Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_1 Please produce all workpapers, in electronic spreadsheet format with formulas intact, supporting each of the testimonies, exhibits, and schedules included in the Company's application and direct testimonies.

RESPONSE

The Company's proposals in this case reflect the outcome of the multiple stakeholder meetings and collaboration with the various stakeholders, including the Joint Intervenors. Please see KPCO_R_JI_1_1_Attachment1 for the requested information. Please also see Exhibits SEB-2 and SEB-3, which were provided in excel format.

Witness: Tanner S. Wolffram

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_2 Please produce any memoranda, research summaries, or analysis conducted by GDS concerning PAYS.
a.: Please also produce all workpapers, notes, spreadsheets (machine readable, unprotected, with formulas intact) that were utilized in the creation of such document.

RESPONSE

After discussions with stakeholders and at the Company's request, GDS conducted an analysis of on-bill tariff programs or PAYS programs. GDS compiled their research into KPCO_R_JI_1_2_Attachment1. An on-bill tariff program was not included in the near-term program design recommendations due to the potential narrow focus of the program and potential duplication of the current income-qualified program. Instead, GDS focused on expanding the Company's TEE program and recommended other programs that could more broadly reach all customers while Kentucky Power re-establishes DSM/EE programs.

Witness: Warren Hirons (GDS Associates)

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

Pay As You Save (PAYS) Program Research

The 2023 Market Potential Study conducted by GDS Associates, Inc. identified cost-effective programs for Kentucky Power's consideration. The primary objective of the program design recommendations of the MPS was to expand energy efficiency for all customers with specific emphasis on low- and moderate-income residential customers. A PAYS program is not recommended in the study. The study focused on low- and moderate-income residential customers and evaluated the needs of customers who would be served by a PAYS program.

A review of recent PAYS program activity has not consistently demonstrated that they can be either cost-effective or effectively reach the target market. PAYS programs are not widely offered by investor-owned utilities. Ameren Missouri and Evergy (Missouri) are among a small number of IOUs to offer PAYS programs. In 2021, the Ameren Missouri PAYS program was not cost-effective (0.68 TRC ratio) and had very limited participation, with just a 7% conversion rate (% of projects identified being financed). The program only had limited reach among the segments which it is uniquely positioned to serve (e.g. landlords and tenants), and customers reported plans to move forward with recommended upgrades outside the program. The Evergy PAYS program had similar limitations and achieved just a 3% conversion rate.

Historical results for the Ameren Missouri program show it to be not cost-effective and driving almost no participation. The How$mart® program offered by electric cooperatives in Kentucky has served just 0.23% of customers in over 10 years, and the cost-effectiveness of this program is unknown.

State	Program	Utility	Number of Customers	Inception (yr)	Active (Y/N/A)*	Source of Capital	Program Operator	Project Type	Projects Completed	Percent of Customers
AR	HELP PAYS®	Ouachita Electric Coop	6,916	2016	Y	Nat. Rural Utilities Coop. Finance Corp. USDA RESP	EEtility	TOTAL SF Not solar MF Not Solar Commercial Solar - Res Solar - Com	406 285 88 9 23 1	6%
CA	Water Upgrades $ave	Regional Program	NA	2021	Y	Joint Powers Authority	EEtility	SF, MF	13 SF 0 MF	NA NA
CA	Green Hayward PAYS®	City of Hayward	NA	2015	N	Utility Operations	Frontier Energy	MF	6 MF Bldgs 162 Units	1.2%
CA	Windsor Efficiency PAYS®	Town of Windsor Water Utility	7,846 NA	2012	N	Utility Operations	Sonoma Cnty Energy Independence	SF MF	242 SF 5 MF Bldgs 233 Units	3% SF NA
HI	Solar Saver Pilot	Hawaiian Electric Hawai'i Electric Light Maui Electric	304,261 85,029 70,872	2007	N	Conservation Budget	Utility	SF	484	NA
KS	How$mart®	Midwest Energy	29,706	2008	Y	Various	Utility	SF, Commercial	2,475	8.3%
KY	How$mart® KY	Big Sandy RECC Grayson Electric Coop Fleming-Mason Energy Jackson Energy Coop Farmers RECC Licking Valley RECC	12,500 15,000 23,730 51,000 20,000 17,000	2011	Y	Various	Mountain Association	SF, Commercial	320	0.23%

The Ameren and Evergy program evaluation results have indicated that even if given access to upfront capital, the copays associated with the PAYS program are prohibitive to participation (copays are occasionally required to fulfill the payback parameters of the program; thus, all of the upfront barriers may not be eliminated).

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

Even if energy efficiency measures are installed at no upfront cost to a customer, a PAYS program by design requires customers to pay a tariffed charge on their utility bill. Any efficiency gains realized in the short term will not be enough to outweigh the burden of a utility bill that would include a tariff charge. The problem of termination notices and disconnection notices may not be eliminated.

PAYS feasibility studies have found that PAYS programs are best suited for a specific set of customers. Recognizing that Kentucky Power is committed to establishing a portfolio for all customers, GDS found it would be more beneficial for Kentucky Power to focus on program models that are known to be successful and cost-effective as it ramps up energy efficiency activities.

DATA REQUEST

JI 1_3 Please list any utilities, including all investor-owned utilities, municipal utilities, or co-ops, that KPC has communicated with regarding the design, evaluation, or discussion of any Inclusive Utility Investment, Tariffed-on-Bill, or PAYS program (hereafter all of these programs will collectively be referred to as "IUI" programs).
a.: Provide any notes regarding these communications, spreadsheets (machine readable, unprotected, with formulas intact), or other materials associated with these communications.

RESPONSE

Members of the Joint Intervenors and Kentucky Power have attended several collaborative sessions over the past year where topics have included DSM/EE, Kentucky Power customer services, and housing deficiencies. At an all-day workshop attended by both Kentucky Power and Joint Intervenors on March 14, 2024 at Kentucky Power's Paintsville service center, Duke Energy presented on a tariff on-bill program being launched in their North Carolina region. A copy of the presentation given by Duke Energy is provided as KPCO_R_JI_1_3_Attachment1.

a. Beyond the presentation mentioned above, the documents presented and minutes taken at the workshop were provided to the Company by the Joint Intervenors after the meeting. As such, the requested information is in the custody and control of the Joint Intervenors. The Company has no additional information responsive to this request.

Witness: Barrett L. Nolen

Tariff On-Bill
Improve & Save

March 2024

DUKE ENERGY

BUILDING A **SMARTER** ENERGY FUTURE ®

Welcome

Zachary Beaty
Sr Products & Services Manager
Zachary.Beaty@Duke-Energy.com

Agenda

Introduction and Video

TOB Summary

Market Size and Analysis

Customer Journey

Customer Protections

Duke Incentives

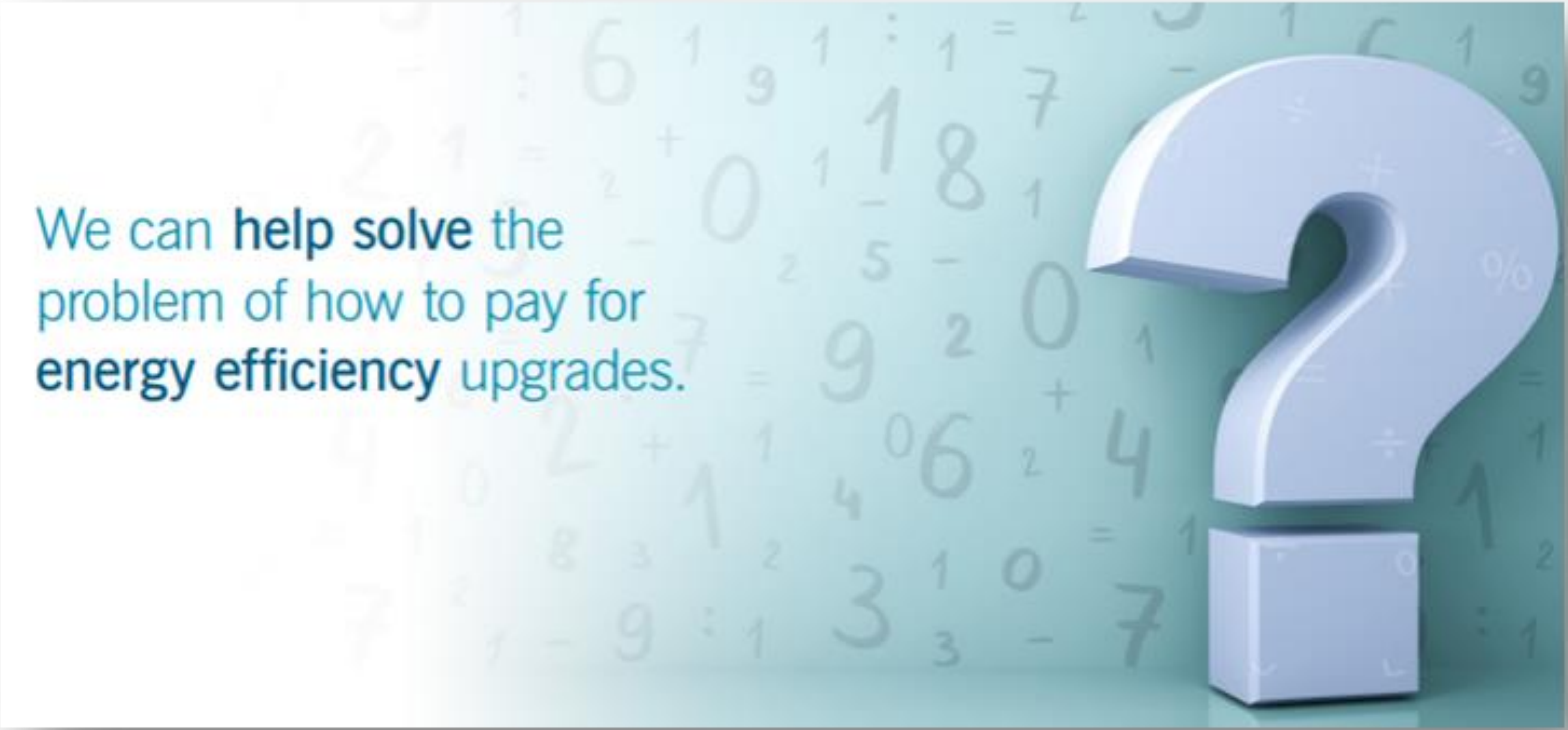
Q&A

DUKE ENERGY.

What is Tariff on Bill (TOB)?

"An on-bill tariff program allows a utility to pay for energy efficiency improvements at a specific residence and recover payment for those improvements over time on the utility bill for that location. The on-bill tariff model differs from on-bill loans and repayment models in that tariffs are not a loan, but rather a utility expenditure for which cost recovery is tied to the utility meter according to terms set forth in a utility tariff."[1]

[1] U.S. Department of Energy, 'Issue Brief: Low-Income Energy Efficiency Financing through On-Bill Tariff Programs', https://betterbuildingssolutioncenter.energy.gov, October 2023


We can help solve the problem of how to pay for energy efficiency upgrades.

- Improve & Save - Duke Energy (duke-energy.com)

- *Watch video on landing page*

Improve & Save Program

Program Description

A residential program designed to make homes more efficient and save customers money by reducing energy usage through tariffed residential improvements that are paid for as part of the home's Duke Energy bill.

Duke Energy will pay for the installation and equipment up-front.

Improvements include:

- HVAC replacement w/ Duct Sealing
- Water Heater replacement
- Attic insulation and Air Sealing
- Smart thermostat

Solving Customer Problems

Affordable Payments — Average total monthly energy bill is less with the TOB charge than it is before the improvements so that customers can afford the upgrades.

No Credit Barriers — No credit check or home lien. Access to low interest rates that may not otherwise be available to customers.

Older Homes — Customers will be able to update older homes and receive energy efficiency incentives.

Moving Out — The TOB charge is associated with the home. If someone moves out the TOB charge will persist with the next resident.

Maintenance — Maintenance will be provided to ensure the continued operation and efficiency of the equipment.

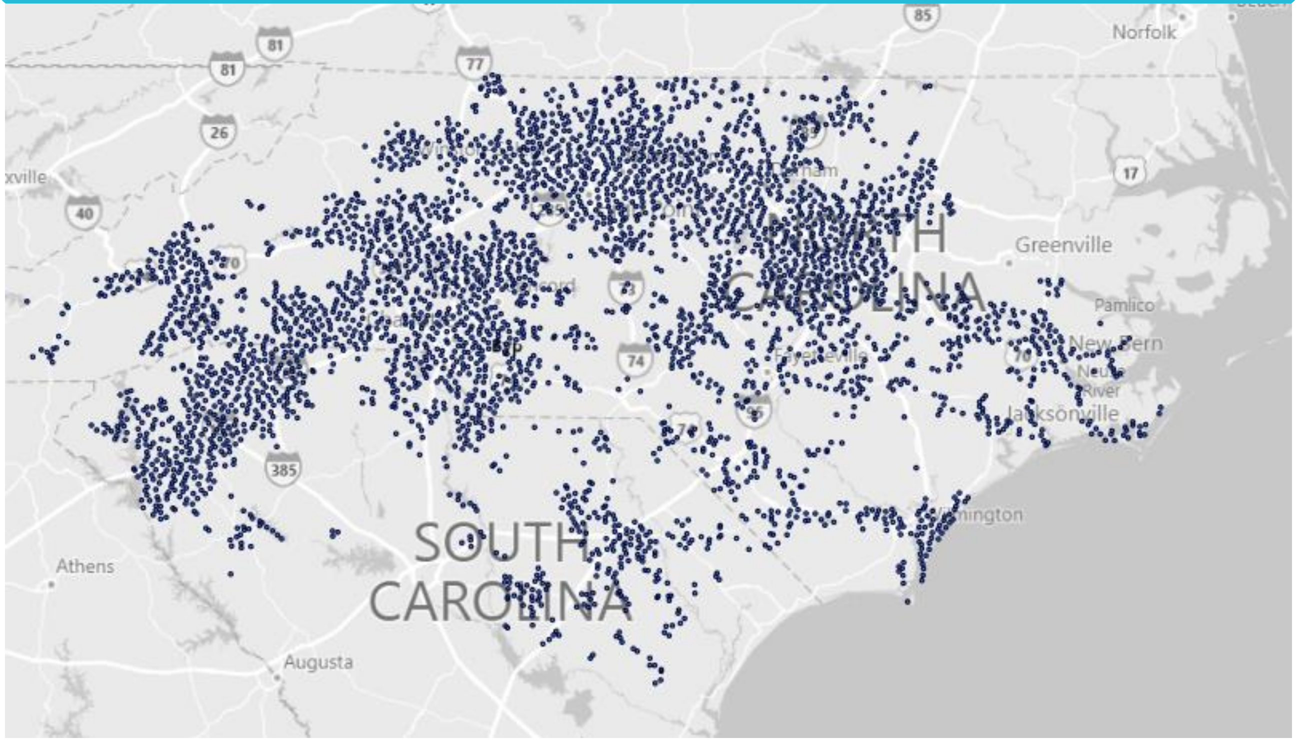
Target Customer & Market Size

Improve & Save seeks to serve 3,800 homes over five years.

SC (Pilot) seeks to serve 1,000 customers over 3 years

IRA Rebates coupled with TOB should help reach more residential customers.

Using Data Analytics, we seek to reach Customers with the highest potential savings impacts.



DUKE ENERGY.

CUSTOMER JOURNEY

Customer Receives Marketing Material, visits landing page to check if eligible for program

If eligible, direct install measures ordered, home audit is scheduled

Home Audit is conducted by energy advisor; direct install measures are installed

Energy Advisor leaves behind initial findings

Conduct modeling, apply incentives and perform customer benefit test

Provide customer proposal based on modeling results

Customer accepts proposal, TA confirms install and cost

Installation occurs

Post Installation follow-up including maintenance and warranty

Customer receives bill including Improve & Save line-item charge

Duke Energy Task

(Vendor Partner)

Trade Ally Task

Customer Protections

- Customer Benefit Test
  - There must be at least a 10% savings opportunity to participate without a copayment
- Renter Participation
  - For renter occupied premises, the owner must consent to the changes
  - Anyone starting service at a TOB participating premise will be notified upon starting service
- Notification of Charges
  - Notice filed with local Registers of Deeds offices to inform prospective or new buyers of the TOB monthly charge, the associated measures installed, and contact information
  - Duke will notify customers when starting service at a TOB premise
- Early Pay-Off
  - No additional costs or penalties to pay-off early
- Pause Charges
  - If the HVAC or water heater is not working and cannot be repaired within 5 business days then we may pause future charges until it is fixed
- Maintenance & Warranty
  - Manage maintenance schedule and providers to keep equipment functioning efficiently
  - Extended warranty to cover labor and parts

Improve & Save
Incentives for Estimated Energy Savings

The audit's modelled savings calculation is used to determine the Duke incentive (Incentive amounts may have been modified since the date of this presentation)

	Estimated Savings			
	1-49%	50-69%	70-84%	85-100%
MiniSplit+Duct Sealing	$ 800.00	$ 3,929.00	$ 4,771.00	$ 5,613.00
MiniSplit+Duct Sealing & AI+AS	$ 1,050.00	$ 4,664.00	$ 5,663.00	$ 6,663.00
HVAC+Duct Sealing	$ 600.00	$ 3,239.00	$ 3,933.00	$ 4,627.00
HVAC+Duct Sealing & AI+AS	$ 850.00	$ 3,974.00	$ 4,825.00	$ 5,677.00
AI+AS	$ 250.00	$ 735.00	$ 893.00	$ 1,050.00
HPWH	$ 350.00	$ 840.00	$ 1,020.00	$ 1,200.00

DUKE ENERGY

Improve & Save

Questions?

Zachary.Beaty@Duke-Energy.com

- **How did you determine your rate of return?**

The Company proposed earning its approved return (WACC) based on the latest rate case, on the capital investment associated with the installation of the energy efficiency measures.

- **How did you model the TOB repayment?**

The Company used historical installation costs and adders for inflation and supply chain issues to see the estimated repayment.

- **How did you determine what incentives to provide?**

The Company modelled high use customer demographics to determine the added value the system would receive to increase early replacement incentives we could offer to the customer compared to other similar programs.

DUKE ENERGY®

DATA REQUEST

JI 1_4 Please provide any recent and relevant information regarding cost-effectiveness tests and EM&V reports associated with IUI programs that have informed GDS's or KPC's analysis of IUI programs.

RESPONSE

IUI programs were not selected in the program design recommendations in the market potential study because GDS Associates recommended focusing on proven and cost-effective programs as the Company reinstated a suite of DSM/EE programs. Nonetheless, Ameren Missouri offers an IUI program and their 2021 residential evaluation that includes PAYS can be found at https://efis.psc.mo.gov/Document/Display/9242 and https://efis.psc.mo.gov/Document/Display/9243. This was reviewed by GDS and the Total Resource Cost (TRC) score of 0.68 was referenced in the summary provided to the Company.

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_5 Please state if KPC, or any entity on KPC’s behalf, has considered or analyzed the potential of an IUI program related to DSM/EE measures in existing buildings.
a.: If so, please provide any relevant documents, analyses, spreadsheets (machine readable, unprotected, with formulas intact) that KPC used to evaluate such a program.
b.: If not, please explain why not.

RESPONSE

IUI programs were not selected in the program design recommendations in the market potential study. GDS Associates recommended focusing on proven and cost-effective programs as the Company reinstated a suite of DSM/EE programs. Please also see the response to JI 1_2.

a. N/A.

b. Based on historical results of IUI programs offered by other utilities, GDS did not recommend an IUI, or PAYS, program to Kentucky Power as it reinstated DSM/EE programs. The results of other programs show them to not be cost-effective while driving minimal participation.

