99	37%	10.3	8.5	939	21.8	56%	49%	1.7	58%	2.2	239
0%	-	100	20%	101	31%	8.3	6.9	-	18.6	40%	42%	1.1	43%	2.0	-
0%	-	50	10%	102	24%	5.4	4.5	-	16.6	22%	32%	0.7	23%	2.2	-
0%	**3,680**							**41,970**							**18,217**
60%	**Avg Flow**														

Profile 3

Design Data & Flow Profile				Constant Speed Pump					Variable Speed Pump						
				(Rides the pump curve)									Curve Fit	1.1356800	
Design Head			80	Generic curve fits					Calculation	-1.212121	-0.464286		from EPRI	-3.189767	
Design GPM			500	-0.16832	-0.46429	Motor Eff.			of Static	2.187879	1.032857			3.035644	
Min. Static Head			16	-0.14027	1.03286	is almost			Pressure	0.013333	0.220000			-0.029156	
Nominal BHP			17.1	1.35963	0.22000	constant			on the						
Estimated Motor HP			20						Modulation						
% Motor Load at Design			85%						Curve			Motor Eff.	90%		
				Correction Factors			Motor Eff.				Corr. Fact.	VFD Eff.	98%		
				95.2%	75.0%		90%				75%	Corr.Fact.	1.05		
% Hours	**Hrs/yr**	**GPM**	**% flow**	**Head**	**Pump. Eff.**	**BHP**	**Cur. kW**	**kWh**	**Head**	**Eq. Flow**	**Pump Eff.**	**BHP**	**Comb. Eff.**	**Pro. kW**	**kWh**
5%	184	500	100%	80	59%	17.1	14.2	2,605	80.0	99%	59%	17.1	88%	14.5	2,662
29%	1,067	450	90%	84	58%	16.4	13.6	14,470	67.8	100%	59%	13.0	88%	11.1	11,830
40%	1,472	400	80%	87	56%	15.6	12.9	19,030	57.0	99%	59%	9.7	87%	8.4	12,300
15%	552	350	70%	90	54%	14.8	12.3	6,763	47.4	95%	59%	7.1	85%	6.2	3,439
7%	258	300	60%	92	50%	13.9	11.5	2,965	39.0	89%	58%	5.1	82%	4.6	1,193
4%	147	250	50%	95	47%	12.9	10.7	1,572	32.0	80%	56%	3.6	77%	3.5	511
0%	-	200	40%	97	42%	11.7	9.7	-	26.2	69%	54%	2.5	69%	2.7	-
0%	-	150	30%	99	37%	10.3	8.5	-	21.8	56%	49%	1.7	58%	2.2	-
0%	-	100	20%	101	31%	8.3	6.9	-	18.6	40%	42%	1.1	43%	2.0	-
0%	-	50	10%	102	24%	5.4	4.5	-	16.6	22%	32%	0.7	23%	2.2	-
0%	**3,680**							**47,405**							**31,935**
80%	**Avg Flow**														

Table 46: Cost VFDs

		VFD Installation Cost Estimate					
Drive HP	VFD Installed Installed	Feeder unit $	30 Feeder Total $	P/I Transducer	Press Sensor	Control Cable	Totals
1	$ 3,170	$ 6.35	$ 191	$ 200	$ 200	$ 100	$ 3,861
2	$ 3,280	$ 6.35	$ 191	$ 200	$ 200	$ 100	$ 3,971
3	$ 3,400	$ 6.51	$ 195	$ 200	$ 200	$ 100	$ 4,095
5	$ 3,650	$ 6.77	$ 203	$ 200	$ 200	$ 100	$ 4,353
7.5	$ 4,800	$ 6.77	$ 203	$ 200	$ 200	$ 100	$ 5,503
10	$ 5,025	$ 6.77	$ 203	$ 200	$ 200	$ 100	$ 5,728
15	$ 6,450	$ 7.04	$ 211	$ 200	$ 200	$ 100	$ 7,161
20	$ 7,350	$ 7.04	$ 211	$ 200	$ 200	$ 100	$ 8,061
25	$ 8,700	$ 7.04	$ 211	$ 200	$ 200	$ 100	$ 9,411
30	$ 10,100	$ 7.59	$ 228	$ 200	$ 200	$ 100	$ 10,828
40	$ 10,600	$ 8.99	$ 270	$ 200	$ 200	$ 100	$ 11,370
50	$ 13,400	$ 11.85	$ 356	$ 200	$ 200	$ 100	$ 14,256

Commercial Energy Star Washing Machines end-use measures are listed in Table 47.

Table 47: Description of Energy Star Washing Machines

Potential Situation	Improvement	Quantity
Std Commercial Clothes Washers	Energy Star Commercial Clothes Washers	Per Unit

FES-C1 – Energy Star Commercial Clothes Washers, (Washers Only)

Technology Description

ENERGY STAR qualified commercial clothes washers wash more clothes per load than standard clothes washers and use less water and energy to do so. This calculation is comparing the annual energy savings resulting from purchasing an ENERGY STAR qualified clothes washer over a standard clothes washer that is DOE 2007 compliant. This calculation is for the clothes washer only and does not take into account the dryer savings resulting from lower moisture levels per load. The hot water energy savings are assuming the water is heated with an electric water heater.