Witness: Barrett L. Nolen

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_6 Please state if KPC, or any entity on KPC's behalf, has considered or analyzed the potential of an IUI program related to new construction.
a.: If so, please provide any relevant documents, analyses, spreadsheets (machine readable, unprotected, with formulas intact) that KPC used to evaluate such a program.

b.: If not, please explain why not.

RESPONSE

a. Please see the Company's response to JI 1_2 and 1_5.

b. N/A.

Witness: Barrett L. Nolen

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_7 Please refer to the list of 2024 Clean Energy Credits posted on the Kentucky Energy and Environment Cabinet website:
: For households:
: Publication 5886-A: Clean Energy Tax Incentives for Individuals
: Publication 5797: Home Energy Tax Credits
: Publication 5967: Energy Efficient Home Improvements Credit
: Publication 5968: Residential Clean Energy Credits
: For businesses
: Publication 5886: Clean Energy Tax Incentives for Businesses
: Publication 5724-B: Credit for Commercial Clean Vehicles
: Publication 5832: Energy Efficient Commercial Buildings Deduction
: Publication 5855: Prevailing Wage & Registered Apprenticeship Overview
: For tax-exempt and governmental entities, along with certain other applicable entities:
: Publication 5817, Elective Pay Overview
: Publication 5817-G, Clean Energy Tax Incentives: Elective Pay-Eligible Tax Credits

a.: Has KPC developed any materials or resources to inform its customers about or help its customers to access any of the programs listed?
i.: If so, please produce the relevant materials or describe the relevant resources if unable to be produced.
ii.: If not, does Kentucky Power have plans to develop such materials or resources?
1.: If yes, please describe such plans.
2.: If not, please state why not.

RESPONSE

Kentucky Power's website provides information on several tax credits available to customers. The Company also makes proactive contacts with commercial customers and during this discussion may provide details about rebates that are applicable to that industry or upgrades that the Company is planning.

Customers can learn about federal income tax options available for energy efficiency measures installed at https://www.kentuckypower.com/savings/home/energy/appliances-electronics/ which then refers customers to https://www.energystar.gov/about/federal-tax-credits to learn more. This link provides details about various rebates available for energy efficiency upgrades such as heat pumps, windows, doors, insulation, water heaters, furnaces, central air conditioners and clean energy equipment upgrades such as solar energy systems and battery storage technology.

Rebates associated with electric vehicles are available at https://www.kentuckypower.com/clean-energy/electric-cars/ and refer customers to https://afdc.energy.gov/laws/10513 for more details.

Information about electric vehicle grants and tax credits can be found on the Company's webpage at https://www.kentuckypower.com/business/federal-grants/. The Company has worked with customers to promote grants available under the EPA's Clean School Bus Program, National Electric Vehicle Infrastructure (NEVI) Program, and the Charging and Fueling Infrastructure (CFI) Grant Program.

Business customers can review information regarding the USDA's Rural Energy for America Program at https://www.kentuckypower.com/savings/business/ which refers customers to https://www.rd.usda.gov/programs-services/energy-programs/rural-energy-america-program-renewable-energy-systems-energy-efficiency-improvement-guaranteed-loans/ky to learn more.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_8 Does KPC have a plan to help customers access the Home Efficiency Rebates and the Home Electrification and Appliance Rebates, for which the Kentucky Department for Energy Development and Independence has been awarded early administrative funding from the U.S. Department of Energy.
a.: If so, please describe KPC's plans to assist customers in accessing these materials and provide any relevant customer-facing materials.
b.: If not, please explain why not.
c.: Please provide any communications, notes, or materials relating to any meetings KPC has had with the Kentucky Department for Energy Development and Independence or any other state entity regarding these programs.

RESPONSE

Kentucky Power recognizes the opportunity available for customers through the energy rebates. It is Kentucky Power's understanding that the Kentucky Department for Energy Development and Independence is still in the application phase of the program. Kentucky Power is committed to working to ensure that customers are informed of the program. This is one of the areas where collaboration with the Joint Intervenors could prove beneficial to customers.

a. Kentucky Power plans to utilize several communication platforms to ensure that customers are aware of the program. These communication tools include the Kentucky Power website, customer newsletter, social media, and bill insert. Kentucky Power also plans to ensure that information is available at the Community Action Offices. The only printed materials that Kentucky Power has used in planning and discussions are publicly available on the DOE website: https://www.energy.gov/sites/default/files/2024-04/home-energy-rebates-faq-fact-sheet_040224.pdf

b. N/A

c. Kentucky Power has had discussions regarding the home energy rebate program with government officials, community action agencies, other utilities, and even certain members of the Joint Intervenors. Some of these conversations have been simple idea requests around revolving loan funds or how we can ensure that customers have access to funding.

Witness: Barrett L. Nolen

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_9 Please describe how the baseline is determined for the KPC's current and proposed DSM programs for the purposes of determining the net energy impact and net lost revenue and produce any relevant materials or analysis.

RESPONSE

In the market potential study, the baseline for determining energy savings may vary depending on the assumed replacement type (i.e., replace on burnout/new construction vs. retrofit). For most replace on burnout/new construction measures, the baseline is the current federal equipment standard baseline. For retrofit measures, the baseline may either be the federal baseline or the average market condition depending on the type of measure. The proposed programs are based on the market potential study's measure characterization. After actual program experience is reviewed, the Company may update future measure baselines.

Witness: Tanner S. Wolffram

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_10 Please provide a description, formula, and inputs for the calculation of the net energy impact data in Exhibit SEB-2, “Net Energy Impact Tab.”

RESPONSE

The net energy impact information for the TEE program comes from the 2015 Kentucky Power Company Demand Side Management Program Plan which was filed as Exhibit 6 to the DSM Application in case number 2015-00271.

First, take the Energy Savings for the TEE program (443 MWh) from the Targeted Energy Efficiency – Incremental Net Savings, Mid Scenario on page 69. Next, convert the 443 MWh to kWh by multiplying by 1,000. Finally, divide the 443,000 kWh by the number of participants (175) listed on the Estimated Participation table. The product is the net energy impact of 2,531 kWh per participant.

The net impacts are calculated in the same fashion for the proposed new programs. The total kWh of projected savings from the new programs is divided by the projected number of participants in the new programs to arrive at a net energy impact per customer. For the HEIP, the incremental net savings for the program scenario is 417,000 kWh. This total savings is divided by the projected number of participants (661) to arrive at the net energy impact of 631 kWh per participant. The Company would also note that during the preparation of this response, an input error on the “Net Energy Impact” tab of Exhibit SEB-2 related to the HEIP program was identified. The Company has filed an updated version of Exhibit SEB-2 to correct the input error.

For the Commercial Energy Solutions Program, the total incremental net savings for the program scenario is 2,537,909 kWh divided by the projected number of participants (130) to arrive at the net energy impact of 19,522 kWh per participant.

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_11 Please provide the conversion rate of the TEE Program and the estimated or expected conversion rate of HEIP in terms of number of projects identified by the program implementer being completed.
a.: If Kentucky Power uses some other definition for "conversion rate" for evaluation of these programs, please describe the alternate definition and related estimated conversion rate figure.

RESPONSE

a. Kentucky Power objects to this request on the basis that it is vague and ambiguous, specifically as it relates to the term "conversation rate". In support of the objection, the Company states it is unclear as to the meaning of that term as it applies to the TEE program and, as such, cannot determine whether or not it uses other definition or term in the evaluation of this program.

Preparer: Counsel

DATA REQUEST

JI 1_12 Please provide KPC's current authorized pre-tax weighted average cost of capital from its most recent rate case.

RESPONSE

The Company objects to this request on the basis that the request is not reasonably calculated to lead to the discovery of admissible evidence. In support of this objection, the Company states that the DSM mechanism does not utilize a WACC. Further, the Company objects to the request to the extent it seeks information that is publicly available and accessible to the Joint Intervenors. Without waiving this objection, the Company states that its current pre-tax weighted average cost of capital was most recently authorized in the Commission's January 19, 2024 Order in Case No. 2023-00159.

Witness: Tanner S. Wolffram

Preparer: Counsel

DATA REQUEST

JI 1_13 Regarding the TEE Program, from the period January 1, 2019 to June 1, 2024, please provide:
a.: The number of program participants per month.
b.: The number of referrals to the TEE program per month by Kentucky Power employees or CAA employees (if known).
c.: The number of program applicants per month.
d.: The dollar amount spent per customer.
e.: The average monthly electric bill for customers who participated in the TEE Program.
f.: Any reports from the CAAs to the Company regarding its administration of the TEE program.

RESPONSE

a. The requested information is publicly available in the Company's annual DSM status report filings (specifically Schedule C).

b. and c. The Company does not maintain the requested information. The TEE program is supplemental to the Department of Energy's Weatherization program. Nonetheless, Company representatives refer customers on a case-by-case basis, but these referrals are not tracked. Information about the TEE program is available on the Company's website at https://www.kentuckypower.com/savings/home/targeted-energy-efficiency.

d. Please see KPCO_R_KPSC_1_1_Attachment1, column FW for the requested information.

e. Please see the Company's response to JI 1-15.

f. Please see KPCO_R_KPSC_1_1_Attachment1 for requested information.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_14 For all residential customers, please provide the following information for all by month:
a.: The average balance amount.
b.: The average monthly bill amount.
c.: The average monthly payment amount.
d.: The average monthly usage.
e.: The number of Termination notices issued.
f.: The number of Service terminations.
g.: The number of unique customers receiving a termination notice for nonpayment (i.e., if a customer receives one or more termination notices, this customer would only be counted as one).
h.: The number of unique customers with service terminated for nonpayment (i.e., if a customer has service terminated once, this customer would only be counted as one).

RESPONSE

a.-h. The Company only retains this data on a rolling three-year basis. As such, the Company does not have information to provide the data requested for the period January 1, 2019 to June 2019. Please see KPCO_R_JI_1_14_Attachment1 for the requested information for July 2023 through June 2024. Please see the Company’s annual reports filed in Case No. 2019-00366 for the information dating back to July 2019.

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_15 For TEE program participants, please provide the following information by month, from the period January 1, 2019 to June 1, 2024:
a.: The average balance amount.
b.: The average monthly bill amount.
c.: The average monthly payment amount.
d.: The average monthly usage (Gas and Electric separate, where applicable).
e.: The number of Termination notices issued.
f.: The number of Service terminations.
g.: The number of unique customers receiving a termination notice for nonpayment (i.e., if a customer receives one or more termination notices, this customer would only be counted as one).
h.: The number of unique customers with service terminated for nonpayment (i.e., if a customer has service terminated once, this customer would only be counted as one).

RESPONSE

a.-h. The Company only retains this data on a rolling three-year basis. As such, the Company does not have information to provide the data requested for the period January 1, 2019 to June 2019 nor the data requested for subparts (a) and (h) for the period January 1, 2019 to June 2020. Please see KPSC_R_JI_1_15_Attachment1 for the rest of requested information.

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_16 For the TEE Program, from the period January 1, 2019 to June 1, 2024, please provide on an annual basis:
a.: The number of customers that apply for participation in the TEE program, but who are not able to participate.
b.: The number of applicants for the program that are not served by the TEE program due to lack of funding.
c.: The number of applicants evaluated by the program who did not meet program eligibility requirements.
d.: The number of applicants evaluated by the program who did meet program eligibility requirements.
e.: The number of applicants who received a home energy audit through this program.
f.: The number of applicants who received weatherization/energy conservation measures available under this program.
g.: The number of participants who receive a home energy audit but choose not to participate further in the TEE program.
h.: The number of eligible participants who are unable to receive weatherization/energy services measures because of a health, safety, or structural issue.
i.: The number of eligible customers who are not able to participate due to CAA capacity (e.g. labor shortage).
j.: The number of customers that get rejected from the TEE program for any other reason that the Company tracks.
k.: If the Company does not have this data, please explain why not.

RESPONSE

a. b. c. g. h. i. j. and k. Community Action Kentucky (“CAK”), through local community action agencies, administers and qualifies customers for the Company’s TEE program. As such, the Company does not maintain the requested information and, therefore, it is not within the Company’s possession or control.

d. 382 applicants met the TEE program eligibility requirements and participated. The Company does not maintain data on the number of applicants that met the program eligibility requirements who did not ultimately participate in the program.

e. All customers who participate receive an energy audit.

f. All customers who participate receive some form of conservation measure.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_17 For the TEE Program, for the period January 1, 2019 to June 1, 2024, please provide, on an annual basis, the number of customers who participated in the TEE Program who also received assistance from one of the Company's HEA Programs.

RESPONSE

The Company only retains this data on a rolling three-year basis. As such, the Company does not have information to provide the data requested for the period January 1, 2019 to June 2019. For the period from July 1, 2019 to June 1, 2024, of the 382 participants in the TEE program, 223 customers also received assistance from one of the Company's HEA programs. The breakdown by year is as follows:

- 2019: 48
- 2020: 25
- 2021: 51
- 2022: 47
- 2023: 34
- 2024: 18

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_18 Please describe the Company's process for assisting eligible customers who are unable to participate in the TEE Program in a given year due to the allocated funds being expended.
a.: Do the Company or CAAs maintain a waiting list for the TEE Program if funds are expended before the end of the year?

RESPONSE

Community Action Kentucky ("CAK"), through local community action agencies, administers and qualifies customers for the Company's TEE program. The Company relies on CAK's expertise to refer customers to programs for which they may be eligible other than the TEE program, including LIHEAP, HEART, and THAW. The Company communicates energy efficiency conservation measures and information about LIHEAP, HEART, and THAW to customers in various ways including emails, newsletters, bill inserts, on our website and through discussion by phone. Customers also have access to personalized energy efficiency tips through their own energy dashboard on our website after completing a short survey to provide more detailed information about equipment in their home. The Company also provides optional programs to assist customers throughout the year, including the Average Monthly Payment (AMP) plan to levelize bill amounts and payment arrangements to divide a balance into monthly installments.

a. Community action agencies maintain a waiting list for customers who qualify for TEE but have not received assistance.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_19 Please describe the Company's process if allocated funds for the TEE program are not fully expended in a given year.
a.: Does the Company conduct any additional outreach to customers in that event?
b.: Are the funds rolled over to the next program year?

RESPONSE

The Company is in communication with the community action agencies who operate the TEE program throughout each program year discussing eligibility of projects, monthly invoices, and budget forecasts. If a certain agency is on track to come in under or over budget, the Company will communicate that and reserves the right to re-allocate TEE program funding between the three primary agencies in its service territory: Big Sandy Area Community Action Program, LKLP Community Action Council, and Northeast Kentucky Community Action Agency.

a. The Company relies on the agencies to notify them if additional outreach is needed for the DOE's Weatherization Assistance Program (WAP) and the Company's Targeted Energy Efficiency Program. Additional outreach has not historically been necessary due to forecasted agency spend and the number of eligible customers on the waitlist.

b. No. If funds are not depleted each year, the underspend is included in the following year's annual DSM surcharge true-up and would be a credit to customers.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_20 Does the Company conduct any proactive outreach regarding the TEE Program to residential customers who appear to exceed the average monthly usage threshold of 700 kWh and who carry a balance over multiple months, are in arrears, and/or have received a termination notice.
a.: If so, please describe the methods of that customer outreach and whether it includes a referral to the relevant CAA.
b.: If not, please explain why not.

RESPONSE

a. N/A

b. The Company has historically not conducted proactive outreach about the DOE's WAP and the Company's TEE program because it is not necessary given the forecasted spend and feedback from the agencies on the number of eligible customers on the waitlist.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_21 Please refer to the MPS, Appendix C (Exhibit BLN-1, p. 60 of 123).
a.: Please state whether any of the listed NEBs were incorporated into the market potential study as an adder or multiplier to the energy and cost savings benefits.
b.: Please explain whether the MPS considered non-energy benefits related to equity or to reduction of energy burdens for low-income customers.
i.: If so, please explain how.
ii.: If not, please explain why not.

RESPONSE

a. None of the non-energy benefits listed were incorporated as an adder or multiplier to the energy and cost savings benefits.

b. No non-energy benefits related to equity or reduction in energy burdens were considered for low-income customers. As noted in Appendix C of the market potential study, the study only provided quantifiable estimates of lifetime MWh savings, tons of CO2 reductions, and pounds of SOX and NOX reductions, associated with the potential scenarios. Additional quantification of non-energy benefits would require significant additional analysis that was not part of the scope of the study. While non-energy benefits did not impact the cost-effectiveness screening, income qualified measures were not required to screen as cost effective for purposes of the MPS.

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_22 Please refer to Witness Nolen’s Testimony, p. 15, lines 8-13.
a.: Please state, and provide any relevant notes or analysis regarding, the following:
i.: the approximate Weatherization Readiness Funds allocated to each agency by the DOE;
ii.: the number of homes completed per year by each CAA; and
iii.: the types of projects typically funded by the Weatherization Readiness Fund.
b.: Please provide any additional reasoning behind the selection of the $1000 per home amount for the supplemental funding for the Weatherization Readiness Fund.

RESPONSE

a. The Company currently does not provide supplemental funding for the Weatherization Readiness Funds and therefore does not maintain the requested information. Assuming approval of the Company supplemental DOE program, the Company will began maintaining information going forward regarding Weatherization Readiness Fund projects that utilize Kentucky Power TEE program funding.

b. The Company relied on feedback from the community action agencies in its service territory. Based on the community action agencies’ experience with the Weatherization Readiness Fund and the number and types of projects funded, $1,000 was selected as the amount that would be impactful for each participating customer.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_23 Please refer to Exhibit SEB-2. Please confirm that the “Participation” tab reflects an assumption that there will be zero participants in any of the three DSM programs after February 2024 through December 2025.
a.: If confirmed, please explain why this assumption was used in this Exhibit.
b.: If not confirmed, please identify where in the Exhibit SEB-2 reflects program participation assumptions from February 2024 through December 2025.

RESPONSE

Not confirmed.

a. N/A.

b. The “Participation” table in Exhibit SEB-2 reflects actual participants in the programs up to the most recent information prior to the Company’s filing. At the time of filing, the Company only had actual participation data through February 2024 for the TEE program and the HEI and Commercial Energy Solution programs have not been approved. Thus, there was no actual data to be provided and, as such, the tab reflects 0.

For forecasted participation data, please see tab “Input-Incentives”, column F.

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_24 Smart thermostats are listed as a measure eligible for incentives in the Commercial Proscriptive and Home Energy Improvement Programs. Has the Company considered the feasibility of a smart thermostat demand response program utilizing those smart thermostats, or a standalone smart thermostat demand response program?
a.: If so, please state the Company's conclusions regarding such a program and provide any related information or analysis.
b.: If not, please explain why not.

RESPONSE

a. Kentucky Power does not intend to include potential dispatchable DSM as an addition to its demand-side resource offerings. Kentucky Power has two demand response (DR) tariffs available for commercial and industrial customers including Rider D.R.S. (Demand Response Service) and Tariff C.S.-I.R.P. (Contract Service – Interruptible Power) in addition to one voluntary energy curtailment option with Tariff V.C.S. (Voluntary Curtailment Service). In an effort to control the cost of the market potential study and administration of DSM programs, Kentucky Power instructed GDS not to include DR offerings in their estimates of energy efficiency potential savings.

b. GDS did survey residential customers on their willingness to participate in a thermostat DR program in its research for the market potential study. The incentives proposed in the Commercial Energy Solutions Program and Home Energy Improvement Program for smart thermostats would establish a pathway for establishing potential thermostat DR programs in the future. However, it is the Company's position that the current DR offerings outlined in part a. are sufficient and allow the Company to adequately curtail during times of peak demand.

Witness: Barrett L. Nolen

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_25 Please refer to Witness Bishop's Testimony, p. 6, lines 1-11.
a.: Please state whether the Company's recovery of the 15% shared-savings incentive is contingent upon actual achievement of the savings described in the California Practice Manual.
b.: Please state whether the Company's recovery of the 15% shared-savings incentive is based on achievement of any quantifiable metric.
c.: Please state whether and how the Company has historically verified achievement of the savings amount for which it has recovered the shared-savings incentive.

RESPONSE

a. The shared-savings incentive is not contingent upon achievement of a certain level of savings. However, the shared-savings incentive is designed to increase as the net savings increase, thereby incentivizing the Company to achieve the highest level of net savings practical.

b. As explained in Company Witness Bishop's testimony, the shared-savings incentive is limited to 15% of the net savings associated with the programs.

c. The Company has historically utilized a third-party evaluator to verify energy savings based upon which the Company gets 15%, if the savings cannot be verified then the Company would get 5%.

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_26 Please refer to Witness Bishop's Testimony, p. 9, lines 7-15.

a.: Did the Company evaluate the cost to include a notice with customer bills regarding the proposed change to the Company's tariff? If so, please explain what the Company found in its evaluation, including any cost estimates for such notice. If not, please explain why not.

b.: Did the Company evaluate the cost to mail a written notice to each customer regarding the proposed change to the Company's tariff? If so, please explain what the Company found in its evaluation, including any cost estimates for mailing such a notice. If not, please explain why not.

c.: Did the Company evaluate using a combination of billing, mailed, and/or newspaper notices to inform customers regarding the proposed change to the Company's tariff?

i.: If so, please explain what the Company found in its evaluation, including any cost estimates for this combination notice method.

ii.: If not, please explain why not.

d.: Did the Company evaluate whether some of the newspapers of general circulation in the Kentucky Power service area had circulation across multiple counties in the service area?

e.: Please provide the basis for Mr. Bishop's statement that, "[t]his was the most efficient manner of providing the required customer notice of the options provided for by regulation," with reference to other manners of providing the notice, and any relevant cost estimates.

f.: How has the Company provided notice in its five most recent applications subject to the notice provisions of 807 KAR 5:011, Section 8, and what were the costs of those notices? Please provide any relevant cost documentation.

RESPONSE

a. The Company generally does not include notice for its applications (where applicable) within customer bills as the information necessary to be included is not available on the required timeline under 807 KAR 5:011 Section 8(2) for this approach.

b. No such detailed evaluation exists. The Company considered the price of stamps ($0.68 cents currently) and then multiplied that by the approximate number of accounts (160,660). This resulted in $109,248.80 which would have been significantly more than the estimated cost to publish in the newspapers.

c. No. Additional noticing would have added additional costs. The Company utilized the lowest reasonable cost approach to provide notice required by the Commission’s regulations.

d. The Company is required by regulation to run its notice in a newspaper of general circulation in each county. Please see KPCO_R_JI_1_26_Attachment1 for the list of papers which meet this requirement and the county in which they run.

e. Please see the response to subparts a.-c.

f. Please see KPCO_R_JI_1_26_Attachment2.

Witness: Tanner S. Wolffram

Paper	County
Ashland Daily Independent	Boyd
Jackson Times Voice	Breathitt
Louisa Big Sandy News	Lawrence
Mountain Eagle	Letcher
Carter Co. Times	Carter
Hyden Leslie co News	Leslie
Hazard Herald	Perry
Rowan Co News	Rowan
Troublesome Creek Times	Knott
Lewis Vanceburg County Herald	Lewis
Booneville Sentinel	Owsley
Manchester Enterprise	Clay
Appalachian News Express	Pike
Floyd Co Times Chronicle	Floyd
Mountain Citizen	Martin
Salyersville Independent	Magoffin
Sandy Hook Elliott Co News	Elliott
Greenup Gazette	Greenup
Paintsville Herald	Johnson
West Liberty Licking Valley Courier	Morgan

	Case #	Case Description	Cost
1	2023-00159	2023 Base Rate Case	$143,735.01
2	2021-00004	Amended ECP	$77,201.64
3	2020-00174	2020 Base Rate Case	$26,719.20
4	2019-00389	Amended ECP	$25,327.50
5	2018-00311	HEART and THAW	$27,077.48

KENTUCKY PRESS SERVICE
101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 226-3867

Wednesday, August 9, 2023 09:59 AM

Invoice

	Scott Bishop	**Invoice Date**	08/07/23
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	1645 Winchester Ave Ashland, KY 41101-	**Order**	23081KK0

Client KY POWER COMPANY
Reps Rachel McCarty

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
ASHLAND DAILY INDEPENDENT							
Supplemental Notice -- PAGE 1	07/14/2023	8 x 21	$13.33	SAU	$0.00	0.0000%	$2,239.44
Supplemental Notice -- PAGE 2	07/14/2023	8 x 12.5	$13.33	SAU	$0.00	0.0000%	$1,333.00
Supplemental Notice -- PAGE 1	07/21/2023	8 x 21	$13.33	SAU	$0.00	0.0000%	$2,239.44
Supplemental Notice -- PAGE 2	07/21/2023	8 x 12.5	$13.33	SAU	$0.00	0.0000%	$1,333.00
Supplemental Notice -- PAGE 1	07/28/2023	8 x 21	$13.33	SAU	$0.00	0.0000%	$2,239.44
Supplemental Notice -- PAGE 2	07/28/2023	8 x 12.5	$13.33	SAU	$0.00	0.0000%	$1,333.00
BOONEVILLE SENTINEL							
Supplemental Notice -- PAGE 1	07/20/2023	9 x 21	$12.44	CLDIS	$0.00	0.0000%	$2,351.16
Supplemental Notice -- PAGE 2	07/20/2023	9 x 12.5	$12.44	CLDIS	$0.00	0.0000%	$1,399.50
Supplemental Notice -- PAGE 1	07/27/2023	9 x 21	$12.44	CLDIS	$0.00	0.0000%	$2,351.16
Supplemental Notice -- PAGE 2	07/27/2023	9 x 12.5	$12.44	CLDIS	$0.00	0.0000%	$1,399.50
Supplemental Notice -- PAGE 1	08/03/2023	9 x 21	$12.44	CLDIS	$0.00	0.0000%	$2,351.16
Supplemental Notice -- PAGE 2	08/03/2023	9 x 12.5	$12.44	CLDIS	$0.00	0.0000%	$1,399.50
Carter County Times							
Supplemental Notice -- PAGE 1	07/19/2023	6 x 21.5	$13.94	CLDIS	$0.00	0.0000%	$1,798.26
Supplemental Notice -- PAGE 2	07/19/2023	6 x 12.5	$13.94	CLDIS	$0.00	0.0000%	$1,045.50
Supplemental Notice -- PAGE 1	07/26/2023	6 x 21.5	$13.94	CLDIS	$0.00	0.0000%	$1,798.26
Supplemental Notice -- PAGE 2	07/26/2023	6 x 12.5	$13.94	CLDIS	$0.00	0.0000%	$1,045.50

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 226-3867

Wednesday, August 9, 2023 09:59 AM

Invoice

Agency	Scott Bishop KENTUCKY POWER COMPANY 1645 Winchester Ave Ashland, KY 41101-	**Invoice Date**	08/07/23
		PO Number	
		Order	23081KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Supplemental Notice -- PAGE 1	08/02/2023	6 x 21.5	$13.94	CLDIS	$0.00	0.0000%	$1,798.26
Supplemental Notice -- PAGE 2	08/02/2023	6 x 12.5	$13.94	CLDIS	$0.00	0.0000%	$1,045.50
HAZARD HERALD							
Supplemental Notice -- PAGE 1	07/20/2023	8 x 21.5	$14.50	CLDIS	$0.00	0.0000%	$2,494.00
Supplemental Notice -- PAGE 2	07/20/2023	8 x 12.5	$14.50	CLDIS	$0.00	0.0000%	$1,450.00
Supplemental Notice -- PAGE 1	07/27/2023	8 x 21.5	$14.50	CLDIS	$0.00	0.0000%	$2,494.00
Supplemental Notice -- PAGE 2	07/27/2023	8 x 12.5	$14.50	CLDIS	$0.00	0.0000%	$1,450.00
Supplemental Notice -- PAGE 1	08/03/2023	8 x 21.5	$14.50	CLDIS	$0.00	0.0000%	$2,494.00
Supplemental Notice -- PAGE 2	08/03/2023	8 x 12.5	$14.50	CLDIS	$0.00	0.0000%	$1,450.00
HINDMAN TROUBLESOME CREEK TIMES							
Supplemental Notice -- PAGE 1	07/20/2023	6 x 21.5	$10.00	CLDIS	$0.00	0.0000%	$1,290.00
Supplemental Notice -- PAGE 2	07/20/2023	6 x 12.5	$10.00	CLDIS	$0.00	0.0000%	$750.00
Supplemental Notice -- PAGE 1	07/27/2023	6 x 21.5	$10.00	CLDIS	$0.00	0.0000%	$1,290.00
Supplemental Notice -- PAGE 2	07/27/2023	6 x 12.5	$10.00	CLDIS	$0.00	0.0000%	$750.00
Supplemental Notice -- PAGE 1	08/03/2023	6 x 21.5	$10.00	CLDIS	$0.00	0.0000%	$1,290.00
Supplemental Notice -- PAGE 2	08/03/2023	6 x 12.5	$10.00	CLDIS	$0.00	0.0000%	$750.00
HYDEN LESLIE CO. NEWS							
Supplemental Notice -- PAGE 1	07/20/2023	8 x 21	$7.00	CLDIS	$0.00	0.0000%	$1,176.00
Supplemental Notice -- PAGE 2	07/20/2023	8 x 12.5	$7.00	CLDIS	$0.00	0.0000%	$700.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 226-3867

Invoice

Agency	Scott Bishop KENTUCKY POWER COMPANY 1645 Winchester Ave Ashland, KY 41101-	**Invoice Date**	08/07/23
		PO Number	
		Order	23081KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Supplemental Notice -- PAGE 1	07/27/2023	8 x 21	$7.00	CLDIS	$0.00	0.0000%	$1,176.00
Supplemental Notice -- PAGE 2	07/27/2023	8 x 12.5	$7.00	CLDIS	$0.00	0.0000%	$700.00
Supplemental Notice -- PAGE 1	08/03/2023	8 x 21	$7.00	CLDIS	$0.00	0.0000%	$1,176.00
Supplemental Notice -- PAGE 2	08/03/2023	8 x 12.5	$7.00	CLDIS	$0.00	0.0000%	$700.00
INEZ MOUNTAIN CITIZEN							
Supplemental Notice -- PAGE 1	07/19/2023	6 x 21.5	$8.22	CLDIS	$0.00	0.0000%	$1,060.38
Supplemental Notice -- PAGE 2	07/19/2023	6 x 12.5	$8.22	CLDIS	$0.00	0.0000%	$616.50
Supplemental Notice -- PAGE 1	07/26/2023	6 x 21.5	$8.22	CLDIS	$0.00	0.0000%	$1,060.38
Supplemental Notice -- PAGE 2	07/26/2023	6 x 12.5	$8.22	CLDIS	$0.00	0.0000%	$616.50
Supplemental Notice -- PAGE 1	08/02/2023	6 x 21.5	$8.22	CLDIS	$0.00	0.0000%	$1,060.38
Supplemental Notice -- PAGE 2	08/02/2023	6 x 12.5	$8.22	CLDIS	$0.00	0.0000%	$616.50
Jackson Times-Voice							
Supplemental Notice -- PAGE 1	07/19/2023	9 x 21	$8.00	CLDIS	$0.00	0.0000%	$1,512.00
Supplemental Notice -- PAGE 2	07/19/2023	9 x 12.5	$8.00	CLDIS	$0.00	0.0000%	$900.00
Supplemental Notice -- PAGE 1	07/26/2023	9 x 21	$8.00	CLDIS	$0.00	0.0000%	$1,512.00
Supplemental Notice -- PAGE 2	07/26/2023	9 x 12.5	$8.00	CLDIS	$0.00	0.0000%	$900.00
Supplemental Notice -- PAGE 1	08/02/2023	9 x 21	$8.00	CLDIS	$0.00	0.0000%	$1,512.00
Supplemental Notice -- PAGE 2	08/02/2023	9 x 12.5	$8.00	CLDIS	$0.00	0.0000%	$900.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 226-3867

Invoice

Agency	Scott Bishop KENTUCKY POWER COMPANY 1645 Winchester Ave Ashland, KY 41101-	Invoice Date PO Number Order	08/07/23 23081KK0

Client KY POWER COMPANY

Reps Rachel McCarty

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
LOUISA BIG SANDY NEWS							
Supplemental Notice -- PAGE 1	07/19/2023	6 x 21	$8.86	CLDIS	$0.00	0.0000%	$1,116.36
Supplemental Notice -- PAGE 2	07/19/2023	6 x 12.5	$8.86	CLDIS	$0.00	0.0000%	$664.50
Supplemental Notice -- PAGE 1	07/26/2023	6 x 21	$8.86	CLDIS	$0.00	0.0000%	$1,116.36
Supplemental Notice -- PAGE 2	07/26/2023	6 x 12.5	$8.86	CLDIS	$0.00	0.0000%	$664.50
Supplemental Notice -- PAGE 1	08/02/2023	6 x 21	$8.86	CLDIS	$0.00	0.0000%	$1,116.36
Supplemental Notice -- PAGE 2	08/02/2023	6 x 12.5	$8.86	CLDIS	$0.00	0.0000%	$664.50
MANCHESTER ENTERPRISE							
Supplemental Notice -- PAGE 1	07/19/2023	9 x 21.5	$13.29	CLDIS	$0.00	0.0000%	$2,571.62
Supplemental Notice -- PAGE 2	07/19/2023	9 x 12.5	$13.29	CLDIS	$0.00	0.0000%	$1,495.12
Supplemental Notice -- PAGE 1	07/26/2023	9 x 21.5	$13.29	CLDIS	$0.00	0.0000%	$2,571.62
Supplemental Notice -- PAGE 2	07/26/2023	9 x 12.5	$13.29	CLDIS	$0.00	0.0000%	$1,495.12
Supplemental Notice -- PAGE 1	08/02/2023	9 x 21.5	$13.29	CLDIS	$0.00	0.0000%	$2,571.62
Supplemental Notice -- PAGE 2	08/02/2023	9 x 12.5	$13.29	CLDIS	$0.00	0.0000%	$1,495.12
PAINTSVILLE HERALD							
Supplemental Notice -- PAGE 1	07/19/2023	8 x 21.5	$10.00	CLDIS	$0.00	0.0000%	$1,720.00
Supplemental Notice -- PAGE 2	07/19/2023	8 x 12.5	$10.00	CLDIS	$0.00	0.0000%	$1,000.00
Supplemental Notice -- PAGE 1	07/26/2023	8 x 21.5	$10.00	CLDIS	$0.00	0.0000%	$1,720.00
Supplemental Notice -- PAGE 2	07/26/2023	8 x 12.5	$10.00	CLDIS	$0.00	0.0000%	$1,000.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 226-3867

Invoice

Agency	Scott Bishop KENTUCKY POWER COMPANY 1645 Winchester Ave Ashland, KY 41101-	**Invoice Date** **PO Number** **Order**	08/07/23 23081KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Supplemental Notice -- PAGE 1	08/02/2023	8 x 21.5	$10.00	CLDIS	$0.00	0.0000%	$1,720.00
Supplemental Notice -- PAGE 2	08/02/2023	8 x 12.5	$10.00	CLDIS	$0.00	0.0000%	$1,000.00
PIKEVILLE APPALACHIAN NEWS-EXPRESS							
Supplemental Notice -- PAGE 1	07/18/2023	9 x 21.5	$12.60	CLDIS	$0.00	0.0000%	$2,438.10
Supplemental Notice -- PAGE 2	07/18/2023	9 x 12.5	$12.60	CLDIS	$0.00	0.0000%	$1,417.50
Supplemental Notice -- PAGE 1	07/25/2023	9 x 21.5	$12.60	CLDIS	$0.00	0.0000%	$2,438.10
Supplemental Notice -- PAGE 2	07/25/2023	9 x 12.5	$12.60	CLDIS	$0.00	0.0000%	$1,417.50
Supplemental Notice -- PAGE 1	08/01/2023	9 x 21.5	$12.60	CLDIS	$0.00	0.0000%	$2,438.10
Supplemental Notice -- PAGE 2	08/01/2023	9 x 12.5	$12.60	CLDIS	$0.00	0.0000%	$1,417.50
Prestonsburg Floyd County Chronicle & Times							
Supplemental Notice -- PAGE 1	07/19/2023	9 x 21.5	$13.40	CLDIS	$0.00	0.0000%	$2,592.90
Supplemental Notice -- PAGE 2	07/19/2023	9 x 12.5	$13.40	CLDIS	$0.00	0.0000%	$1,507.50
Supplemental Notice -- PAGE 1	07/26/2023	9 x 21.5	$13.40	CLDIS	$0.00	0.0000%	$2,592.90
Supplemental Notice -- PAGE 2	07/26/2023	9 x 12.5	$13.40	CLDIS	$0.00	0.0000%	$1,507.50
Supplemental Notice -- PAGE 1	08/02/2023	9 x 21.5	$13.40	CLDIS	$0.00	0.0000%	$2,592.90
Supplemental Notice -- PAGE 2	08/02/2023	9 x 12.5	$13.40	CLDIS	$0.00	0.0000%	$1,507.50
Rowan County News							
Supplemental Notice -- PAGE 1	07/20/2023	6 x 21	$6.00	CLDIS	$0.00	0.0000%	$756.00
Supplemental Notice -- PAGE 2	07/20/2023	6 x 12.5	$6.00	CLDIS	$0.00	0.0000%	$450.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 226-3867

Wednesday, August 9, 2023 09:59 AM

Invoice

Agency	Scott Bishop KENTUCKY POWER COMPANY 1645 Winchester Ave Ashland, KY 41101-	**Invoice Date**	08/07/23
		PO Number	
		Order	23081KK0

Client KY POWER COMPANY
Reps Rachel McCarty

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Supplemental Notice -- PAGE 1	07/27/2023	6 x 21	$6.00	CLDIS	$0.00	0.0000%	$756.00
Supplemental Notice -- PAGE 2	07/27/2023	6 x 12.5	$6.00	CLDIS	$0.00	0.0000%	$450.00
Supplemental Notice -- PAGE 1	08/03/2023	6 x 21	$6.00	CLDIS	$0.00	0.0000%	$756.00
Supplemental Notice -- PAGE 2	08/03/2023	6 x 12.5	$6.00	CLDIS	$0.00	0.0000%	$450.00
SALYERSVILLE INDEPENDENT							
Supplemental Notice -- PAGE 1	07/20/2023	6 x 20.75	$8.86	CLDIS	$0.00	0.0000%	$1,103.07
Supplemental Notice -- PAGE 2	07/20/2023	6 x 12.5	$8.86	CLDIS	$0.00	0.0000%	$664.50
Supplemental Notice -- PAGE 1	07/27/2023	6 x 20.75	$8.86	CLDIS	$0.00	0.0000%	$1,103.07
Supplemental Notice -- PAGE 2	07/27/2023	6 x 12.5	$8.86	CLDIS	$0.00	0.0000%	$664.50
Supplemental Notice -- PAGE 1	08/03/2023	6 x 20.75	$8.86	CLDIS	$0.00	0.0000%	$1,103.07
Supplemental Notice -- PAGE 2	08/03/2023	6 x 12.5	$8.86	CLDIS	$0.00	0.0000%	$664.50
SANDY HOOK ELLIOTT COUNTY NEWS							
Supplemental Notice -- PAGE 1	07/21/2023	6 x 21	$4.94	CLDIS	$0.00	0.0000%	$622.44
Supplemental Notice -- PAGE 2	07/21/2023	6 x 12.5	$4.94	CLDIS	$0.00	0.0000%	$370.50
Supplemental Notice -- PAGE 1	07/28/2023	6 x 21	$4.94	CLDIS	$0.00	0.0000%	$622.44
Supplemental Notice -- PAGE 2	07/28/2023	6 x 12.5	$4.94	CLDIS	$0.00	0.0000%	$370.50
Supplemental Notice -- PAGE 1	08/04/2023	6 x 21	$4.94	CLDIS	$0.00	0.0000%	$622.44
Supplemental Notice -- PAGE 2	08/04/2023	6 x 12.5	$4.94	CLDIS	$0.00	0.0000%	$370.50