Methodology and Assumptions

A spreadsheet calculation was performed using industry data put together by the US Department of Energy and Energy Star.

Key assumptions:

Annual cycles per washer per year = 950 cycles

- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

- Dryer energy savings as a result of lower moisture levels were not included.

Estimated Energy Savings – kWh

Energy Star qualified Commercial Clothes Washer: 380 kWh/yr

Summer Peak Savings

Energy Star qualified Commercial Clothes Washer: 0.019 kW

(only accounts for machine energy savings)

Measure Life

10-12 years

Initial One-Time Cost

US Department of Energy quoted the average retail price of a conventional clothes washer at $750, not including installation/labor costs. It quoted the average retail price of an ENERGY STAR qualified clothes washer at $1,077, not including installation/labor costs. These numbers were based on 2006 industry data gathered from across the country. ENERGY STAR's savings calculator had a conventional unit at $350, while it had an average ENERGY STAR qualified clothes washer at $500. The average incremental cost between these two comparisons is roughly $240.

Any Recurring Costs

None

Suggested Incentive

$50-$100/qualifying unit.

Requirements For Application

ENERGY STAR qualified commercial clothes washers must have a Modified Energy Factor (MEF) of 1.72 or higher.

Existing Energy Standards

US Department of Energy standard for commercial clothes washers is an MEF of 1.26 or better.

Sources of Information

Energy Star, US Department of Energy, Multi-housing Laundry Assn

Additional Information:

Assumptions:

DOE Standard 2007	1.26	MEF (requirement)
Energy Star 2007	1.72	MEF (requirement)
	950	cycles/year; Multihousing Laundry Assn (cited by Energy Star)
	3.0	cycles/day for Multifamily applications; cited by CEE
	6.0	cycles/day for Laundry Applications; cited by CEE
	4.5	cycles/day; weighted average
	0.114	kWh; machine energy per cycle, Energy Star 2007 (DOE 2006)
	0.133	kWh; machine energy per cycle, DOE Standard 2007 (DOE 2006)
	0.409	kWh; electric water heating energy per cycle, Energy Star 2007 (DOE 2006)
	0.790	kWh; electric water heating energy per cycle, DOE Standard 2007 (DOE 2006)
	0.400	kWh; energy savings per cycle
	$750.00	average retail price for DOE Standard clothes washer, DOE 2006
	$1,077.31	average retail price for Energy Star qualified clothes washer, DOE 2006
	$327.31	incremental cost difference to purchase Energy Star qualified clothes washer

Average Number of Washer Cycles per year:

950 cycles X 0.400 kWh savings/cycle = 380 kWh saved per year

0.019 kW; peak summer demand savings

Annual Cost Savings:

380 kWh/yr X ______ /kWh = $0.00 per year savings

Recommended incentive per washer:

$50

Other End-use measures

Office equipment, both PC & Non-PC end-use measures are listed in Table 48.

Table 48: Other office equipment

Potential Situation	Improvement	Quantity
No Plug Load Occupancy Sensors Document Stations	Plug Load Occupancy Sensors Document Stations	Per Unit
Std. Power Supply_Desktop Unit	80Plus Power Supply_Desktop Unit	Per Unit
Std. Power Supply_Server Unit	80Plus Power Supply_Server Unit	Per Unit
No Computer Power Manager	Computer Power Manager	Per Unit

Description of Office equipment measures:

Plug Load Occupancy Sensors for Document Stations

Technology Description

Occupancy sensors that control ‘document stations’, i.e., fax machines, copiers, scanners, etc reduce the idling runtime of these machines when no one is using them or is around them.

Methodology and Assumptions

A spreadsheet calculation was performed with standard equipment wattages, both idle wattages and continuous use wattages. Savings for typical conversions were calculated. A 25% savings factor was assumed.

Key assumptions:

Savings factor during a typical 10 hour business day = 25%

Idle wattage of laser printer = 50W

Idle wattage of fax machine, scanner, etc = 50W

Idle wattage of copier = 120W

Estimated Energy Savings – kWh

Plug Load Occupancy Sensor for Document Station = 803 kWh

Summer Peak Savings

Plug Load Occupancy Sensor for Document Station = 0.055 kW

Measure Life, 5 years

Initial One-Time Cost

Cost estimates are variable and can range from $80 to $400+.

Assume average cost of $150.

Any Recurring Costs

None

Suggested Incentive

$25/central document station (Multi user area with fax, copier, printer, etc.)

It's possible that document station can be controlled by a single power strip with sensor at a cost of $80 to $100 which would result in a high percentage incentive.