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE
101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 226-3867

Invoice

Agency	Scott Bishop KENTUCKY POWER COMPANY 1645 Winchester Ave Ashland, KY 41101-	Invoice Date	08/07/23
		PO Number	
		Order	23081KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
THE GREENUP BEACON							
Supplemental Notice -- PAGE 1	07/25/2023	6 x 20.25	$4.00	CLDIS	$0.00	0.0000%	$486.00
Supplemental Notice -- PAGE 2	07/25/2023	6 x 12.5	$4.00	CLDIS	$0.00	0.0000%	$300.00
Supplemental Notice -- PAGE 1	08/01/2023	6 x 20.25	$4.00	CLDIS	$0.00	0.0000%	$486.00
Supplemental Notice -- PAGE 2	08/01/2023	6 x 12.5	$4.00	CLDIS	$0.00	0.0000%	$300.00
Supplemental Notice -- PAGE 1	08/08/2023	6 x 20.25	$4.00	CLDIS	$0.00	0.0000%	$486.00
Supplemental Notice -- PAGE 2	08/08/2023	6 x 12.5	$4.00	CLDIS	$0.00	0.0000%	$300.00
VANCEBURG LEWIS COUNTY HERALD							
Supplemental Notice -- PAGE 1	07/18/2023	6 x 21	$4.44	CLDIS	$0.00	0.0000%	$559.44
Supplemental Notice -- PAGE 2	07/18/2023	6 x 12.5	$4.44	CLDIS	$0.00	0.0000%	$333.00
Supplemental Notice -- PAGE 1	07/25/2023	6 x 21	$4.44	CLDIS	$0.00	0.0000%	$559.44
Supplemental Notice -- PAGE 2	07/25/2023	6 x 12.5	$4.44	CLDIS	$0.00	0.0000%	$333.00
Supplemental Notice -- PAGE 1	08/01/2023	6 x 21	$4.44	CLDIS	$0.00	0.0000%	$559.44
Supplemental Notice -- PAGE 2	08/01/2023	6 x 12.5	$4.44	CLDIS	$0.00	0.0000%	$333.00
WEST LIBERTY LICKING VALLEY COURIER							
Supplemental Notice -- PAGE 1	07/20/2023	6 x 21	$5.38	CLDIS	$0.00	0.0000%	$677.88
Supplemental Notice -- PAGE 2	07/20/2023	6 x 12.5	$5.38	CLDIS	$0.00	0.0000%	$403.50
Supplemental Notice -- PAGE 1	07/27/2023	6 x 21	$5.38	CLDIS	$0.00	0.0000%	$677.88
Supplemental Notice -- PAGE 2	07/27/2023	6 x 12.5	$5.38	CLDIS	$0.00	0.0000%	$403.50

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 226-3867

Wednesday, August 9, 2023 09:59 AM

Invoice

	Scott Bishop	**Invoice Date**	08/07/23
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	1645 Winchester Ave Ashland, KY 41101-	**Order**	23081KK0

Client KY POWER COMPANY
Reps Rachel McCarty

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Supplemental Notice -- PAGE 1	08/03/2023	6 x 21	$5.38	CLDIS	$0.00	0.0000%	$677.88
Supplemental Notice -- PAGE 2	08/03/2023	6 x 12.5	$5.38	CLDIS	$0.00	0.0000%	$403.50
WHITESBURG MOUNTAIN EAGLE							
Supplemental Notice -- PAGE 1	07/19/2023	8 x 21	$9.50	CLDIS	$0.00	0.0000%	$1,596.00
Supplemental Notice -- PAGE 2	07/19/2023	8 x 12.5	$9.50	CLDIS	$0.00	0.0000%	$950.00
Supplemental Notice -- PAGE 1	07/26/2023	8 x 21	$9.50	CLDIS	$0.00	0.0000%	$1,596.00
Supplemental Notice -- PAGE 2	07/26/2023	8 x 12.5	$9.50	CLDIS	$0.00	0.0000%	$950.00
Supplemental Notice -- PAGE 1	08/02/2023	8 x 21	$9.50	CLDIS	$0.00	0.0000%	$1,596.00
Supplemental Notice -- PAGE 2	08/02/2023	8 x 12.5	$9.50	CLDIS	$0.00	0.0000%	$950.00

Total Advertising	$143,735.01
Discounts	$0.00
Tax: USA	$0.00
Total Invoice	$143,735.01
Payments	$0.00
Adjustments	$0.00
Balance Due	$143,735.01

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, February 24, 2021 10:06 AM

Invoice

	Lerah M. Scott	**Invoice Date**	2/24/2021
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	1645 Winchester Ave Ashland, KY 41101-	**Order**	21023KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
ASHLAND DAILY INDEPENDENT							
Notice of KY Power Company's Application	02/03/2021	8 x 18	$12.66	SAU	$0.00	0.0000%	$1,823.04
Notice of KY Power Company's Application	02/10/2021	8 x 18	$12.66	SAU	$0.00	0.0000%	$1,823.04
Notice of KY Power Company's Application	02/17/2021	8 x 18	$12.66	SAU	$0.00	0.0000%	$1,823.04
BOONEVILLE SENTINEL							
Notice of KY Power Company's Application	02/03/2021	9 x 18	$12.44	CLDIS	$0.00	0.0000%	$2,015.28
Notice of KY Power Company's Application	02/10/2021	9 x 18	$12.44	CLDIS	$0.00	0.0000%	$2,015.28
Notice of KY Power Company's Application	02/17/2021	9 x 18	$12.44	CLDIS	$0.00	0.0000%	$2,015.28
Carter County Times							
Notice of KY Power Company's Application	02/03/2021	6 x 18	$13.94	CLDIS	$0.00	0.0000%	$1,505.52
Notice of KY Power Company's Application	02/10/2021	6 x 18	$13.94	CLDIS	$0.00	0.0000%	$1,505.52
Notice of KY Power Company's Application	02/17/2021	6 x 18	$13.94	CLDIS	$0.00	0.0000%	$1,505.52
HAZARD HERALD							
Notice of KY Power Company's Application	02/04/2021	8 x 18	$14.50	CLDIS	$0.00	0.0000%	$2,088.00
Notice of KY Power Company's Application	02/11/2021	8 x 18	$14.50	CLDIS	$0.00	0.0000%	$2,088.00
Notice of KY Power Company's Application	02/18/2021	8 x 18	$14.50	CLDIS	$0.00	0.0000%	$2,088.00
HINDMAN TROUBLESOME CREEK TIMES							
Notice of KY Power Company's Application	02/04/2021	6 x 18	$10.00	CLDIS	$0.00	0.0000%	$1,080.00
Notice of KY Power Company's Application	02/11/2021	6 x 18	$10.00	CLDIS	$0.00	0.0000%	$1,080.00
Notice of KY Power	02/18/2021	6 x 18	$10.00	CLDIS	$0.00	0.0000%	$1,080.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, February 24, 2021 10:06 AM

Invoice

	Lerah M. Scott	Invoice Date	2/24/2021
Agency	KENTUCKY POWER COMPANY	PO Number	
	1645 Winchester Ave Ashland, KY 41101-	Order	21023KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Company's Application							
HYDEN LESLIE CO. NEWS							
Notice of KY Power Company's Application	02/04/2021	8 x 18	$7.00	CLDIS	$0.00	0.0000%	$1,008.00
Notice of KY Power Company's Application	02/11/2021	8 x 18	$7.00	CLDIS	$0.00	0.0000%	$1,008.00
Notice of KY Power Company's Application	02/18/2021	8 x 18	$7.00	CLDIS	$0.00	0.0000%	$1,008.00
INEZ MOUNTAIN CITIZEN							
Notice of KY Power Company's Application	02/03/2021	6 x 18	$8.22	CLDIS	$0.00	0.0000%	$887.76
Notice of KY Power Company's Application	02/10/2021	6 x 18	$8.22	CLDIS	$0.00	0.0000%	$887.76
Notice of KY Power Company's Application	02/17/2021	6 x 18	$8.22	CLDIS	$0.00	0.0000%	$887.76
Jackson Times-Voice							
Notice of KY Power Company's Application	02/03/2021	9 x 18	$8.00	CLDIS	$0.00	0.0000%	$1,296.00
Notice of KY Power Company's Application	02/10/2021	9 x 18	$8.00	CLDIS	$0.00	0.0000%	$1,296.00
Notice of KY Power Company's Application	02/17/2021	9 x 18	$8.00	CLDIS	$0.00	0.0000%	$1,296.00
LOUISA BIG SANDY NEWS							
Notice of KY Power Company's Application	02/03/2021	6 x 18	$8.86	CLDIS	$0.00	0.0000%	$956.88
Notice of KY Power Company's Application	02/10/2021	6 x 18	$8.86	CLDIS	$0.00	0.0000%	$956.88
Notice of KY Power Company's Application	02/17/2021	6 x 18	$8.86	CLDIS	$0.00	0.0000%	$956.88
MANCHESTER ENTERPRISE							
Notice of KY Power Company's Application	02/03/2021	9 x 18	$12.00	CLDIS	$0.00	0.0000%	$1,944.00
Notice of KY Power Company's Application	02/10/2021	9 x 18	$12.00	CLDIS	$0.00	0.0000%	$1,944.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, February 24, 2021 10:06 AM

Invoice

	Lerah M. Scott	**Invoice Date**	2/24/2021
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	1645 Winchester Ave Ashland, KY 41101-	**Order**	21023KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper / Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Notice of KY Power Company's Application	02/17/2021	9 x 18	$12.00	CLDIS	$0.00	0.0000%	$1,944.00
PAINTSVILLE HERALD							
Notice of KY Power Company's Application	02/03/2021	8 x 18	$10.00	CLDIS	$0.00	0.0000%	$1,440.00
Notice of KY Power Company's Application	02/10/2021	8 x 18	$10.00	CLDIS	$0.00	0.0000%	$1,440.00
Notice of KY Power Company's Application	02/17/2021	8 x 18	$10.00	CLDIS	$0.00	0.0000%	$1,440.00
PIKEVILLE APPALACHIAN NEWS-EXPRESS							
Notice of KY Power Company's Application	02/02/2021	9 x 18	$12.60	CLDIS	$0.00	0.0000%	$2,041.20
Notice of KY Power Company's Application	02/09/2021	9 x 18	$12.60	CLDIS	$0.00	0.0000%	$2,041.20
Notice of KY Power Company's Application	02/16/2021	9 x 18	$12.60	CLDIS	$0.00	0.0000%	$2,041.20
Prestonsburg Floyd County Chronicle & Times							
Notice of KY Power Company's Application	02/03/2021	9 x 18	$13.40	CLDIS	$0.00	0.0000%	$2,170.80
Notice of KY Power Company's Application	02/10/2021	9 x 18	$13.40	CLDIS	$0.00	0.0000%	$2,170.80
Notice of KY Power Company's Application	02/17/2021	9 x 18	$13.40	CLDIS	$0.00	0.0000%	$2,170.80
Rowan County News							
Notice of KY Power Company's Application	02/04/2021	6 x 18	$6.00	CLDIS	$0.00	0.0000%	$648.00
Notice of KY Power Company's Application	02/11/2021	6 x 18	$6.00	CLDIS	$0.00	0.0000%	$648.00
Notice of KY Power Company's Application	02/18/2021	6 x 18	$6.00	CLDIS	$0.00	0.0000%	$648.00
SALYERSVILLE INDEPENDENT							
Notice of KY Power Company's Application	02/04/2021	9 x 18	$8.86	CLDIS	$0.00	0.0000%	$1,435.32
Notice of KY Power	02/11/2021	9 x 18	$8.86	CLDIS	$0.00	0.0000%	$1,435.32

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, February 24, 2021 10:06 AM

Invoice

Agency	Lerah M. Scott KENTUCKY POWER COMPANY 1645 Winchester Ave Ashland, KY 41101-	**Invoice Date**	2/24/2021
		PO Number	
		Order	21023KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper / Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Company's Application							
Notice of KY Power Company's Application	02/18/2021	9 x 18	$8.86	CLDIS	$0.00	0.0000%	$1,435.32
SANDY HOOK ELLIOTT COUNTY NEWS							
Notice of KY Power Company's Application	02/05/2021	6 x 18	$4.94	CLDIS	$0.00	0.0000%	$533.52
Notice of KY Power Company's Application	02/12/2021	6 x 18	$4.94	CLDIS	$0.00	0.0000%	$533.52
Notice of KY Power Company's Application	02/19/2021	6 x 18	$4.94	CLDIS	$0.00	0.0000%	$533.52
THE GREENUP BEACON							
Notice of KY Power Company's Application	02/02/2021	6 x 18	$4.00	CLDIS	$0.00	0.0000%	$432.00
Notice of KY Power Company's Application	02/09/2021	6 x 18	$4.00	CLDIS	$0.00	0.0000%	$432.00
Notice of KY Power Company's Application	02/16/2021	6 x 18	$4.00	CLDIS	$0.00	0.0000%	$432.00
VANCEBURG LEWIS COUNTY HERALD							
Notice of KY Power Company's Application	02/02/2021	6 x 18	$4.44	CLDIS	$0.00	0.0000%	$479.52
Notice of KY Power Company's Application	02/09/2021	6 x 18	$4.44	CLDIS	$0.00	0.0000%	$479.52
Notice of KY Power Company's Application	02/16/2021	6 x 18	$4.44	CLDIS	$0.00	0.0000%	$479.52
WEST LIBERTY LICKING VALLEY COURIER							
Notice of KY Power Company's Application	02/04/2021	6 x 18	$5.38	CLDIS	$0.00	0.0000%	$581.04
Notice of KY Power Company's Application	02/11/2021	6 x 18	$5.38	CLDIS	$0.00	0.0000%	$581.04
Notice of KY Power Company's Application	02/18/2021	6 x 18	$5.38	CLDIS	$0.00	0.0000%	$581.04
WHITESBURG MOUNTAIN EAGLE							
Notice of KY Power Company's Application	02/03/2021	8 x 18	$9.50	CLDIS	$0.00	0.0000%	$1,368.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KPS
KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, February 24, 2021 10:06 AM

Invoice

	Lerah M. Scott	**Invoice Date**	2/24/2021
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	1645 Winchester Ave Ashland, KY 41101-	**Order**	21023KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Notice of KY Power Company's Application	02/10/2021	8 x 18	$9.50	CLDIS	$0.00	0.0000%	$1,368.00
Notice of KY Power Company's Application	02/17/2021	8 x 18	$9.50	CLDIS	$0.00	0.0000%	$1,368.00

Total Advertising	$77,201.64
Discounts	$0.00
Tax: USA	$0.00
Total Invoice	$77,201.64
Payments	$000
Adjustments	$0.00
Balance Due	$77,201.64

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent

KPS
KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Friday, July 31, 2020 11 25 AM

Invoice

	Scott Bishop	**Invoice Date**	07/31/20
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	1645 Winchester Ave Ashland, KY 41101-	**Order**	20074KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
ASHLAND DAILY INDEPENDENT							
Supplemental Notice	07/09/2020	6 x 10	$19 00	SAU	$0.00	0.0000%	$1,140 00
Supplemental Notice	07/16/2020	6 x 10	$19 00	SAU	$0.00	0.0000%	$1,140 00
Supplemental Notice	07/23/2020	6 x 10	$19. 00	SAU	$0.00	0.0000%	$1,140 00
BOONEVILLE SENTINEL							
Supplemental Notice	07/15/2020	7 x 10	$8 86	CLDIS	$0.00	0.0000%	$620 20
Supplemental Notice	07/22/2020	7 x 10	$8 86	CLDIS	$0.00	0.0000%	$620 20
Supplemental Notice	07/29/2020	7 x 10	$8 86	CLDIS	$0.00	0.0000%	$620. 20
HAZARD HERALD							
Supplemental Notice	07/09/2020	6 x 10	$7 75	CLDIS	$0.00	0.0000%	$465.00
Supplemental Notice	07/16/2020	6 x 10	$7.75	CLDIS	$0.00	0.0000%	$465 00
Supplemental Notice	07/23/2020	6 x 10	$7.75	CLDIS	$0.00	0.0000%	$465 00
HINDMAN TROUBLESOME CREEK TIMES							
Supplemental Notice	07/09/2020	4 x 10	$10.00	CLDIS	$0.00	0.0000%	$400 00
Supplemental Notice	07/16/2020	4 x 10	$10.00	CLDIS	$0.00	0.0000%	$400.00
Supplemental Notice	07/23/2020	4 x 10	$10.00	CLDIS	$0.00	0.0000%	$400 00
HYDEN LESLIE CO. NEWS							
Supplemental Notice	07/09/2020	6 x 10	$7.00	CLDIS	$0.00	0.0000%	$420.00
Supplemental Notice	07/16/2020	6 x 10	$7.00	CLDIS	$0.00	0.0000%	$420.00
Supplemental Notice	07/23/2020	6 x 10	$7.00	CLDIS	$0.00	0.0000%	$420 00
INEZ MOUNTAIN CITIZEN							
Supplemental Notice	07/15/2020	4 x 10	$8.22	CLDIS	$0.00	0 0000%	$328 80
Supplemental Notice	07/22/2020	4 x 10	$8.22	CLDIS	$0.00	0.0000%	$328 80
Supplemental Notice	07/29/2020	4 x 10	$8.22	CLDIS	$0.00	0.0000%	$328 80
Jackson Times-Voice							
Supplemental Notice	07/15/2020	7 x 10	$8.00	CLDIS	$0.00	0.0000%	$560 00
Supplemental Notice	07/22/2020	7 x 10	$8.00	CLDIS	$0.00	0.0000%	$560 00
Supplemental Notice	07/29/2020	7 x 10	$8.00	CLDIS	$0.00	0.0000%	$560 00
LOUISA BIG SANDY NEWS							
Supplemental Notice	07/15/2020	4 x 10	$8.86	CLDIS	$0.00	0.0000%	$354 40
Supplemental Notice	07/22/2020	4 x 10	$8.86	CLDIS	$0.00	0.0000%	$354 .40

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Friday, July 31, 2020 11:25 AM

Invoice

	Scott Bishop	**Invoice Date**	07/31/20
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	1645 Winchester Ave Ashland, KY 41101-	**Order**	20074KK0

Client KY POWER COMPANY
Reps Rachel McCarty

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Supplemental Notice	07/29/2020	4 x 10	$8 86	CLDIS	$0.00	0 0000%	$354 40
MANCHESTER ENTERPRISE							
Supplemental Notice	07/15/2020	7 x 10	$12.00	CLDIS	$0.00	0 0000%	$840 00
Supplemental Notice	07/22/2020	7 x 10	$12.00	CLDIS	$0.00	0 0000%	$840 00
Supplemental Notice	07/29/2020	7 x 10	$12.00	CLDIS	$0.00	0 0000%	$840 00
PAINTSVILLE HERALD							
Supplemental Notice	07/15/2020	6 x 10	$7.50	CLDIS	$0.00	0 0000%	$450.00
Supplemental Notice	07/22/2020	6 x 10	$7.50	CLDIS	$0.00	0 0000%	$450 00
Supplemental Notice	07/29/2020	6 x 10	$7.50	CLDIS	$0 00	0.0000%	$450 00
PIKEVILLE APPALACHIAN NEWS-EXPRESS							
Supplemental Notice	07/10/2020	6 x 10	$12.60	CLDIS	$0.00	0.0000%	$756 00
Supplemental Notice	07/17/2020	6 x 10	$12.60	CLDIS	$0.00	0.0000%	$756 00
Supplemental Notice	07/24/2020	6 x 10	$12.60	CLDIS	$0.00	0.0000%	$756 00
Prestonsburg Floyd County Chronicle & Times							
Supplemental Notice	07/15/2020	6 x 10	$7.75	CLDIS	$0.00	0.0000%	$465 00
Supplemental Notice	07/22/2020	6 x 10	$7.75	CLDIS	$0.00	0.0000%	$465 00
Supplemental Notice	07/29/2020	6 x 10	$7.75	CLDIS	$0.00	0.0000%	$465 00
Rowan County News							
Supplemental Notice	07/09/2020	5 x 10	$6.00	CLDIS	$0.00	0.0000%	$300 00
Supplemental Notice	07/16/2020	5 x 10	$6.00	CLDIS	$0.00	0.0000%	$300 00
Supplemental Notice	07/23/2020	5 x 10	$6.00	CLDIS	$0.00	0.0000%	$300 00
SALYERSVILLE INDEPENDENT							
Supplemental Notice	07/09/2020	6 x 10	$8.86	CLDIS	$0.00	0.0000%	$531 60
Supplemental Notice	07/16/2020	6 x 10	$8.86	CLDIS	$0.00	0.0000%	$531 60
Supplemental Notice	07/23/2020	6 x 10	$8.86	CLDIS	$0.00	0.0000%	$531 60
SANDY HOOK ELLIOTT COUNTY NEWS							
Supplemental Notice	07/10/2020	4 x 10	$4.94	CLDIS	$0.00	0.0000%	$197 60
Supplemental Notice	07/17/2020	4 x 10	$4.94	CLDIS	$0.00	0.0000%	$197.60
Supplemental Notice	07/24/2020	4 x 10	$4.94	CLDIS	$0.00	0.0000%	$197 60
THE GREENUP BEACON							
Supplemental Notice	07/14/2020	4 x 10	$4.00	CLDIS	$0.00	0.0000%	$160 00

ANY QUESTIONS CONCERNING TEAR SHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT KY 40601
Voice (502) 223-8821 Fax (502) 875-2624

Friday, July 31, 2020 11 25 AM

Invoice

	Scott Bishop	**Invoice Date**	07/31/20
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	1645 Winchester Ave Ashland, KY 41101-	**Order**	20074KK0

Client KY POWER COMPANY

Reps Rachel McCarty

Newspaper / Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Supplemental Notice	07/21/2020	4 x 10	$4 00	CLDIS	$000	0.0000%	$160.00
Supplemental Notice	07/28/2020	4 x 10	$4 00	CLDIS	$000	0.0000%	$160 00
VANCEBURG LEWIS COUNTY HERALD							
Supplemental Notice	07/14/2020	4 x 10	$4 44	CLDIS	$0 00	0.0000%	$177 60
Supplemental Notice	07/21/2020	4 x 10	$4.44	CLDIS	$0.00	0.0000%	$177 60
Supplemental Notice	07/28/2020	4 x 10	$4 44	CLDIS	$000	0.0000%	$177 60
WEST LIBERTY LICKING VALLEY COURIER							
Supplemental Notice	07/09/2020	4 x 10	$5 38	CLDIS	$0 00	0.0000%	$215 20
Supplemental Notice	07/16/2020	4 x 10	$5 38	CLDIS	$000	0.0000%	$215 20
Supplemental Notice	07/23/2020	4 x 10	$5 38	CLDIS	$0 00	0.0000%	$215 20
WHITESBURG MOUNTAIN EAGLE							
Supplemental Notice	07/15/2020	6 x 10	$8 75	CLDIS	$0.00	0.0000%	$525 00
Supplemental Notice	07/22/2020	6 x 10	$8 75	CLDIS	$0.00	0.0000%	$525 00
Supplemental Notice	07/29/2020	6 x 10	$8 75	CLDIS	$0 00	0.0000%	$525 00

Total Advertising	$26,719.20
Discounts	$0.00
Tax: USA	$0 00
Total Invoice	$26,719 20
Payments	$0 00
Adjustments	$0 00
Balance Due	$26,719 20

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE
101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

.Y PRESS SERVICE

ay December 11, 2019 12:22 PM

Invoice

	Scott Bishop	Invoice Date	12/11/2019
Agency	KENTUCKY POWER COMPANY	PO Number	
	855 Central Ave. Suite 200 Ashland, KY 41101-	Order	19121KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
ASHLAND DAILY INDEPENDENT							
Notice of Kentucky Power Company's Application	11/19/2019	5 x 8.75	$19.00	SAU	$0.00	0.0000%	$831 25
Notice of Kentucky Power Company's Application	11/26/2019	5x8.75	$19.00	SAU	$0.00	0.0000%	$831 25
Notice of Kentucky Power Company's Application	12/03/2019	5x8.75	$19.00	SAU	$0.00	0.0000%	$831 25
BOONEVILLE SENTINEL							
Notice of Kentucky Power Company's Application	11/20/2019	6x8.75	$8.86	CLDIS	$0.00	0 0000%	$465 15
Notice of Kentucky Power Company's Application	11/26/2019	6x8.75	$8.86	CLDIS	$0.00	0 0000%	$465.15
Notice of Kentucky Power Company's Application	12/04/2019	6x8.75	$8.86	CLDIS	$0.00	0.0000%	$465.15
GRAYSON JOURNAL-ENQUIRER							
Notice of Kentucky Power Company's Application	11/20/2019	5x8.75	$17.20	CLDIS	$0.00	0.0000%	$752.50
Notice of Kentucky Power Company's Application	11/27/2019	5x8.75	$17 20	CLDIS	$0.00	0.0000%	$752.50
Notice of Kentucky Power Company's Application	12/04/2019	5x8.75	$17 20	CLDIS	$0.00	0.0000%	$752.50
GREENUP NEWS							
Notice of Kentucky Power Company's Application	11/21/2019	5x8.75	$6.00	CLDIS	$0.00	0.0000%	$262 50
Notice of Kentucky Power Company's Application	11/28/2019	5x875	$6 00	CLDIS	$0.00	0.0000%	$262.50
Notice of Kentucky Power Company's Application	12/05/2019	5x875	$6.00	CLDIS	$0.00	0.0000%	$262.50
HAZARD HERALD							
Notice of Kentucky Power Company's Application	11/21/2019	5x8 75	$7.75	CLDIS	$0.00	0.0000%	$339.06
Notice of Kentucky Power Company's Application	11/28/2019	5x875	$7.75	CLDIS	$0.00	0.0000%	$339.06
Notice of Kentucky Power	12/05/2019	5x875	$7.75	CLDIS	$0.00	0.0000%	$339.06

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, December 11, 2019 12 22 PM

Invoice

Agency	Scott Bishop KENTUCKY POWER COMPANY 855 Central Ave. Suite 200 Ashland, KY 41101-	Invoice Date	12/11/2019
		PO Number	
		Order	19121KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Company's Application							
HINDMAN TROUBLESOME CREEK TIMES							
Notice of Kentucky Power Company's Application	11/21/2019	4x8 75	$10.00	CLDIS	$0.00	0.0000%	$350 00
Notice of Kentucky Power Company's Application	11/28/2019	4x8.75	$10.00	CLDIS	$0.00	0.0000%	$35000
Notice of Kentucky Power Company's Application	12/05/2019	4x8.75	$10 00	CLDIS	$0.00	0.0000%	$350 00
HYDEN LESLIE CO. NEWS							
Notice of Kentucky Power Company's Appli cation	11/21/2019	5x8.75	$7.00	CLDIS	$0.00	0.0000%	$306.25
Notice of Kentucky Power Company's Appli cation	11/28/2019	5x8.75	$7.00	CLDIS	$0.00	0.0000%	$306 25
Notice of Kentucky Power Company's Application	12/05/2019	5 x8.75	$7.00	CLDIS	$0.00	0.0000%	$306 25
INEZ MOUNTAIN CITIZEN							
Notice of Kentucky Power Company's Application	11/20/2019	5x8.75	$8.22	CLDIS	$0.00	0.0000%	$359.62
Notice of Kentucky Power Company's Application	11/27/2019	5x8.75	$8.22	CLDIS	$0.00	0.0000%	$35962
Notice of Kentucky Power Company's Application	12/04/2019	5x8.75	$8.22	CLDIS	$0.00	0.0000%	$359 62
Jackson Times-Voice							
Notice of Kentucky Power Company's Application	11/20/2019	6x8.75	$8.00	CLDIS	$0.00	0.0000%	$420.00
Notice of Kentucky Power Company's Application	11/27/2019	6x8.75	$8.00	CLDIS	$0.00	0.0000%	$420 00
Notice of Kentucky Power Company's Application	12/04/2019	6x8.75	$8.00	CLDIS	$0.00	0.0000%	$420 00
LOUISA BIG SANDY NEWS							
Notice of Kentucky Power Company's Application	11/20/2019	4x875	$8.86	CLDIS	$0.00	0.0000%	$310 10
Notice of Kentucky Power Company's Application	11/26/2019	4x8.75	$8.86	CLDIS	$0.00	0.0000%	$310.10

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1 5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, December 11, 2019 12 22 PM

Invoice

	Scott Bishop	**Invoice Date**	12/11/2019
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	855 Central Ave. Suite 200 Ashland, KY 41101-	**Order**	19121KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper / Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Notice of Kentucky Power Company's Application	12/04/2019	4 x 8.75	$8 86	CLDIS	$0.00	0.0000%	$310 10
MANCHESTER ENTERPRISE							
Notice of Kentucky Power Company's Application	11/20/2019	6 x 8.75	$12 00	CLDIS	$0.00	0.0000%	$630 00
Notice of Kentucky Power Company's Application	11/27/2019	6 x 8.75	$12 00	CLDIS	$0.00	0.0000%	$630 00
Notice of Kentucky Power Company's Application	12/04/2019	6 x 8.75	$12 00	CLDIS	$0.00	0.0000%	$630 00
MOREHEAD NEWS							
Notice of Kentucky Power Company's Application	11/20/2019	5 x 8.75	$18.75	CLDIS	$0.00	0.0000%	$820 31
Notice of Kentucky Power Company's Application	11/27/2019	5x8.75	$18.75	CLDIS	$0.00	0.0000%	$820 31
Notice of Kentucky Power Company's Application	12/04/2019	5x8.75	$18.75	CLDIS	$0 00	0.0000%	$820 31
PAINTSVILLE HERALD							
Notice of Kentucky Power Company's Application	11/20/2019	5x8.75	$7.50	CLDIS	$0.00	0.0000%	$328 12
Notice of Kentucky Power Company's Application	11/27/2019	5x8.75	$7.50	CLDIS	$0.00	0.0000%	$328 12
Notice of Kentucky Power Company's Application	12/04/2019	5x8.75	$7.50	CLDIS	$0.00	0.0000%	$328 12
PIKEVILLE APPALACHIAN NEWS-EXPRESS							
Notice of Kentucky Power Company's Application	11/19/2019	5x8.75	$12.60	CLDIS	$0 00	0.0000%	$551.25
Notice of Kentucky Power Company's Application	11/26/2019	5 x 8.75	$12.60	CLDIS	$0.00	0.0000%	$551.25
Notice of Kentucky Power Company's Application	12/03/2019	5x8.75	$12.60	CLDIS	$0.00	0.0000%	$551 25
Prestonsburg Floyd County Chronicle & Times							
Notice of Kentucky Power Company's Application	11/20/2019	5x8.75	$7.75	CLDIS	$0.00	0.0000%	$339.06
Notice of Kentucky Power	11/27/2019	5 x8.75	$7.75	CLDIS	$0.00	0.0000%	$339.06

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE
101 CONSUMER LANE
FRANKFORT KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, December 11, 2019 12 22 PM

Invoice

	Scott Bishop	**Invoice Date**	12/11/2019
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	855 Central Ave. Suite 200 Ashland, KY41101-	**Order**	19121KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Company's Application							
Notice of Kentucky Power Company's Application	12/04/2019	5x875	$7 75	CLDIS	$0.00	0.0000%	$339 06
SALYERSVILLE INDEPENDENT							
Notice of Kentucky Power Company's Application	11/21/2019	5x875	$8 86	CLDIS	$0.00	0.0000%	$387 62
Notice of Kentucky Power Company's Application	11/27/2019	5x875	$8 86	CLDIS	$0.00	0.0000%	$387 62
Notice of Kentucky Power Company's Application	12/05/2019	5x875	$8 86	CLDIS	$0.00	0.0000%	$387 62
SANDY HOOK ELLIOTT COUNTY NEWS							
Notice of Kentucky Power Company's Application	11/22/2019	5x875	$4 94	CLDIS	$0.00	0.0000%	$216 12
Notice of Kentucky Power Company's Application	11/29/2019	5x875	$4 94	CLDIS	$0.00	0.0000%	$216.12
Notice of Kentucky Power Company's Application	12/06/2019	5x875	$4 94	CLDIS	$0.00	0.0000%	$216 12
VANCEBURG LEWIS COUNTY HERALD							
Notice of Kentucky Power Company's Application	11/19/2019	4x875	$4 44	CLDIS	$0.00	0.0000%	$155 40
Notice of Kentucky Power Company's Application	11/26/2019	4x875	$4 44	CLDIS	$0.00	0.0000%	$155.40
Notice of Kentucky Power Company's Application	12/03/2019	4x875	$4 44	CLDIS	$0.00	0.0000%	$155 40
WEST LIBERTY LICKING VALLEY COURIER							
Notice of Kentucky Power Company's Application	11/21/2019	5x875	$5 38	CLDIS	$0.00	0.0000%	$235 38
Notice of Kentucky Power Company's Application	11/28/2019	5x875	$5 38	CLDIS	$0.00	0.0000%	$235 38
Notice of Kentucky Power Company's Application	12/05/2019	5x875	$5 38	CLDIS	$0.00	0.0000%	$235 38
WHITESBURG MOUNTAIN EAGLE							
Notice of Kentucky Power Company's Application	11/20/2019	5x875	$8 75	CLDIS	$0.00	0.0000%	$382.81

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Wednesday, December 11, 2019 1222 PM

Invoice

	Scott Bishop	Invoice Date	12/11/2019
Agency	KENTUCKY POWER COMPANY	PO Number	
	855 Central Ave. Suite 200 Ashland, KY 41101-	Order	19121KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper

Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Notice of Kentucky Power Company's Application	11/27/2019	5 x 8 75	$8 75	CLDIS	$0.00	0.0000%	$382 81
Notice of Kentucky Power Company's Application	12/04/2019	5 x 8 75	$8 75	CLDIS	$0.00	0.0000%	$382 81

Total Advertising	$25,327 50
Discounts	$0 00
Tax: USA	$0 00
Total Invoice	$25,327 50
Payments	$0.00
Adjustments	$0.00
Balance Due	$25,327.50

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KPS
KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Friday, October 12, 2018 03:54 PM

Invoice

	Scott Bishop	**Invoice Date**	10/12/2018
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	P.O. BOX 5190 REGULATORY SERVICES 101A ENTERPRISE DR. FRANKFORT, KY 40602	**Order**	18101KK0

Client KY POWER COMPANY
Reps Rachel McCarty

Newspaper / Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
ASHLAND DAILY INDEPENDENT							
Notice KY Power	09/18/2018	6 x 7.5	$35.00	SAU	$0.00	0.0000%	$1,575.00
Notice KY Power	09/25/2018	6 x 7.5	$35.00	SAU	$0.00	0.0000%	$1,575.00
Notice KY Power	10/02/2018	6 x 7.5	$35.00	SAU	$0.00	0.0000%	$1,575.00
BOONEVILLE SENTINEL							
Notice KY Power	09/19/2018	6 x 8	$8.86	CLDIS	$0.00	0.0000%	$425.28
Notice KY Power	09/26/2018	6 x 8	$8.86	CLDIS	$0.00	0.0000%	$425.28
Notice KY Power	10/03/2018	6 x 8	$8.86	CLDIS	$0.00	0.0000%	$425.28
GRAYSON JOURNAL-ENQUIRER							
Notice KY Power	09/19/2018	6 x 9	$17.20	CLDIS	$0.00	0.0000%	$928.80
Notice KY Power	09/26/2018	6 x 9	$17.20	CLDIS	$0.00	0.0000%	$928.80
Notice KY Power	10/03/2018	6 x 9	$17.20	CLDIS	$0.00	0.0000%	$928.80
GREENUP NEWS							
Notice KY Power	09/20/2018	6 x 7.5	$6.00	CLDIS	$0.00	0.0000%	$270.00
Notice KY Power	09/27/2018	6 x 7.5	$6.00	CLDIS	$0.00	0.0000%	$270.00
Notice KY Power	10/04/2018	6 x 7.5	$6.00	CLDIS	$0.00	0.0000%	$270.00
HAZARD HERALD							
Notice KY Power	09/20/2018	4 x 8	$7.75	CLDIS	$0.00	0.0000%	$248.00
Notice KY Power	09/27/2018	4 x 8	$7.75	CLDIS	$0.00	0.0000%	$248.00
Notice KY Power	10/04/2018	4 x 8	$7.75	CLDIS	$0.00	0.0000%	$248.00
HINDMAN TROUBLESOME CREEK TIMES							
Notice KY Power	09/20/2018	4 x 8	$10.00	CLDIS	$0.00	0.0000%	$320.00
Notice KY Power	09/27/2018	4 x 8	$10.00	CLDIS	$0.00	0.0000%	$320.00
Notice KY Power	10/04/2018	4 x 8	$10.00	CLDIS	$0.00	0.0000%	$320.00
HYDEN LESLIE CO. NEWS							
Notice KY Power	09/20/2018	6 x 7.5	$7.00	CLDIS	$0.00	0.0000%	$315.00
Notice KY Power	09/27/2018	6 x 7.5	$7.00	CLDIS	$0.00	0.0000%	$315.00
Notice KY Power	10/04/2018	6 x 7.5	$7.00	CLDIS	$0.00	0.0000%	$315.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE
101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Friday, October 12, 2018 03:54 PM

Invoice

	Scott Bishop	**Invoice Date**	10/12/2018
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	P.O. BOX 5190 REGULATORY SERVICES 101A ENTERPRISE DR. FRANKFORT, KY 40602	**Order**	18101KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
INEZ MOUNTAIN CITIZEN							
Notice KY Power	09/19/2018	4 x 8	$8.22	CLDIS	$0.00	0.0000%	$263.04
Notice KY Power	09/26/2018	4 x 8	$8.22	CLDIS	$0.00	0.0000%	$263.04
Notice KY Power	10/03/2018	4 x 8	$8.22	CLDIS	$0.00	0.0000%	$263.04
Jackson Times-Voice							
Notice KY Power	09/19/2018	6 x 8	$8.00	CLDIS	$0.00	0.0000%	$384.00
Notice KY Power	09/26/2018	6 x 8	$8.00	CLDIS	$0.00	0.0000%	$384.00
Notice KY Power	10/03/2018	6 x 8	$8.00	CLDIS	$0.00	0.0000%	$384.00
LOUISA BIG SANDY NEWS							
Notice KY Power	09/19/2018	4 x 8	$8.00	CLDIS	$0.00	0.0000%	$256.00
Notice KY Power	09/26/2018	4 x 8	$8.00	CLDIS	$0.00	0.0000%	$256.00
Notice KY Power	10/03/2018	4 x 8	$8.00	CLDIS	$0.00	0.0000%	$256.00
MANCHESTER ENTERPRISE							
Notice KY Power	09/19/2018	6 x 8	$12.66	CLDIS	$0.00	0.0000%	$607.68
Notice KY Power	09/26/2018	6 x 8	$12.66	CLDIS	$0.00	0.0000%	$607.68
Notice KY Power	10/03/2018	6 x 8	$12.66	CLDIS	$0.00	0.0000%	$607.68
MOREHEAD NEWS							
Notice KY Power	09/19/2018	6 x 9	$18.75	CLDIS	$0.00	0.0000%	$1,012.50
Notice KY Power	09/26/2018	6 x 9	$18.75	CLDIS	$0.00	0.0000%	$1,012.50
Notice KY Power	10/03/2018	6 x 9	$18.75	CLDIS	$0.00	0.0000%	$1,012.50
PAINTSVILLE HERALD							
Notice KY Power	09/19/2018	4 x 8	$7.50	CLDIS	$0.00	0.0000%	$240.00
Notice KY Power	09/26/2018	4 x 8	$7.50	CLDIS	$0.00	0.0000%	$240.00
Notice KY Power	10/03/2018	4 x 8	$7.50	CLDIS	$0.00	0.0000%	$240.00
PIKEVILLE APPALACHIAN NEWS-EXPRESS							
Notice KY Power	09/18/2018	6 x 7.5	$12.60	CLDIS	$0.00	0.0000%	$567.00
Notice KY Power	09/25/2018	6 x 7.5	$12.60	CLDIS	$0.00	0.0000%	$567.00
Notice KY Power	10/02/2018	6 x 7.5	$12.60	CLDIS	$0.00	0.0000%	$567.00