Requirements For Application

Must control at least 3 devices in central document station

Existing Energy Standards

None

Sources of Information

June 2000 ASHRAE Journal Study, 2001 ASHRAE Fundamentals, manufacturers websites

Table 49: Estimated Energy savings:

Laser Printers	Continuous Use	130 to 550 watts	
	Idle Use	10 to 125 watts	Avg. Est. = 50 watts
Copiers	Continuous Use	400 to 1100 watts	
	Idle Use	20 to 300 watts	Avg. Est. = 120 watts
Fax, stamp machine, scanner etc.	Idle Use or Energy Saver Mode		Avg. Est. = 50 watts

Savings per document station

$$\frac{(50 + 120 + 50) \text{ x } 10 \text{ hours/day x } 365 \text{ days/year x } .25}{1000 \text{ watts/kWh}} = 803 \text{ kWh}$$

Summer Peak Demand Savings: Studied for a 15 minute increment

0.22 kW	X	0.25 hr	=	0.055	kWh
0.22 kW	X	0.1875 hr	=	0.04125	kWh
				0.01375	kWh savings

0.01375 kWh / 0.25 hr = 0.055 kW saved during 15 min increments

Additional Multifamily dwelling measures are addressed in the "Appendix 5B 2010 KCPL Multifamily Final Report.doc".

3.4 ADVANCED ,METERING AND DISTRIBUTION ASSESSMENT

(D) Assess how advancements in metering and distribution technologies that may be reasonably anticipated to occur during the planning horizon affect the ability to implement or deliver potential demand-side programs;22.050 (3) (D)

An ongoing major research project in the KCPL Green Zone is addressing this. A thorough description of this assessment can be found in the

“Appendix 5G 2011-01-5 KCPL_SmG_DOE_ProjKickOff_.ppt”.

3.5 ENDUSE MEASURES MARKETING PLAN

(E) Design a marketing plan and delivery process to present the menu of end-use measures to the members of each market segment and to persuade decision-makers to implement as many of these measures as may be appropriate to their situation. When appropriate, consider multiple approaches such as rebates, financing, and direct installations for the same menu of end-use measures;22.050 (3) (E)

The marketing and communications strategy will be designed to inform customers of the availability and benefits of the program and how they can participate in the program. The strategy will include outreach to all customers. An important part of the marketing plan will be content and functionality on the GMO website, which will direct customers to information about the program. More specifically, the marketing and communications plan will include:

A combination of strategies includes major media advertising and outreach community forums and events, and through direct outreach to customers.

Marketing activities will include:

- Brochures that describe the benefits and features of the program including program participation and processes. The brochures will be available for various public awareness events (presentations, seminars etc).
- Bill inserts, bill messages and email messages.
- GMO website content providing program information resources, contact information, and links to other relevant service and information resources.
- GMO customer representatives trained to promote the program to their customers.
- Presence at conferences and public events used to increase general awareness of the program and distribute program promotional materials.
- The marketing strategy for C&I will be stratified with segmentation and a more direct approach based on actual energy needs, usage trends, industry classifications, LEED certification requirements, new and retrofit construction, and incentive requirements. Company account mangers (Energy Consultants and Commercial Consultants) will work closely with facility mangers to identify opportunities and engage appropriate third parties and industry experts to deliver energy saving solutions on an on-going basis. Marketing materials and presentations will be created to feature C&I products and services that can be distributed at trade shows, meetings, and presentations.
- Customized newsletters (called <u>Energy Talk</u>) will be created and sent to C&I partners and prospects to educate and inform them about KCP&L/GMO's product suite. Events will be sponsored to build relationships with partners and an Advisory Council will be created to solicit feedback from C&I partners on a quarterly basis. Partnerships will be created with key users to include actual energy savings programs as

well as educational and community components to build KCP&L/GMO's awareness through its strategic partners.

3.6 STATEWIDE MARKETING AND OUTREACH PROGRAM EVALUATION

(F) Evaluate, describe, and document the feasibility, cost-reduction potential, and potential benefits of statewide marketing and outreach programs, joint programs with natural gas utilities, upstream market transformation programs, and other activities. In the event that statewide marketing and outreach programs are preferred, the utilities shall develop joint programs in consultation with the stakeholder group; 22.050 (3) (F)

The Home Performance with Energy Star program addresses this rule. A description of the program is as follows:

HPwES is a multi-state approach coordinating efforts between the state sponsor, Missouri Department of Natural Resources' Energy Center (MDNR) and local partners. KCP&L will partner regionally with the Metropolitan Energy Center (MEC) and Missouri Gas Energy (MGE) to implement a successful program in the Kansas City area. The State of Kansas is also funding a portion of the program.

MDNR will conduct the role of coordinating agreements with local partners, produce a multi-state marketing plan, facilitate peer exchange, monitor quality assurance, and report results to the Department of Energy (DOE)/Environmental Protection Agency (EPA) HPwES Program.

MEC will manage the process flow of the local HPwES Program. This will include contractor recruiting, training and certifications, management of the lead generation process, whole house performance education for customers via workshops, and quality assurance delivery.