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE

101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Friday, October 12, 2018 03:54 PM

Invoice

	Scott Bishop	**Invoice Date**	10/12/2018
Agency	KENTUCKY POWER COMPANY	**PO Number**	
	P.O. BOX 5190 REGULATORY SERVICES 101A ENTERPRISE DR. FRANKFORT, KY 40602	**Order**	18101KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper / Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total
Prestonsburg Floyd County Chronicle & Times							
Notice KY Power	09/19/2018	6 x 7.5	$7.75	CLDIS	$0.00	0.0000%	$348.75
Notice KY Power	09/26/2018	6 x 7.5	$7.75	CLDIS	$0.00	0.0000%	$348.75
Notice KY Power	10/03/2018	6 x 7.5	$7.75	CLDIS	$0.00	0.0000%	$348.75
SALYERSVILLE INDEPENDENT							
Notice KY Power	09/20/2018	6 x 7.5	$8.86	CLDIS	$0.00	0.0000%	$398.70
Notice KY Power	09/27/2018	6 x 7.5	$8.86	CLDIS	$0.00	0.0000%	$398.70
Notice KY Power	10/04/2018	6 x 7.5	$8.86	CLDIS	$0.00	0.0000%	$398.70
SANDY HOOK ELLIOTT COUNTY NEWS							
Notice KY Power	09/21/2018	4 x 8	$4.94	CLDIS	$0.00	0.0000%	$158.08
Notice KY Power	09/28/2018	4 x 8	$4.94	CLDIS	$0.00	0.0000%	$158.08
Notice KY Power	10/05/2018	4 x 8	$4.94	CLDIS	$0.00	0.0000%	$158.08
VANCEBURG LEWIS COUNTY HERALD							
Notice KY Power	09/18/2018	4 x 8	$4.44	CLDIS	$0.00	0.0000%	$142.08
Notice KY Power	09/25/2018	4 x 8	$4.44	CLDIS	$0.00	0.0000%	$142.08
Notice KY Power	10/02/2018	4 x 8	$4.44	CLDIS	$0.00	0.0000%	$142.08
WEST LIBERTY LICKING VALLEY COURIER							
Notice KY Power	09/20/2018	4 x 8	$5.38	CLDIS	$0.00	0.0000%	$172.16
Notice KY Power	09/27/2018	4 x 8	$5.38	CLDIS	$0.00	0.0000%	$172.16
Notice KY Power	10/04/2018	4 x 8	$5.38	CLDIS	$0.00	0.0000%	$172.16
WHITESBURG MOUNTAIN EAGLE							
Notice KY Power	09/19/2018	6 x 7.5	$8.75	CLDIS	$0.00	0.0000%	$393.75
Notice KY Power	09/26/2018	6 x 7.5	$8.75	CLDIS	$0.00	0.0000%	$393.75
Notice KY Power	10/03/2018	6 x 7.5	$8.75	CLDIS	$0.00	0.0000%	$393.75

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

KENTUCKY PRESS SERVICE

KENTUCKY PRESS SERVICE
101 CONSUMER LANE
FRANKFORT,KY 40601-
Voice (502) 223-8821 Fax (502) 875-2624

Friday, October 12, 2018 03:54 PM

Invoice

	Scott Bishop	Invoice Date	10/12/2018
Agency	KENTUCKY POWER COMPANY	PO Number	
	P.O. BOX 5190 REGULATORY SERVICES 101A ENTERPRISE DR. FRANKFORT, KY 40602	Order	18101KK0
Client	KY POWER COMPANY		
Reps	Rachel McCarty		

Newspaper Caption	Run Date	Ad Size	Rate	Rate Name	Color	Disc.	Total

Total Advertising	$27,077.46
Discounts	$0.00
Tax: USA	$0.00
Total Invoice	$27,077.46
Payments	$0.00
Adjustments	$0.00
Balance Due	$27,077.46

ANY QUESTIONS CONCERNING TEARSHEETS AND/OR REQUESTS FOR ACCOUNT CREDIT MUST BE MADE WITHIN FIVE DAYS OF THE DATE OF THIS INVOICE. IF THE REQUEST IS NOT RECEIVED WITHIN FIVE DAYS, THE CLIENT IS RESPONSIBLE FOR FULL PAYMENT OF THE INVOICE AMOUNT. **As of MAY 1, 2017, a 2.5 percent convenience fee will be added if paying by Credit Card.** Amount Due Subject to 1.5% Service Charge After 30 Days Please Pay From This Invoice. No Statement Will Be Sent.

DATA REQUEST

JI 1_27 Please refer to Witness Bishop's Testimony, p. 9, lines 18-20, and Exhibit SEB-5. Did the actual cost to publish the notice match the estimate provided by the Kentucky Press Service? If not, please provide the actual cost.

RESPONSE

No. The estimate to publish the notice was $31,900.00. The actual publication cost was $30,333.30, a difference of $(1,566.67).

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_28 Please refer to Exhibit SEB-6, p. 2 of 37. Please produce a copy of the "joint application filed September 27, 1995," including exhibits.

RESPONSE

Please see KPCO_R_JI_1_28_Attachment1 for the requested information.

Witness: Tanner S. Wolffram

Kentucky Power Company
1701 Central Avenue
P.O. Box 1428
Ashland, Kentucky 41105-1428
606-327-1111

PSC # 95-427

#1

AEP KENTUCKY POWER

Mr. Don R. Mills,
Executive Director
Public Service Commission
P. O. Box 615
Frankfort, KY 40602

27 September 1995

Dear Mr. Mills:

RE: IN THE MATTER OF THE JOINT APPLICATION PURSUANT TO 1994 HOUSE BILL NO. 501 FOR THE APPROVAL OF THE KENTUCKY POWER COMPANY ("KPCO") COLLABORATIVE DEMAND-SIDE MANAGEMENT PROGRAMS, AND FOR AUTHORITY FOR KPCO TO IMPLEMENT A TARIFF TO RECOVER COSTS, NET LOST REVENUES AND RECEIVE INCENTIVES ASSOCIATED WITH THE IMPLEMENTATION OF THE KPCO COLLABORATIVE DEMAND-SIDE MANAGEMENT PROGRAMS

Enclosed for filing is an original and 10 copies of the above-referenced Joint Application. This Joint Application is filed on behalf of Kentucky Power Company ("KPCo") pursuant to 1994 House Bill No. 501 seeking approval of demand-side management programs and cost recovery for said programs.

The Joint Applicants are KPCo, the Office of the Kentucky Attorney General, the Kentuckians for the Commonwealth, Community Action Agencies Group, Kentucky Power Customers Alliance, Coleman Oil Company, Kentucky Tech Northeast Region, Cedar Knoll Galleria, and Kentucky Industrial Utility Customers.

Specifically, the Joint Applicants seek authority for KPCo, in conjunction with its utility services and pursuant to the 1994 House Bill No. 501: (1) to implement certain enumerated DSM programs, (2) to establish a collaborative process for the approval of additional programs, (3) to implement an electric tariff to recover costs associated with the implementation of demand-side management programs, which include net lost revenues and incentives related to those programs, (4) to enable the payment of incentives to customers for participation in said programs, and (5) to receive the Kentucky Public Service Commission's authority to account for the DSM plan in accordance with Exhibit D.

The Joint Applicants request the Commission to approve the DSM programs on or before October 27, 1995.

If you have any questions please feel free to contact me.

Sincerely,

Errol K. Wagner

Errol K. Wagner
Accounting, Rates & Planning Director

jw

Enclosures

cc: all parties of record

Kentucky Power Company
1701 Central Avenue
P.O. Box 1428
Ashland, Kentucky 41105-1428
606-327-1111

AEP KENTUCKY POWER

Mr. Don R. Mills,
Executive Director
Public Service Commission
P. O. Box 615
Frankfort, KY 40602

27 September 1995

Dear Mr. Mills:

RE: IN THE MATTER OF THE JOINT APPLICATION PURSUANT TO 1994 HOUSE BILL NO. 501 FOR THE APPROVAL OF THE KENTUCKY POWER COMPANY ("KPCO") COLLABORATIVE DEMAND-SIDE MANAGEMENT PROGRAMS, AND FOR AUTHORITY FOR KPCO TO IMPLEMENT A TARIFF TO RECOVER COSTS, NET LOST REVENUES AND RECEIVE INCENTIVES ASSOCIATED WITH THE IMPLEMENTATION OF THE KPCO COLLABORATIVE DEMAND-SIDE MANAGEMENT PROGRAMS

Enclosed for filing is an original and 10 copies of the above-referenced Joint Application. This Joint Application is filed on behalf of Kentucky Power Company ("KPCo") pursuant to 1994 House Bill No. 501 seeking approval of demand-side management programs and cost recovery for said programs.

The Joint Applicants are KPCo, the Office of the Kentucky Attorney General, the Kentuckians for the Commonwealth, Community Action Agencies Group, Kentucky Power Customers Alliance, Coleman Oil Company, Kentucky Tech Northeast Region, Cedar Knoll Galleria, and Kentucky Industrial Utility Customers.

Specifically, the Joint Applicants seek authority for KPCo, in conjunction with its utility services and pursuant to the 1994 House Bill No. 501: (1) to implement certain enumerated DSM programs, (2) to establish a collaborative process for the approval of additional programs, (3) to implement an electric tariff to recover costs associated with the implementation of demand-side management programs, which include net lost revenues and incentives related to those programs, (4) to enable the payment of incentives to customers for participation in said programs, and (5) to receive the Kentucky Public Service Commission's authority to account for the DSM plan in accordance with Exhibit D.

The Joint Applicants request the Commission to approve the DSM programs on or before October 27, 1995.

If you have any questions please feel free to contact me.

Sincerely,

Errol K. Wagner

Errol K. Wagner
Accounting, Rates & Planning Director

jw

Enclosures

cc: all parties of record

MAILING LIST

OFFICE OF THE KENTUCKY ATTORNEY GENERAL
Ann Louise Cheuvront
Assistant Attorney General
P. O. Box 2000
Frankfort, Kentucky 40602-2000

KENTUCKIANS FOR THE COMMONWEALTH
Patty Wallace
Rt. 1, Box 840
Louisa, KY 41230

COMMUNITY ACTION AGENCIES GROUP
Owen Fielding
P. O. Box U
Olive Hill, KY 41164

KENTUCKY POWER CUSTOMERS ALLIANCE
Judy Crum
P. O. Box 459
Hager Hill, KY 41222

COLEMAN OIL COMPANY
Richard Hagerman
836 E. Euclid Avenue, Suite J
Lexington, KY 40502

KENTUCKY TECH NORTHEAST REGION
Howard Moore
4818 Roberts Drive
Ashland, KY 41102

CEDAR KNOLL GALLERIA
Tyna McCown
10699 US 60 West, Suite 43
Ashland, KY 41102

KENTUCKY INDUSTRIAL UTILITY CUSTOMERS
David Boehm
2110 CBLD Center, 36 E. 7th Street
Cincinnati, OH 45202

KENTUCKY LEGAL SERVICES
Tony Martin
201 W. Short St.
Suite 506
Lexington, KY 40507

KENTUCKY LEGAL SERVICES
Kay Guinane
201 W. Short St.
Suite 506
Lexington, KY 40507

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE JOINT APPLICATION PURSUANT TO 1994 HOUSE BILL NO. 501 FOR THE APPROVAL OF THE KENTUCKY POWER COMPANY ("KPCO") COLLABORATIVE DEMAND-SIDE MANAGEMENT PROGRAMS, AND FOR AUTHORITY FOR KPCO TO IMPLEMENT A TARIFF TO RECOVER COSTS, NET LOST REVENUES AND RECEIVE INCENTIVES ASSOCIATED WITH THE IMPLEMENTATION OF THE KPCO COLLABORATIVE DEMAND-SIDE MANAGEMENT PROGRAMS	)	CASE NO. 95-____

****

A P P L I C A T I O N

To the Honorable Kentucky Public Service Commission:

Kentucky Power Company, the Office of the Kentucky Attorney General, the Kentuckians for the Commonwealth, Community Action Agencies Group, Kentucky Power Customers Alliance, Coleman Oil Company, Kentucky Tech Northeast Region, Cedar Knoll Galleria, and Kentucky Industrial Utility Customers ("Joint Applicants") hereby seek approval of Kentucky Power Company Demand-side Management Collaborative programs and authority to implement a tariff to recover costs which include net lost revenues and receive incentives associated with the implementation of the Kentucky Power Company Collaborative demand-side management programs.

Kentucky Power Company ("KPCO") is a Kentucky corporation located at 1701 Central Avenue, Ashland, Kentucky 41101 and a public utility as defined in Section 278.010 of the Kentucky Revised Statutes, engaged in the business of furnishing electric service to various municipalities and unincorporated areas in twenty counties in Eastern Kentucky. The remaining Joint Applicants are KPCO customers or representatives of KPCO customers.

The Joint Applicants are each members of the Kentucky Power Company Demand-side Management Collaborative ("Collaborative"). The KPCO Demand-Side Management Collaborative Plan ("Plan"), for which the Collaborative seeks this Commission's approval as a part of this proceeding, is attached as Attachment A. The Plan hereto sets forth the Joint Applicants' agreement for implementing initial DSM Programs, establishing mechanisms for the recovery of DSM program costs (including net lost revenues, incentive, and over/under recovery balances) and providing guidance to the DSM Collaborative efforts between KPCO and its customers. The Joint Applicants believe this Plan is in the public interest and is consistent with the provisions of 1994 House Bill 501, KRS§278.285.

Specifically, the Joint Applicants seek authority for KPCO in conjunction with its utility services and pursuant to 1994 House Bill No. 501, (1) to implement certain enumerated DSM programs, (2) to establish a collaborative process for the approval of additions and/or modifications to programs, (3) to implement an electric tariff to recover costs associated with the implementation of Demand-Side Management programs, which include net lost revenues and incentives related to those programs, (4) to enable the payment of incentives to customers for participation in said programs, and (5) to receive the Kentucky Public Service Commission's authority to account for the DSM plan in accordance with Exhibit D. Joint

Applicants, upon the facts to be set forth hereafter, request that the Commission approve the Demand-Side Management Plan and all attachments thereto.

The 1994 House Bill No. 501, KRS§278.285, provides the Commission with the authority to review and approve DSM Plans and to approve an associated recovery mechanism. Specifically, the Commission may consider factors, including, but not limited to:

(a) Specific consumption pattern changes the utility is seeking;

(b) The cost-benefit analysis and other justification for the specific DSM measures in a utility's plan;

(c) The utility's proposal to recover the full costs of DSM programs, any net lost revenues due to reduced sales resulting from DSM programs; and proposed incentives to provide positive financial rewards to a utility to encourage implementation of cost-effective DSM programs;

(d) Whether the proposed DSM programs are consistent with its most recent Integrated Resource Plan;

(e) Whether the DSM Plan results in any unreasonable disadvantage to any customer sector;

(f) The extent to which the customer representatives and the Office of the Attorney General have been involved in developing the Plan; and

(g) The extent to which the Plan provides affordable, available and useful programs to customers. [KRS§278.285(1)]

In addition, the proposed DSM recovery mechanism designed to recover the full costs of Commission-approved DSM programs, net lost revenues, and incentives, may be reviewed and approved as a part of a proceeding to review the DSM Plan. [KRS§278.285(2)]

Finally, KRS§278.285(3) specifies that the cost of DSM programs must be assigned to the customer sector which benefits from the programs, and that certain industrial customers with energy intensive processes may implement cost-effective energy efficiency measures in lieu of participating in utility DSM programs, and shall not be assigned costs from such utility programs.

In support of this Joint Application, pursuant to Administrative Regulation 807KAR5:001, the Joint Applicants submit the following:

PROGRAMS

The Joint Applicants desire to implement ten Demand-Side Management programs in Kentucky Power Company's service territory:

I. Residential Programs:

(i) Energy Fitness;

(ii) Targeted Energy Efficiency;

(iii) Compact Fluorescent Bulb;

(iv) High Efficiency Heat Pump;

(v) High Efficiency Heat Pump-Mobile Home;

(vi) Mobile Home New Construction;

II. Commercial Programs:

(vii) Smart Audit;

(viii) Smart Financing;

III. Industrial Programs:

(ix) Smart Audit; and

(x) Smart Financing.

A description of the above programs is included in the Plan under Sections III, IV and V. The program portfolio by customer sector is cost-effective based on the Total Resource Cost (TRC) test and achieves desired consumption pattern changes.

COST RECOVERY

The Legislature granted authority in 1994 House Bill No. 501 to allow Commission approved mechanisms with contemporaneous recovery of DSM program costs, net lost revenues, and incentives. The Joint Applicants now urge the Commission to adopt the mechanisms agreed to by the Joint Applicants and incorporated into the filing, whereby DSM programs can be implemented so that benefits flow to all stakeholders.

The recovery mechanism is designed to recover the DSM program costs applicable to those DSM programs implemented for the appropriate customer sector. The charge is designed to recover DSM program costs, which include net lost revenues, incentives, and any over/under recovery balances.

As required by 1994 House Bill No. 501, the mechanisms attribute the costs, net lost revenues and incentives to the customer sector which benefits from the programs. Also, as required, the industrial customers were permitted to opt-out of participation in the DSM programs and by so doing will not pay for the Company's DSM programs. To opt-out, they have represented that they are energy intensive customers and have implemented cost-effective efficiency measures on their own.

The Plan provides for a sunset provision with respect to net lost revenues. If during the 3-year plan there is no change in base rates, the Collaborative has agreed the sunset provision provides that the first year's net lost revenues will no longer be recovered in Year 4. The second year's net lost revenues would cease to be recovered in Year 5, and so forth. Recovery of DSM program expenses and incentives remain separate from a base rate proceeding.

EXPERIMENTAL DEMAND-SIDE MANAGEMENT ADJUSTMENT CLAUSE TARIFF

The Collaborative Plan includes a proposed Experimental Demand-Side Management Adjustment Clause Tariff (see Exhibit F) which authorizes a surcharge designed to recover the costs related to all ten demand-side management programs, as well as the appropriate levels of net lost revenues and incentives associated with the DSM programs proposed for implementation. This tariff would be applicable to service provided under the following electric service tariffs: R.S., R.S.-L.M.-T.O.D., Experimental R.S.-T.O.D., S.G.S., M.G.S., Experimental M.G.S.-T.O.D., L.G.S., Q.P., C.I.P.-T.O.D., I.R.P. and M.W.

The proposed residential charge per KWH was calculated by dividing DSM program costs projected for the period ending October 31, 1996, by the adjusted projected sales. The calculations in support of the residential recovery mechanism are provided in Exhibit C to the Plan.

The proposed charge for the commercial and industrial sectors were calculated in the same fashion as the residential sector. The industrial sector reflects the opt-out provision in the surcharge calculation.