With the infrastructure in place, GMO and MGE will work to promote the program throughout respective service territories. This effort will include marketing, lead generation, and customer incentives. GMO's scope will also include an impact evaluation of the program within GMO's service territory in program year three. For a more thorough description, see the appendixes:

Appendix 5H 1MGEPeerExchange[1].pdf

Appendix 5I 2011 HPwES MO Peer Exchange.ppt

Appendix 5J HPwES - Program Plan 1.1-without cost.doc

Appendix 5K Home Performance-MO Peer Exchange.ppt

Appendix 5L MGE KCPL joint news release.pdf

3.7 COST EFFECTIVENESS

(G) Estimate the characteristics needed for the twenty (20)-year planning horizon to assess the cost effectiveness of each potential demand-side program, including: 22.050 (3) (G)

1. An assessment of the demand and energy reduction impacts of each stand-alone end-use measure contained in each potential demand-side program;

The impacts of the stand-alone end-use measures were included in Section 3.2

2. An assessment of how the interactions between end-use measures, when bundled with other end-use measures in the potential demand-side program, would affect the stand-alone end-use measure impact estimates;

These interactions were included in the modeling of measures and the various building types in section 3.2

3. An estimate of the incremental and cumulative number of program participants and end-use measure installations due to the potential demand-side program;

Incremental and cumulative program participants were calculated in the Work Paper "GMO_Program Cost-Effectiveness_HC.xlxs". Additionally, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

4. For each year of the planning horizon, an estimate of the incremental and cumulative demand reduction and energy savings due to the potential demand-side program; and

This is also included in the Work Paper "GMO_Program Cost-Effectiveness_HC.xlxs".

5. For each year of the planning horizon, an estimate of the costs, including:

A. The incremental cost of each stand-alone end-use measure;

Measure costs were included in 3.2.

B. The cost of incentives paid by the utility to customers or utility financing to encourage participation in the potential demand-side program. The utility shall consider multiple levels of incentives paid by the utility for each end-use measure within a potential demand-side program, with corresponding adjustments to the maximum achievable potential and the realistic achievable potential of that potential demand-side program;

Incentives are calculated in the Work Paper “GMO_Program Cost-Effectiveness_HC.xlxs”. Multiple incentive levels were considered. The “Appendix 5B 2010 KCPL Multifamily Final Report.docx” contains examples of multiple levels of incentives that were considered.

Additionally, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility’s control area. This requirement is included in the scope of work and project schedule which are contained in the “Appendix A Navigant_SOW_Signed_01162012.pdf”. The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group. The following is an excerpt from the statement of work.

C. The cost of incentives to customers to participate in the potential demand-side program paid by the entities other than the utility;

No assumption was made that any incentives would be paid by entities other than the utility.

D. The cost to the customer and to the utility of technology to implement a potential demand–side program;

This is only the case with the Optimizer program. That program is described in section 3.2

E. The utility's cost to administer the potential demand-side program; and

Program costs are shown in Work Paper "GMO_Program Cost-Effectiveness_HC.xlxs" We assume that administrative costs will be 25% of total program costs.

F. Other costs identified by the utility;

The cost of Evaluation, measurement and verification are approximately 5% of total program cost shown in the Work Paper "GMO_Program Cost-Effectiveness_HC.xlxs".

3.8 PARTICIPANTS AND IMPACTS

(H) A tabulation of the incremental and cumulative number of participants, load impacts, utility costs, and program participant costs in each year of the planning horizon for each potential demand-side program; and

Refer to the response to section 3.7.3 for participants. The other costs are included in the Work Paper GMO_Program Cost-Effectiveness_HC.xlxs".

3.9 SOURCES AND QUALITY OF INFORMATION

(I) The utility shall describe and document how it performed the assessments and developed the estimates pursuant to subsection (3)(G) and shall provide documentation of its sources and quality of information. 22.050 (3) (I)

This was completed in section 3.7

Additionally, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group. The following is an excerpt from the statement of work.

The Supplier shall identify and develop potential demand-side programs pursuant to Missouri electric utility resource planning rules, 4 CSR 240-22.050 (3). These demand-side programs shall be designed to deliver an appropriate selection of end-use measures to each market segment.

Supplier will consider and assess multiple designs for demand-side programs and recommend an optimal design for implementation.

Supplier will evaluate the Cost-Effectiveness_HC of the programs identified pursuant to Missouri electric utility resource planning rules, 4 CSR 240-22.050 (5) and Missouri Electric Utility Demand-Side Programs Filling and Submission Requirements 4 CSR240-3.164 (2) (B)

For each demand-side resource option or portfolio, the Supplier shall describe and document the monthly load impact estimates in kWh and kW over the planning horizon, 2012-2031. Supplier will provide summary tables of annual load impact that includes estimated annual changes in energy usage and demand.

Supplier will provide detailed description of each proposed demand-side program to include at least:

Customers targeted;

Measures included;

Customer incentives;

Proposed promotional techniques;

Specification of whether the program will be administered by the utility or a Supplier;

Projected gross and net annual energy savings;
Proposed annual energy savings targets and cumulative energy savings targets;
Projected gross and net annual demand savings;
Proposed annual demand savings targets and cumulative demand savings targets;
Net-to-gross factors;
Size of the potential market and projected penetration rates;
Any market transformation elements included in the program.
Budget information in the following categories:

- Administrative costs listed separately for the utility and/or program administrator;
- Program incentive costs;
- Estimated equipment costs;
- Estimated installation costs;
- EM&V costs; and
- Miscellaneous itemized costs, some of which may be an allocation of total
- costs for overhead items such as the market potential study or the statewide technical reference manual;

Description of any strategies used to minimize free riders;
Description of any strategies used to maximize spillover; and
For demand-side program plans, the proposed implementation schedule of Individual demand-side programs.
The Supplier will be required to document their design process which shall include at least the following activities and elements:
• Review demand-side programs that have been implemented by other utilities with similar characteristics and identify programs that would be applicable for the GPES;
• Identify, describe, and document market segments that are numerous and diverse enough to provide relatively complete coverage of the major classes and decision makers identified in subsections 1 and 2 and that are specifically

defined to reflect the primary market imperfections that are common to the members of the market segment;

• Identify a comprehensive list of end-use measures and demand-side programs considered and develop menus of end-use measures for each demand side program. The demand-side programs shall be appropriate to the shared characteristics of each market segment. The end-use measures shall reflect technological changes in end-uses that may be reasonably anticipated to occur during the planning horizon;

• Assess how advancements in metering and distribution technologies that may be reasonably anticipated to occur during the planning horizon affect the ability to implement or deliver potential demand-side programs;

• Estimate the characteristics needed for the twenty (20)-year planning horizon to assess the cost effectiveness of each potential demand-side program, including:

An assessment of the demand and energy reduction impacts of each standalone end-use measure contained in each potential demand-side program;

An assessment of how the interactions between end-use measures, when bundled with other end-use measures in the potential demand-side program, would affect the stand-alone end-use measure impact estimates;

An estimate of the incremental and cumulative number of program participants and end-use measure installations due to the potential demand-side program;

For each year of the planning horizon, an estimate of the incremental and cumulative demand reduction and energy savings due to the potential demand-side program; and

For each year of the planning horizon, an estimate of the costs, including:

The incremental cost of each stand-alone end-use measure;

An estimate of the cost of incentives to be paid by the GPES to customers to encourage participation in the potential demand-side program. The Supplier shall consider multiple levels of incentives paid by GPES for each end-use measure within a potential demand-side program, with corresponding adjustments to the maximum achievable potential and the realistic achievable potential of that potential demand-side program;

The cost of incentives to customers to participate in the potential demandside program paid by the entities other than the GPES;

An estimate of the cost to the customer and to the GPES of technology to implement a potential demand–side program;

An estimate of GPES' cost to administer the potential demand-side program; and

Other costs identified by the Supplier that GPES would incur;

A tabulation of the incremental and cumulative number of participants, load impacts, GPES costs, and program participant costs in each year of the planning horizon for each potential demand-side program; and

The Supplier shall describe and document how it performed the assessments and developed the estimates and shall provide documentation of its sources and quality of information.

The Supplier will be required to evaluate the Cost-Effectiveness_HC of the set of potential demand-side programs developed pursuant to Missouri 4 CSR 240.22.050 (5) and

Missouri 4 CSR 240-3.164 (B) which require:

The total resource cost test and a detailed description of GPES' avoided cost calculations and all assumptions used in the calculation. To the extent that the portfolio of programs fails to meet the TRC test, the utility shall examine whether the failure persists if it considers a reasonable range of uncertainty in the assumptions used to calculate avoided costs;

The Supplier shall also include calculations for the utility cost test, the participant test, the nonparticipant test, and the societal cost test.

SECTION 4: DEMAND-SIDE RATE DEVELOPMENT

(4) The utility shall develop potential demand-side rates designed for each market segment to reduce the net consumption of electricity or modify the timing of its use. The utility shall describe and document its demand-side rate planning and design process and shall include at least the following activities and elements:

4.1 DEMAND-SIDE RATE REVIEW

(A) Review demand-side rates that have been implemented by other utilities and identify whether similar demand-side rates would be applicable for the utility taking into account factors such as similarity in electric prices and customer makeup; 22.050 (4) (A)

In order to review the demand-side rates of other utilities, we extracted all of the tariffs of all U.S. investor owned utilities from the Energy Velocity database licensed from Ventyx, an ABB company. We observed that 80% of the utilities that offered demand-side rates had participation rates below 5%. We did not find a utility with Demand-side rate participation greater than 3% that had prices, weather and customer makeup similar to those in MO and GMO. The data used for this analysis is included in the "Work Paper "ALL_IOU_Tariffs.xlxs".

(B) Identify demand-side rates applicable to the major classes and decision-makers identified in subsection (1)(A). When appropriate, consider multiple demand-side rate designs for the same major classes;

KCPL-MO and GMO have 17 separate demand-side tariffs. Table 50: KCPL & GMO Demand-Side Rates & Customers (190 Total), below, shows those tariffs and the customers participating. These tariffs are similar to those offered by neighboring utilities.