The proposed tariff will be in effect for at least three years with periodic adjustments to the rate as filed with the Kentucky Public Service Commission, but in no event beyond May 31, 1999.

Approval of the tariff in this Application will provide for more timely recovery of DSM program costs and enable Kentucky Power Company to aggressively pursue implementation of DSM programs. Commission approval of the accounting entries, as illustrated in Exhibit D, to allow the Company to properly account for DSM programs based on an annual surcharge recovery mechanism, such as the tariff above, is also being requested.

This Joint Application is also intended to provide this Commission with notice that Kentucky Power Company, the Joint Applicants and other customers are working in a collaborative effort which ensures that special DSM needs or conditions in eastern Kentucky are considered.

The Joint Applicants further request the Commission to approve the DSM programs on or before October 27, 1995 in order for the programs to be implemented for and during the 1995-1996 winter season.

WHEREFORE, the Joint Applicants pray that the Commission issue its Order approving the Plan along with the necessary tariff for the implementation of DSM programs in the KPCo service territory.

Respectfully submitted,

KENTUCKY POWER COMPANY

Bruce F Clark /EKW

Bruce F. Clark
STITES & HARBISON
421 W. Main Street
P. O. Box 634
Frankfort, KY 40602-0634
Phone: 502/223-3477
COUNSEL FOR KENTUCKY POWER COMPANY

By ______________________________

OFFICE OF THE KENTUCKY ATTORNEY GENERAL
Ann Louise Cheuvront
Assistant Attorney General
P. O. Box 2000
Frankfort, Kentucky 40602-2000

By *Patty Wallace*

KENTUCKIANS FOR THE COMMONWEALTH
Patty Wallace
Rt. 1, Box 840
Louisa, KY 41230

By ______________________________

COMMUNITY ACTION AGENCIES GROUP
Owen Fielding
P. O. Box U
Olive Hill, KY 41164

By Judy K. Crum
KENTUCKY POWER CUSTOMERS ALLIANCE
Judy Crum
P. O. Box 459
Hager Hill, KY 41222

By Richard Hagerman
COLEMAN OIL COMPANY
Richard Hagerman
836 E. Euclid Avenue, Suite J
Lexington, KY 40502

By: Howard W. Moore

KENTUCKY TECH NORTHEAST REGION
Howard Moore
4818 Roberts Drive
Ashland, KY 41102

By *Tyna L. McCown*

Tyna McCown
10699 US 60 West, Suite 43
Ashland, KY 41102

By David F. Boehm

KENTUCKY INDUSTRIAL UTILITY CUSTOMERS
David Boehm
2110 CBLD Center, 36 E. 7th Street
Cincinnati, OH 45202

By______________________________
KENTUCKY LEGAL SERVICES
Tony Martin
201 W. Short St.
Suite 506
Lexington, KY 40507

By KAY GUINANE /by AT
KENTUCKY LEGAL SERVICES
Kay Guinane
201 W. Short St.
Suite 506
Lexington, KY 40507

ATTACHMENT A

KENTUCKY POWER COMPANY DEMAND-SIDE MANAGEMENT COLLABORATIVE PLAN

Table of Contents

TABLE OF CONTENTS

Table of Contents
Page 2

I. EXECUTIVE SUMMARY

A. Kentucky Power Company Demand-Side Management Collaborative Approval of Company Proposals and Participating Parties

In November 1994, Kentucky Power Company and a number of groups representing a cross section of residential, commercial, and industrial customers established the Kentucky Power Demand-Side Management Collaborative. The purpose of the Collaborative was to jointly develop a demand-side management plan for the company, including program designs, budgets, and cost recovery mechanisms in a manner consistent with KRS 278.285. This agreement represents the results of this effort.

The Kentucky Power Demand-Side Management Collaborative functions as a consensus decision-making body. Program decisions are made by customer class subgroups (residential, commercial, and industrial), as their cost must be assigned to the group benefiting from them. The founding members of the Collaborative representing the residential class are: Kentuckians for the Commonwealth; Community Action Agencies Group; and the Kentucky Power Customers Alliance. The founding members of the Collaborative representing the commercial class are: Coleman Oil Company; Kentucky Tech Northeast Region; and Cedar Knoll Galleria. The Kentucky Industrial Utility Customers (KIUC) group is the founding member of the Collaborative representing the industrial class. All classes are represented by the Office of the Attorney General and Kentucky Power Company, who are voting founding members. All classes are further represented by the Kentucky Division of Energy, American Electric Power Service Corporation, and the Kentucky Department of Education, who are non-voting members. The Kentucky Public Service Commission will be invited to participate as a non-voting member.

The Collaborative will be responsible for the ongoing implementation, monitoring, and evaluation of Kentucky Power's demand-side management efforts.

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

Kentuckians for the Commonwealth is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

Patty Wallace

VOTING MEMBER

Patty Wallace
RR 1 Bx 840
Louisa, KY 41230

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

Community Action Agencies Group is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

Owen Fielding

VOTING MEMBER

Owen Fielding
P. O. Box U
Olive Hill, KY 41164

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

Kentucky Power Customers Alliance is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

Judy K. Crum

VOTING MEMBER

Judy Crum

P. O. Box 459

Hager Hill, KY 41222

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

Coleman Oil Company is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

Richard Hagerman

VOTING MEMBER

Richard Hagerman
836 E. Euclid Avenue, Suite J
Lexington, KY 40502

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

Kentucky Tech Northeast Region is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

Howard W. Moore

VOTING MEMBER

Howard Moore
4818 Roberts Drive
Ashland, KY 41102

KENTUCKY TECH NORTHEAST REGION

4818 ROBERTS DRIVE
ASHLAND, KENTUCKY 41102-9046
606/928-4256
FAX 606/928-6420

June 27, 1995

Ms. Lois Kellogg
Kentucky Power Company
P. O. Box 1428
Ashland, KY 41105-1428

Dear Lois:

We have reviewed your proposal for commercial customers as requested.

The SMART Audit has the potential to be an effective cost-cutting mechanism for your commercial customers. We look forward to working with this idea in the future to assist us in energy conservation as well as cutting our electrical expenses at Kentucky Tech.

Sincerely,

Howard W. Moore

Howard W. Moore
Regional Executive Director

Ed Richardson

Ed Richardson
Training & Development Coordinator

KENTUCKY TECH

Cabinet for Workforce Development
Kentucky Department for Adult & Technical Education
Equal Opportunity M/F/H

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

TYNA MCCOWN is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

Tyna L. McCown

VOTING MEMBER

Tyna McCown

10699 US 60 W, Suite 43

Ashland, KY 41102

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

Kentucky Industrial Utility Customers is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

David F. Boehm

VOTING MEMBER

David Boehm
2110 CBLD Center, 36 E. 7th Street
Cincinnati, OH 45202

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

The Office of the Attorney General of Kentucky is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

VOTING MEMBER

Ann Louise Cheuvront
P. O. Box 2000
Frankfort, KY 40602

KENTUCKY POWER COMPANY

DEMAND-SIDE MANAGEMENT COLLABORATIVE

Kentucky Power Company is a voting member of the Kentucky Power Company Demand-Side Management (DSM) Collaborative. We are in agreement with the three-year DSM plan developed by the Collaborative.

Mark E. Dempsey

VOTING MEMBER

Mark E. Dempsey
1701 Central Avenue
Ashland, KY 41101

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR NATURAL RESOURCES
DIVISION OF ENERGY
691 TETON TRAIL, 2ND FLOOR
FRANKFORT, KENTUCKY 40601
TELEPHONE (502) 564-7192

August 11, 1995

Mr. Don Mills, Executive Director
Kentucky Public Service Commission
730 Schenkel Lane, P.O. Box 615
Frankfort, KY 40602

Dear ~~Mr. Mills~~ Don:

The Kentucky Division of Energy has participated actively for the past year as a nonvoting member of the Kentucky Power Demand-Side Management (DSM) Collaborative. During that time, we have regularly attended meetings of the customer class subgroups as well as the collaborative as a whole. We have welcomed the opportunity to be involved in these ongoing activities, and have provided our input and assistance where appropriate. Although the Division of Energy is not a voting member, we are in agreement with the three-year DSM program plan developed by the collaborative and hope that the Commission views it as a positive contribution to the well-being of the customers in the Kentucky Power Company's service territory.

Sincerely,

John

John M. Stapleton
Director

KENTUCKY DEPARTMENT OF EDUCATION
CAPITAL PLAZA TOWER • 500 MERO STREET • FRANKFORT, KENTUCKY 40601

August 11, 1995

Mr. Mark Dempsey, Chairman
Kentucky Power DSM Collaborative
1701 Central Avenue
Ashland, KY 41101

RE: Kentucky Power Demand-Side Management Collaborative

Dear Mr. Dempsey:

The Kentucky Department of Education provides the 176 local school districts across the Commonwealth with assistance in all aspects of the primary and secondary educational process, including the construction and maintenance of school facilities. The Division of Facilities Management greatly appreciates your invitation to become a member of the Kentucky Power Demand-Side Management Collaborative. Our membership, though non-voting, has been most informative. We hope this membership has been mutually beneficial.

We have received copies of the documentation compiled by the Collaborative in preparation for the upcoming filing with the Public Service Commission. We have reviewed the commercial class programs and recognize the advantage offered, not only to school districts in the service area but to all KPC customers. Please add the Kentucky Department of Education to the list of those supporting the efforts of the Collaborative and these demand-side management programs.

We are looking forward to continuing our membership in the Collaborative in the future and will make an effort to inform the affected school districts of the benefits of these programs. For the Kentucky Department of Education, and those school districts served by KPC, thank you again for your consideration.

Sincerely,

Mark W. Ryles

Mark W. Ryles, Director
Division of Facilities Management

c: Tom Willis, Associate Commissioner of District Support Services

B. Program Activities

The Kentucky Power Company Demand-Side Management Collaborative, pursuant to the Kentucky Public Service Commission's statute KRS 278.285, submits its first three-year energy conservation/demand-side management (DSM) plan beginning November 1, 1995. In the July 1994 order (Administrative Case No. 341), the Commission encouraged utilities to establish energy conservation programs for their customers by means of a collaborative effort.

Kentucky Power Company's Demand-Side Management Collaborative, with the approval of the Commission, will offer the following ten programs to customers in its service territory during the period of November 1, 1995 through October 31, 1998:

Residential

1. Energy Fitness
2. Targeted Energy Efficiency
3. Compact Fluorescent Bulb
4. High-Efficiency Heat Pump
5. High-Efficiency Heat Pump -- Mobile Home
6. Mobile Home New Construction

Commercial

1. SMART Audit
2. SMART Financing

Industrial

1. SMART Audit
2. SMART Financing

In addition, a Self-Directed Provision will allow industrial customers to opt-out of traditional participation in the energy conservation programs based on approval of their own energy conservation plan.

Because of the three-year length of this plan and changing conditions in the utility industry, the Kentucky Power DSM Collaborative reserves the right to recommend the introduction of additional programs within the three-year plan period. Likewise, if evaluation of a particular program indicates that the cost-effectiveness or response to the program in the marketplace is different than initially projected, the Collaborative may recommend that the program be modified. Any modifications or program additions are premised on concurrent revised cost recovery of program costs, net lost revenues, and incentives. Through its active oversight of the Company's programs, the Collaborative will participate in such plan modifications as more fully described in Section VIII(C), "Plan Modifications."

C. Energy and Demand Reduction Estimates

A summary of projected annual energy (MWh) and demand (kW) savings at the end of the three-year program is indicated below. Additional information regarding estimated energy savings and demand reductions for each program are listed in Sections III, IV, and V of the corresponding design documents projected in this plan and also recapped on Exhibit B.

	Projected Annual Savings		
	Energy (MWh)	Demand Winter/Summer(kw)	
Residential			
Energy Fitness	4,439	2,395	376
Targeted Energy Efficiency	6,147	2,007	432
Compact Fluorescent Bulb	205	27	27
High-Efficiency Heat Pump	5,095	3,604	1,082
High-Efficiency HP--Mob Hm	2,138	1,287	329
Mobile Home New Construction	N/A	N/A	N/A
Commercial			
SMART Audit	N/A	N/A	N/A
SMART Financing	12,200	2,725	2,735
Industrial			
SMART Audit	N/A	N/A	N/A
SMART Financing	5,917	1,112	1,131
TOTALS	36,141	13,157	6,112

D. Three-Year Program Costs

Projected annual expenses for each of the programs are shown in Exhibit A. Also, see Exhibit B for a recap of the program costs for the three-year period by program. The proposed budget reflects Kentucky Power's continuing commitment to provide its customers with cost-effective energy conservation programs consistent with its goal of providing low-cost, reliable electric service. The total three-year budget is shown below:

Residential Programs	$2,991,000	
Commercial Programs	$1,486,600	
Industrial Programs	$1,181,200	
TOTAL		$5,658,800

E. Total Revenue Requirements

The Collaborative has agreed to projected revenue requirements for the three-year period of $4,061,015 for the residential, $2,427,998 for the commercial, and $1,558,057 for the industrial sectors as shown on Exhibit C, Page 1. These revenue requirements for each sector include program costs, net lost revenues, and incentives. These cost recovery components are more fully explained in Section VII, "Cost Recovery." Actual revenues will be dependent on the actual level of program implementation.

II. OVERALL STRATEGY FOR THREE-YEAR PLAN

A. Target Audience

Kentucky Power Company serves approximately 164,000 retail customers in its service territory, which covers 3,762 square miles in southeastern Kentucky.

Based on the proposed programs, all classes of customers would have the opportunity to participate in one or more programs which can assist them in using electrical energy more wisely.

B. Promotion Strategy

Kentucky Power Company will utilize various means as appropriate to promote the proposed programs. These methods may consist of (but are not limited to): bill inserts; direct mail; direct contact by Kentucky Power representatives; telemarketing; and newspaper, billboard, radio, and television advertising.

III. RESIDENTIAL PROGRAM DESIGN DOCUMENTS

See following pages for design documents.

A. RESIDENTIAL: Energy Fitness

1. DESCRIPTION

Residential customers utilizing electricity as their heating and water heating source will receive, at no cost to the customer, an energy audit and, where applicable, have installed a mixture of the following measures:

* energy-saving showerheads
* energy-efficient light bulbs
* water heater wraps
* switch and outlet gaskets
* waterbed covers
* heating system inspection
* energy audit with blower door test
* first-line weatherization (weatherstripping and caulking of windows and interior doors)
* air sealing measures and duct sealing
* hot water pipe insulation
* set back water heater thermostat
* faucet aerators.

2. RATIONALE FOR PROGRAM

The audit and consultation will pinpoint energy conservation measures that can be implemented by a customer and educate the customer on the benefits of energy efficiency. Participants will be provided with the direct installation of appropriate energy conservation measures which can decrease energy consumption, lower their electric bills, and increase the comfort level of their homes.

3. PARTICIPATION GOALS

	Customers
November 1995 thru October 1996	500
November 1996 thru October 1997	500
November 1997 thru October 1998	500

4. ELIGIBLE CUSTOMERS

Residential retail customers in Kentucky Power's service territory who currently utilize an electric heating system and an electric water heater and use a minimum average of 1,000 kWh per month are eligible for participation. Unlike the Targeted Energy Efficiency Program, income levels will not be a factor for eligibility.

5. INCENTIVES

No financial incentive is directly given to participants; however, the program is provided at <u>no cost</u> to the customer.

6. IMPLEMENTATION PLAN

a. <u>Promotion</u>

Kentucky Power will contract with outside vendors ("Contractor") to implement the program. The Contractor will accept applications and conduct the screening process.

b. <u>Delivery</u>

The Contractor shall contact the customer directly, offer the program, and arrange for a time to implement the program at the customer's house.

c. Quality Assurance

The program will be regularly reviewed by Company staff responsible for managing the program's operation, as well as the Collaborative residential customer class sub-group.

d. Evaluation

A detailed evaluation plan will outline key research issues relating to the impact and process evaluations to be performed, along with the evaluation objectives, data collection procedures, and evaluation methodologies to be used, the evaluation schedule, reporting timelines, cost estimation, and a preliminary cost/benefit analysis.

Detailed information about each home will be collected by the Contractor for evaluating the program by KPC/AEPSC. The program evaluation objectives are as follows:

(1) Assess participant satisfaction with the energy conservation measures installed, the service performed by the Contractor, and the program as a whole;

(2) Gain insight into the market potential, including the participant characteristics, participation rate, and customer awareness of energy conservation;

(3) Determine the program load impact, including the energy savings and demand reduction, as well as freeridership, persistence, and snap-back effects;

(4) Assess effectiveness of program delivery mechanism, including the efficiency of program operation and promotional efforts and recommendations on program changes; and

(5) Assess the program cost-effectiveness based on various economic tests.

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation:		
First Report	11/95	05/97 to 10/97
Second Report	11/96	05/98 to 10/98
Third Report	11/97	05/99 to 10/99

8. ANNUAL BUDGET

	Year 1	Year 2	Year 3
Contract Services	$110,000	$110,000	$110,000
Evaluation	11,000	11,000	11,000
TOTAL COSTS	$121,000	$121,000	$121,000

9. EXPECTED SAVINGS / BENEFITS

a. Anticipated Load Impact Per Participant:

All-Electric Customers:

Energy Savings Per Year	=	2,860 kWh
Demand Reduction	=	1.53 kW
		(@ system winter peak)
	=	0.24 kW
		(@ system summer peak)

b. Annual Expected Program Savings/Benefits (including T&D losses) @ 500 participants per year):

Summer Peak Demand (kW) Reduction	Winter Peak Demand (kw) Reduction	Annual Energy (MWh) Reduction
125	798	1,480

Projected energy savings and demand reductions are estimated based on the anticipated number of installations of various types of energy-efficient measures. The program's savings/benefits have been reduced to reflect the effects of freeriders.

c. Projected Program MWh Savings and kW Reduction Assuming Participation (including T&D losses):

Goal of 1,500 units is achieved

Energy Savings	=	4,439 MWh
Demand Reduction	=	2,395 kW
		(@ system winter peak)
	=	376 kW
		(@ system summer peak)

10. COST / BENEFIT ANALYSIS

Benefit/cost ratios based on the best information available at the time of program design.

a.	Total Resource Cost	=	3.79
b.	Ratepayer Impact Measure	=	0.65
c.	Participant	=	N/A *
d.	Utility Cost	=	4.22

* Not applicable because of negligible participant costs.

B. RESIDENTIAL: Targeted Energy Efficiency

1. DESCRIPTION

This program is designed to perform energy audits and provide consultation, perform blower door test and install extensive weatherization and energy conservation measures targeted to electric space heating and/or electric water heating.

This program is proposed as a "piggyback" program, leveraging the resources of existing not-for-profit agencies that provide weatherization services to low-income households. These agencies (hereafter referred to as "Contractor") are:

Appalachian Service Project
Big Sandy Area Community Action Program
Leslie Knott Letcher Perry Community Action Council
Middle Kentucky River Area Development Council
Northeast Kentucky Area Development Council
Gateway Community Action Council

In the event federal funding cuts to the Weatherization Assistance Program (WAP) make it impossible for these agencies to fully utilize available Kentucky Power funding dollars, the program design will be adjusted to ensure continued program delivery.

This program includes two major components: electric heat and non-electric heat. The program, as proposed, will be year-round, targeted to high-use low-income customers, and include an energy audit and energy education for all selected households. The program will work as follows:

STEP ONE

Household selection based on usage and potential for savings.

WALK-AWAYS:

Households that are "walk-away's" due to:

* being too structurally deteriorated to merit going forward; or

* having too little potential for energy savings.

STEP TWO: FIRST HOME VISIT

This will require two people and will include:

> Energy education with installation of simple measures where appropriate, including the following:

* hot water pipe insulation
* energy saving showerheads
* energy efficient light bulbs
* water heater wraps
* waterbed covers
* education.