Table 50: KCPL & GMO Demand-Side Rates & Customers (190 Total)

	Tariff	Customer Count	Tariff #	Sheet	Territory
1	Large Power Service	72	MO Tariff No. 1	Sheets 31 - 33	L&P
2	Residential TOU Tariffs				
	Residential Time-of-Day Service	54	KS Tariff Schedule 16	Sheets 1 & 2	KCP&L
	Residential Time-of-Day	40	MO Tariff No. 7	Sheet 8	KCP&L
	Residential Service Time-of-Day	0	MO Tariff No. 1	Sheet 66	GMO
3	Large Power Service - Off-Peak Rider	11	MO Tariff No. 7	Sheet 15	KCP&L
4	RTP and RTP Plus				
	Real-Time Pricing	3	MO Tariff No. 7	Sheet 26	KCP&L
	Real-Time Price Program	3	MO Tariff No. 1	Sheet 73	GMO
	Real-Time Pricing	0	KS Tariff Schedule 79	Sheets 1 - 5	KCP&L
	Real-Time Pricing Plus	0	KS Tariff Schedule 80	Sheets 1 - 5	KCP&L
	Real-Time Pricing Plus	0	MO Tariff No. 7	Sheet 26	KCP&L
5	Two Part Time-of-Use	4	MO Tariff No. 7	Sheet 20	KCP&L
6	Thermal Storage Programs				
	Thermal Storage Rider	1	KS Tariff Schedule 77	Sheet 1	KCP&L
	Thermal Energy Storage Pilot Program FROZEN	1	MO Tariff No. 1	Sheet 70	GMO
	Thermal Storage Rider	0	MO Tariff No. 7	Sheet 22	KCP&L
7	Optional Time-of-Use Adjustment Rider	1	MO Tariff No. 1	Sheet 35	L&P
8	Incremental Energy Rider	0	MO Tariff No. 7	Sheet 24	KCP&L
9	General Service Time-of-Day	0	MO Tariff No. 1	Sheet 67	GMO
		190			

Also the “Appendix 5M Res_TOU_Pilot_HC.pdf” describes the residential time of use pilot tariff that has been introduced in the KCPL Smart Grid.

(C) Assess how technological advancements that may be reasonably anticipated to occur during the planning horizon, including advanced metering and distribution systems, affect the ability to implement demand-side rates;

The “Appendix 5M Res_TOU_Pilot_HC.pdf” introduces the residential time of use pilot tariff that has been introduced in the KCPL Smart Grid. Smart metering will make it possible to collect detailed data on whether or not participants changed their behavior, after opting in to a time of use rate. It will also be possible to measure differences between participant behavior with and without various types of enabling technology.

(D) Estimate the input data and other characteristics needed for the twenty (20)-year planning horizon to assess the cost effectiveness of each potential demand-side rate, including:

1. An assessment of the demand and energy reduction impacts of each potential demand-side rate;

We will have data on the SmartGrid Residential TOU pilot Tariff, after the summer of 2012. That data would include participation levels, changes in participant peak and energy usage. This will make it possible for us to measure the impacts

Additionally, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group. GMO will provide an update on the status of the demand-side rates that we are evaluating, as well as the results of the DSM potential study, at the time of its annual update.

2. An assessment of how the interactions between multiple potential demand-side rates, if offered simultaneously, would affect the impact estimates;

In terms of multiple customers on differing demand-side rates, the impact of each customer should be additive rather than a result of another customer's behavior.

In terms of one customer participating in more than one demand-side rate, we would avoid offering this because of the potential for free ridership. However, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

3. An assessment of how the interactions between potential demand-side rates and potential demand-side programs would affect the impact estimates of the potential demand side programs and potential demand-side rates;

We would need modeling that is to be completed in the DSM Potential study to assess this impact. GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

4. For each year of the planning horizon, an estimate of the incremental and cumulative demand reduction and energy savings due to the potential demand-side rate;

We will have data on the SmartGrid Residential TOU pilot Tariff, after the summer of 2012. That data would include participation levels, changes in participant peak and energy usage. This will make it possible for us to measure the impacts

Additionally, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

and

5. For each year of the planning horizon, an estimate of the costs of each potential demand-side rate, including:

A. The cost of incentives to customers to participate in the potential demand side rate paid by the utility. The utility shall consider multiple levels of incentives to achieve customer participation in each potential demand-side rate, with corresponding adjustments to the maximum achievable potential and the realistic achievable potentials of that potential demand-side rate;

Incentives are not offered for any of our demand side rates. The incentive to participate in the TOU rates we offer is the potential on-going bill savings. To address the the possibility of offering sign up incentives or other incentives, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

B. The cost to the customer and to the utility of technology to implement the potential demand-side rate;

For the SmartGrid pilot TOU program, we are taking advantage of Smart Meters that were installed as part of the KCPL SmartGrid DOE project. As a result, the costs of this program are minimal. For additional potential demand-side rates, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

C. The utility's cost to administer the potential demand-side rate; and D. Other costs identified by the utility;

Our costs to administer the demand-side rates, mentioned in this section are minimal. A more thorough assessment of costs will a product of the DSSM Potential study. GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

(E) A tabulation of the incremental and cumulative number of participants, load impacts, utility costs, and program participant costs in each year of the planning horizon for each potential demand-side program;

This information will be available after the completion of the SmartGrid TOU pilot and the DSM potential study. GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

(F) Evaluate how each demand-side rate would be considered by the utility's Regional Transmission Organization (RTO) in resource adequacy determinations, eligibility to participate as a demand response resource in RTO markets for energy, capacity, and ancillary services;

At this time, the Southwest Power Pool does not recognize demand response as capacity and does not have a market for ancillary services.

and

(G) The utility shall describe and document how it performed the assessments and developed the estimates pursuant to subsection (4)(D) and shall document its sources and quality of information.

The description of our ongoing assessment is documented throughout the response to this section. Additionally, GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group. GMO will provide an update on the status of the demand-side rates that we are evaluating, as well as the results of the DSM potential study, at the time of its annual update.

SECTION 5: DEMAND-SIDE PROGRAM COST EFFECTIVENESS 22.050 (5)

(5) The utility shall describe and document its evaluation of the cost effectiveness of each potential demand-side program developed pursuant to section (3) and each potential demand-side rate developed pursuant to section (4). All costs and benefits shall be expressed in nominal dollars.

This requirement has been fulfilled in the Work Paper "GMO_Program Cost-Effectiveness_HC.xlxs".

(A) In each year of the planning horizon, the benefits of each potential demand-side program and each potential demand-side rate shall be calculated as the cumulative demand reduction multiplied by the avoided demand cost plus the cumulative energy savings multiplied by the avoided energy cost. These calculations shall be performed both with and without the avoided probable environmental costs. The utility shall describe and document the methods, data, and assumptions it used to develop the avoided costs.

This requirement has been fulfilled in the Work Paper "GMO_Program Cost-Effectiveness_HC.xlxs".

1. The utility avoided demand cost shall include the capacity cost of generation, transmission, and distribution facilities, adjusted to reflect reliability reserve margins and capacity losses on the transmission and distribution systems, or the corresponding market-based equivalents of those costs. The utility shall describe and document how it developed its avoided demand cost, and the capacity cost chosen shall be consistent throughout the triennial compliance filing.

The calculation of avoided demand cost is provided in the table below.

Table 51: Avoided Demand Cost ** Highly Confidential **

[redacted]

2. The utility avoided energy cost shall include the fuel costs, emission allowance costs, and other variable operation and maintenance costs of generation facilities, adjusted to reflect energy losses on the transmission and distribution systems, or the corresponding market-based equivalents of those costs. The utility shall describe and document how it developed its avoided energy cost, and the energy costs shall be consistent throughout the triennial compliance filing.

The avoided energy costs are market based equivalents that account for all of these costs and are provided by the MIDAS Market Model.

3. The avoided probable environmental costs include the effects of the probable environmental costs calculated pursuant to 4 CSR 240-22.040(2)(B) on the utility avoided demand cost and the utility avoided energy cost. The utility shall describe and document how it developed its avoided probable environmental cost.

The probable environmental costs were developed as described in the response to ***4 CSR 240-22.040(2)(B)*** and included in the calculation of avoided energy costs.

(B) The total resource cost test shall be used to evaluate the cost effectiveness of the potential demand-side programs and potential demand-side rates. In each year of the planning horizon—

1. The costs of each potential demand-side program shall be calculated as the sum of all incremental costs of end-use measures that are implemented due to the program (including both utility and participant contributions) plus utility costs to administer, deliver, and evaluate each potential demand-side program;

This requirement has been fulfilled in the Work Paper "GMO_Program Cost-Effectiveness_HC.xlxs".

2. The costs of each potential demand-side rate shall be calculated as the sum of all incremental costs that are due to the rate (including both utility and participant contributions) plus utility costs to administer, deliver, and evaluate each potential demand-side rate; and

Our ongoing evaluation of demand-side rates is discussed in section 4. As a pilot program that takes advantage of smart meters being installed in the Smart Grid, incremental costs are minimal. The demand impacts will be known after data is available for the study period.

3. For purposes of this test, the costs of potential demand-side programs and potential demand-side rates shall not include lost revenues or utility incentive payments to customers.

This requirement has been fulfilled in the Work Paper “GMO_Program Cost-Effectiveness_HC.xlxs”. The costs do not include lost revenues and do not include incentive payments. The participant costs are gross participant costs.

(C) The utility cost test shall also be performed for purposes of omparison. In each year of the planning horizon—

This requirement has been fulfilled in the Work Paper “GMO_Program Cost-Effectiveness_HC.xlxs”.

1. The costs of each potential demand-side program and potential demand-side rate shall be calculated as the sum of all utility incentive payments plus utility costs to administer, deliver, and evaluate each potential demand-side program or potential demand-side rate;

The costs were calculated as the sum of all utility incentive payments plus utility costs to administer, deliver, and evaluate each potential demand-side program or potential demand-side rate.

2. For purposes of this test, the costs of potential demand-side programs and potential demand-side rates shall not include lost revenues;

Lost revenues were not included in the calculations.

and

3. The costs shall include, but separately identify, the costs of any rate of return or incentive included in the utility’s recovery of demand-side program costs.

We did not assume a rate of return or utility incentives in the utility cost test calculation.

(D) The present value of program benefits minus the present value of program costs over the planning horizon must be positive or the ratio of

annualized benefits to annualized costs must be greater than one (1) for a potential demand-side program or potential demand-side rate to pass the utility cost test or the total resource cost test. The utility may relax this criterion for programs that are judged to have potential benefits that are not captured by the estimated load impacts or avoided costs, including programs required to comply with legal mandates.

The ratios are included in the Work Paper “GMO_Program Cost-Effectiveness_HC.xlxs”.

(E) The utility shall provide results of the total resource cost test and the utility cost test for each potential demand-side program evaluated pursuant to subsection (5)(B) and for each potential demand–side rate evaluated pursuant to subsection (5)(C) of this rule, including a tabulation of the benefits (avoided costs), demand-side resource costs, and net benefits or costs.

This requirement has been fulfilled in the Work Paper “GMO_Program Cost-Effectiveness_HC.xlxs”.

(F) If the utility calculates values for other tests to assist in the design of demand-side programs or demand-side rates, the utility shall describe and document the tests and provide the results of those tests.

We did not include values of any additional tests.

(G) The utility shall describe and document how it performed the cost effectiveness assessments pursuant to section (5) and shall describe and document its methods and its sources and quality of information.

This requirement has been fulfilled in the Work Paper “GMO_Program Cost-Effectiveness_HC.xlxs”.

SECTION 6: TOTAL RESOURCE COST TEST

(6) Potential demand-side programs and potential demand-side rates that pass the total resource cost test including probable environmental costs shall be considered as demand side candidate resource options and must be included in at least one (1) alternative resource plan developed pursuant to 4 CSR 240-22.060(3).

The portfolio in the Work paper "GMO_Program Cost-Effectiveness_HC.xlxs" was included as an alternative resource plan.

(A) The utility may bundle demand-side candidate resource options into portfolios, as long as the requirements pursuant to section (1) are met and as long as multiple demand side candidate resource options and portfolios advance for consideration in the integrated resource analysis in 4 CSR 240-22.060. The utility shall describe and document how its demand-side candidate resource options and portfolios satisfy these requirements.

The bundled resource options in the Work Paper "GMO_Program Cost-Effectiveness_HC.xlxs" were advanced for consideration in the integrated resource analysis.

(B) For each demand-side candidate resource option or portfolio, the utility shall describe and document the time-differentiated load impact estimates over the planning horizon at the level of detail required by the supply system simulation model that is used in the integrated resource analysis, including a tabulation of the estimated annual change in energy usage and in diversified demand for each year in the planning horizon due to the implementation of the candidate demand-side resource option or portfolio.

The load impact estimates provided to the MIDAS simulation model are provided in the Work Paper "GMO_DSM_Plan.xlsx"

(C) The utility shall describe and document its assessment of the potential uncertainty associated with the load impact estimates of the demand-side candidate resource options or portfolios. The utility shall estimate—

GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

1. The impact of the uncertainty concerning the customer participation levels by estimating and comparing the maximum achievable potential and realistic achievable potential of each demand-side candidate resource option or portfolio; and

GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

2. The impact of uncertainty concerning the cost effectiveness by identifying uncertain factors affecting which end-use resources are

cost effective. The utility shall identify how the menu of cost-effective end-use measures changes with these uncertain factors and shall estimate how these changes affect the load impact estimates associated with the demand-side candidate resource options.

GMO has engaged Navigant Consulting to conduct a Demand-Side Management Potential study in the utility's control area. This requirement is included in the scope of work and project schedule which are contained in the "Appendix A Navigant_SOW_Signed_01162012.pdf". The scope of the potential study was developed by the company. The Original RFP and the proposal was reviewed by stakeholders to the IRP process during July and August of 2011 and quarterly meetings on scope and progress were held with the DSM advisory group.

SECTION 7: DEVELOPMENT OF EVALUATION PLANS

(7) For each demand-side candidate resource option identified in section (6), the utility shall describe and document the general principles it will use to develop evaluation plans pursuant to 4 CSR 240-22.070(8). The utility shall verify that the evaluation costs in subsections (5)(B) and (5)(C) are appropriate and commensurate with these evaluation plans and principles.

GMO will engage a consultant to evaluate future programs and the scope of work will be based on ***4 CSR 240-22.070(8)."***

SECTION 8: DEMAND-SIDE RESOURCES AND LOAD-BUILDING PROGRAMS 22.050 (8)

(8) Demand-side resources and load-building programs shall be separately designed and administered, and all costs shall be separately classified to permit a clear distinction between demand-side resource costs and the costs of load-building programs. The costs of demand-side resource development that also serve other functions shall be allocated between the functions served.

GMO did not include load-building programs in the IRP evaluations. Therefore Rule 22.050 (8) has been fulfilled.