STEP THREE: HEATING SYSTEM REPAIR

Based on experience, 80-90% of the houses will need some heating system repair in order to make air sealing safe. Repair and replacement work will be referred to WAP. Where old electric central heating systems should be replaced with energy-efficient heat pumps, this program will pay the incremental difference between the high-efficiency heat pump system cost and the electric central heating system cost, plus the additional cost of labor and venting. (A blower-door analysis with air sealing and duct sealing measures would be performed.) To be eligible, a household must have air conditioning or plans to add air conditioning. There will be no cost to the households for this measure. Educational measures on heat pumps will be provided in such cases.

STEP FOUR:

Weatherization based on energy audit and blower door analysis. Measures installed would be determined by: (a) heating type and (b) potential for savings, and could include:

1. energy audit and inspection of heating equipment: all households
2. first-line weatherization (weatherstripping and caulking windows and exterior doors)
3. blower door analysis with air sealing and duct sealing measures
4. set water heater thermostats back
5. duct sealing
6. attic insulation
7. sidewall insulation
8. structural repairs that have energy efficiency value; i.e., holes in outside walls, outer doors, windows, ceilings
9. appliance replacement/removal.

STEP FIVE: FINAL INSPECTION

2. RATIONALE FOR PROGRAM

This program is designed to reduce usage and costs of qualified low-income customers, who comprise a large part of the Company's residential customer base. It will be targeted to high users and achieve savings through a combination of direct-install conservation measures based on an energy audit and energy education.

3. PARTICIPATION GOALS

	All-Elec Customers	Non-All-Elec Customers
Nov. 1995 thru Oct. 1996	310	200
Nov. 1996 thru Oct. 1997	310	200
Nov. 1997 thru Oct. 1998	310	200

4. ELIGIBLE CUSTOMERS

Residential retail customers in Kentucky Power's service territory who currently utilize an electric heating system and/or an electric water heater and use a minimum average of 700 kWh per month are eligible for participation.

5. INCENTIVES

No financial incentive is directly given to participants; however, the program is provided at <u>no cost</u> to the customer.

6. IMPLEMENTATION PLAN

a. <u>Promotion</u>

Kentucky Power will partner with Contractors to implement the program. The Community Action Agencies will accept applications and effect the screening process.

b. <u>Delivery</u>

The Contractor shall contact the customer directly, offer the program, and arrange for a time to implement the program at the customer's house.

c. Quality Assurance

The program will be regularly reviewed by Company staff responsible for managing the program's operation, as well as the Collaborative residential customer class sub-group.

d. Evaluation

A detailed evaluation plan will outline key research issues relating to the impact and process evaluations to be performed, along with the evaluation objectives, data collection procedures, and evaluation methodologies to be used, the evaluation schedule, reporting timelines, cost estimation, and a preliminary cost/benefit analysis.

Detailed information about each home will be collected by the Contractor for evaluating the program by KPC/AEPSC. Evaluation will include analysis by vendor selected by KPC/AEPSC. The program evaluation objectives are as follows:

(1) Assess participant satisfaction with the energy conservation measures installed, the service performed by the Contractor, and the program as a whole;

(2) Gain insight into the market potential, including the participant characteristics, participation rate, and customer awareness of energy conservation;

(3) Determine the program load impact, including the energy savings and demand reduction, persistence and snap-back effects;

(4) Assess the program cost-effectiveness based on the various economic tests;

(5) Assess effectiveness of program delivery mechanism; specifically, the benefits gained

in combining program implementation with other federally or state funded programs; and

(6) Assess the impact the program has on customer payments, their ability to maintain service, and Company collection activities.

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation:		
First Report	11/95	05/97 to 10/97
Second Report	11/96	05/98 to 10/98
Third Report	11/97	05/99 to 10/99

8. ANNUAL BUDGET

TOTAL HOMES = 510 — Electric Heat = 310; Non-electric Heat = 200

(The proportion of electrically-heated and non-electrically heated homes in the program is to be flexible, with changes based on targeting priorities.)

Electric Heat Homes:

Weatherization (Wx)	$1,200 x 310 =	$372,000
Heating Systems	1,000 x 153 =	153,000[1]
Appliance Replacement/ Removal		4,800
Evaluation		32,000
SUB-TOTAL		$561,800

Non-electric Heat Homes:

Wx / Conservation	$ 125 x 200 =	$ 25,000
Appliance Replacement/ Removal		3,200
Evaluation		3,000
SUB-TOTAL		$ 31,200

ANNUAL PROGRAM TOTAL $593,000

BUDGET SUMMARY

	Year 1	Year 2	Year 3
Contract Services	$558,000	$558,000	$558,000
Evaluation	35,000	35,000	35,000
TOTAL COSTS	$593,000	$593,000	$593,000

[1] The dollars set aside for heating systems are flexible, and some of those dollars may be used for additional weatherization services if the need for heating systems does not meet projected demand.

9. EXPECTED SAVINGS / BENEFITS

a. Anticipated Load Impact Per Participant:

(1) Electric Heat Customers:

Energy Savings Per Year = 5,570 kWh
Demand Reduction = 1.88 kW
(@ system winter peak)
= 0.38 kW
(@ system summer peak)

(2) Non Electric Heat Customers:

Energy Savings Per Year = 680 kWh
Demand Reduction = 0.10 kW
(@ system winter peak)
= 0.06 kW
(@ system summer peak)

b. Annual Expected Program Savings/Benefits (including T&D losses) @ 510 participants per year):

Summer Peak Demand (kW) Reduction	Winter Peak Demand (kW) Reduction	Annual Energy (MWh) Reduction
144	669	2,049

Projected energy savings and demand reductions are estimated based on the anticipated number of installations of various types of energy-efficient measures. Because of the nature of the program participants, no freeriders are anticipated.

c. Projected Program MWh Savings and kW Reduction Assuming Participation (including T&D losses):

Goal of 930 units is achieved
(electric heat customers)
Goal of 600 units is achieved
(non electric heat customers)

Energy Savings	=	6,147 MWh
Demand Reduction	=	2,007 kW
		(@ system winter peak)
	=	432 kW
		(@ system summer peak)

10. **COST / BENEFIT ANALYSIS**

Benefit/cost ratios based upon the best information available at the time of program design.

a.	Total Resource Cost	=	0.83
b.	Ratepayer Impact Measure	=	0.37
c.	Participant	=	N/A *
d.	Utility Cost	=	0.83

* Not applicable because of no participant costs.

C. RESIDENTIAL: Compact Fluorescent Bulbs

1. DESCRIPTION

Kentucky Power will implement a program to promote energy-efficient lighting technology to residential customers. To encourage customers to purchase compact fluorescent bulbs (CFBs) as replacements for incandescents, a financial incentive will be offered to offset the cost differential. The program will be delivered in a manner that is user-friendly, encourages participation, and is easily administered. The program may utilize, but is not limited to, mail-in rebate, instant rebate, and/or discount mail order as a delivery mechanism.

2. RATIONALE FOR PROGRAM

Because the purchase price of CFBs is considerably higher than standard bulbs, customers are reluctant to purchase CFBs even though economics clearly show a benefit to utilizing these bulbs. This program will educate customers about the benefits of CFBs as replacements for traditional incandescents. For example, the same level of light output can be attained at less wattage, thus reducing energy consumption and lowering the customer's electric bill. In addition, the life of the CFB exceeds that of a standard incandescent, which encourages their use as an energy-conservation measure.

3. PARTICIPATION GOALS

Nov. 1995 through Oct. 1996	1,000 bulbs
Nov. 1996 through Oct. 1997	1,000 bulbs
Nov. 1997 through Oct. 1998	1,000 bulbs
TOTAL	3,000 BULBS

4. ELIGIBLE CUSTOMERS

Residential retail customers in Kentucky Power's service territory are eligible for participation.

5. INCENTIVES

The financial incentive per bulb may vary based on the delivery mechanism being used. The amount of the incentive may be adjusted by KPC to ensure cost effectiveness as well as to manage program participation.

6. IMPLEMENTATION PLAN

a. Promotion

The primary vehicle for promotion of the program will be bill inserts/brochures and store/office displays. The Company may also utilize limited media advertising.

b. Delivery

KPC will work with manufacturers, retail outlets, and/or energy service companies to provide mail-in rebates, instant rebates, and/or discount mail order.

c. Quality Assurance

The program will be regularly reviewed by Company staff responsible for managing the program's operation, as well as the Collaborative residential customer class sub-group.

d. Evaluation

A detailed evaluation plan will outline key research issues relating to the impact and process evaluations to be performed, along with the evaluation objectives, data collection procedures, and evaluation methodologies to be used, the evaluation schedule, reporting timelines, cost estimation, and a preliminary cost/benefit analysis.

The program evaluation objectives are as follows:

(1) Assess participant satisfaction (compact fluorescent bulb performance, price, delivery mechanism, etc.);

(2) Assess effectiveness of program delivery mechanism, including the efficiency of program operation and promotional efforts and recommendations on program changes;

(3) Gain insight into market potential (customer awareness, participant characteristics, participation rate);

(4) Determine the program load impact, including the energy savings and demand reduction, as well as freeridership, persistence, and snap-back effect; and

(5) Assess program cost effectiveness based on various economic tests.

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation:		
First Report	11/95	05/97 to 07/97
Second Report	11/96	05/98 to 07/98
Third Report	11/97	05/99 to 07/99

8. ANNUAL BUDGET

	Year 1	Year 2	Year 3
Promotion	$ 2,000	$ 2,000	$2,000
Expenses / Incentives	5,000	5,000	5,000
Evaluation	3,000	3,000	3,000
TOTAL COSTS	$10,000	$10,000	$10,000

9. EXPECTED SAVINGS / BENEFITS

a. Anticipated Load Impact Per Participant:

All Customers:

Energy Savings Per Year = 78 kWh
Demand Reduction = .01 kW
(@ system winter peak)
= .01 kW
(@ system summer peak)

b. Annual Expected Program Savings/Benefits (including T&D losses) @ 1,000 bulbs per year):

Summer Peak Demand (kW) Reduction	Winter Peak Demand (kW) Reduction	Annual Energy (MWh) Reduction
9	9	68

Projected energy savings and demand reductions are estimated based on the anticipated number of installations of various types of energy-efficient measures. These estimated effects of freeriders are included.

c. Projected Program MWh Savings and kW Reduction Assuming Participation (including T&D losses):

Goal of 3,000 units is achieved (all customers)

Energy Savings	=	205 MWh
Demand Reduction	=	27 kW
		(@ system winter peak)
	=	27 kW
		(@ system summer peak)

10. **COST / BENEFIT ANALYSIS**

Benefit/cost ratios based on the best information available at the time of program design.

a.	Total Resource Cost	=	2.00
b.	Ratepayer Impact Measure	=	0.52
c.	Participant	=	3.51
d.	Utility Cost	=	3.00

D. RESIDENTIAL: High-Efficiency Heat Pump

1. DESCRIPTION

Kentucky Power will offer a financial incentive to HVAC dealers to encourage the installation of high-efficiency heat pumps for replacement of less efficient electric heating systems.

2. RATIONALE FOR PROGRAM

The high-efficiency heat pump program is designed to reduce residential electric energy consumption by replacing older, less efficient electric heating systems with high-efficiency heat pumps. Advanced technology has increased the efficiency of heat pump systems, resulting in higher energy savings and a greater demand reduction. This program is appropriate, as it helps keep electric bills lower for all customers and allows Kentucky Power to utilize its existing generating capacity more efficiently, thereby deferring the need for new generation as well as conserving our country's valuable natural resources.

3. PARTICIPATION GOALS

	Resistance Heat	Non-Resistance Heat
Nov. 1995 thru Oct. 1996	500	500
Nov. 1996 thru Oct. 1997	500	500
Nov. 1997 thru Oct. 1998	500	500

4. ELIGIBLE CUSTOMERS

Residential retail customers in Kentucky Power service territory who currently utilize an electric central heating and cooling system (or plan to install a cooling system) are eligible to participate. Dealers installing qualifying equipment in the homes of customers as outlined above will be eligible to receive the incentive.

5. INCENTIVES

Kentucky Power will offer the HVAC dealer a financial incentive according to predetermined guidelines based on the efficiency (cooling SEER, heating HSPF) of the installed unit. The incentive will be structured to encourage ultra-high efficiency units (SEER greater than or equal to 12.5; HSPF greater than or equal to 8.0).

6. IMPLEMENTATION PLAN

a. Promotion

Kentucky Power will develop relationships with trade allies (i.e., manufacturers, dealers, and contractors) in order to promote high-efficiency heat pump technology. Media advertising, such as newspaper, radio, television, and billboard, may also be used. A co-op advertising program may be offered to trade allies where the Company would share the cost of advertisements promoting high-efficiency heat pumps.

b. Delivery

Kentucky Power representatives will work in conjunction with trade allies to promote high-efficiency heat pumps in place of less efficient electric heating systems.

c. Quality Assurance

The program will be regularly reviewed by Company staff responsible for the program as well as the Company's DSM Collaborative residential customer class sub-group. The Company will maintain communication with trade allies as well as respond to any customer inquiries. A selected sample of installations will be inspected to verify quality of installation.

d. Evaluation

A detailed evaluation plan will outline key research issues relating to the impact and process evaluations to be performed, along with the evaluation objectives, data collection procedures, and evaluation methodologies to be used, the evaluation schedule, reporting timelines, cost estimation, and a preliminary cost/benefit analysis.

The program evaluation objectives are as follows:

(1) Assess participant satisfaction on the heat pump's operation, service performed by the contractor, company representative, and the program as a whole;

(2) Gain insight into the market potential, including the participant characteristics, participation rate, and customer awareness of high-efficiency heat pumps;

(3) Determine the program load impact, including the energy savings and demand reduction as well as freeridership and snap-back effect;

(4) Assess the effectiveness of the program delivery mechanism, including the efficiency of the program operation and marketing efforts and recommendations on program changes; and

(5) Assess the program cost-effectiveness based on various economic tests.

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation:		
First Report	11/95	05/97 to 10/97
Second Report	11/96	05/98 to 10/98
Third Report	11/97	05/99 to 10/99

8. ANNUAL BUDGET

	Year 1	Year 2	Year 3
Expenses	$75,000	$75,000	$75,000
Evaluation	14,000	14,000	14,000
TOTAL COSTS	$89,000*	$89,000*	$89,000*

* Split equally between resistance and non-resistance heat customers.

9. EXPECTED SAVINGS / BENEFITS

a. Anticipated Load Impact Per Participant:

Electric Resistance Heating Replacement Customers:

Energy Savings Per Year = 3,500 kWh
Demand Reduction = 2.34 kW
(@ system winter peak)
= 0.50 kW
(@ system summer peak)

Electric Heat Pump Replacement Customers:

Energy Savings Per Year	=	1,250 kWh
Demand Reduction	=	0.99 kW (@ system winter peak)
	=	0.50 kW (@ system summer peak)

b. Annual Expected Program Savings/Benefits (including T&D losses) @ 1,000 participants per year):

Summer Peak Demand (kW) Reduction	Winter Peak Demand (kW) Reduction	Annual Energy (MWh) Reduction
361	1,201	1,698

Projected energy savings and demand reductions are estimated based on the anticipated number of installations of various types of energy-efficient measures. The estimated effects of freeriders are included.

c. Projected Program MWh Savings and kW Reduction Assuming Participation (including T&D losses):

Goal of 3,000 units is achieved

Energy Savings	=	5,095 MWh
Demand Reduction	=	3,604 kW (@ system winter peak)
	=	1,082 kW (@ system summer peak)

10. COST / BENEFIT ANALYSIS

Benefit/cost ratios based on the best information available at the time of program design.

a.	Total Resource Cost	=	1.31
b.	Ratepayer Impact Measure	=	0.84
c.	Participant	=	1.51
d.	Utility Cost	=	8.92

E. RESIDENTIAL: High-Efficiency Heat Pump -- Mobile Home

1. DESCRIPTION

Kentucky Power will provide an incentive to customers to replace existing electric central furnaces with high-efficiency heat pump systems. Participants also must have an air conditioning system or plan to install one.

2. RATIONALE FOR PROGRAM

The high-efficiency heat pump program is designed to reduce residential electric energy consumption by replacing older, less efficient electric heating systems with high-efficiency heat pumps. Advanced technology has increased the efficiency of heat pump systems, resulting in higher energy savings and a greater demand reduction. This program is appropriate, as it helps keep electric bills lower for all customers and allows Kentucky Power to utilize its existing generating capacity more efficiently, thereby deferring the need for new generation as well as conserving our country's valuable natural resources.

3. PARTICIPATION GOALS

	Customers
Nov. 1995 thru Oct. 1996	300
Nov. 1996 thru Oct. 1997	300
Nov. 1997 thru Oct. 1998	300

4. ELIGIBLE CUSTOMERS

Residential retail customers in Kentucky Power service territory who currently utilize electric heating and cooling systems (or plan to install a cooling system) are eligible to participate.

5. INCENTIVES

Kentucky Power will offer the customer a financial incentive to replace the existing electric heating equipment with a high-efficiency heat pump.

6. IMPLEMENTATION PLAN

a. Promotion

Kentucky Power will develop relationships with trade allies (i.e., manufacturers, dealers, contractors, architects, and engineers) in order to promote high-efficiency heat pump technology. Media advertising, such as newspaper, radio, television, and billboard, may also be used. A co-op advertising program may be offered to trade allies where the Company would share the cost of advertisements promoting high-efficiency heat pumps.

b. Delivery

Kentucky Power representatives will work in conjunction with trade allies to promote high-efficiency heat pumps in place of less efficient electric heating systems.

c. Quality Assurance

The program will be regularly reviewed by Company staff responsible for the program as well as the Company's DSM Collaborative residential customer class sub-group. They will maintain communication with trade allies as well as respond to any customer inquiries. A sample of installations may be inspected to verify quality of installation.

d. Evaluation

A detailed evaluation plan will outline key research issues relating to the impact and process evaluations to be performed, along with the evaluation objectives, data collection procedures, and evaluation methodologies to be used, the evaluation schedule, reporting time-lines, cost estimation, and a preliminary cost/benefit analysis.

The program evaluation objectives are as follows:

(1) Assess participant satisfaction on the heat pump's operation, service performed by the contractor, company representative, and the program as a whole;

(2) Gain insight into the market potential, including the participant characteristics, participation rate, and customer awareness of high-efficiency heat pumps;

(3) Determine the program load impact, including the energy savings and demand reduction, as well as freeridership and snap-back effect;

(4) Assess the effectiveness of the program delivery mechanism, including the efficiency of the program operation and marketing efforts and recommendations on program changes; and

(5) Assess the program cost-effectiveness based on various economic tests.

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation:		
First Report	11/95	05/97 to 10/97

Evaluation (con't):

Second Report	11/96	05/98 to 10/98
Third Report	11/97	05/99 to 10/99

8. **ANNUAL BUDGET**

	Year 1	Year 2	Year 3
Expenses	$150,000	$150,000	$150,000
Evaluation	13,000	13,000	13,000
TOTAL COSTS	$163,000	$163,000	$163,000

9. **EXPECTED SAVINGS / BENEFITS**

a. Anticipated Load Impact Per Participant:

Electric Resistance Heating Replacement Customers:

Energy Savings Per Year = 3,085 kWh
Demand Reduction = 1.84 kW
(@ system winter peak)
= 0.47 kW
(@ system summer peak)

b. Annual Expected Program Savings/Benefits (including T&D losses) @ 300 participants per year):

Summer Peak Demand (kW) Reduction	Winter Peak Demand (kW) Reduction	Annual Energy (MWh) Reduction
110	429	713

Projected energy savings and demand reductions are estimated based on the anticipated number of installations of various types of energy-efficient measures. The estimated effects of freeriders are included.

c. Projected Program MWh Savings and kW Reduction Assuming Participation (including T&D losses):

Goal of 900 units is achieved

Energy Savings	=	2,138 MWh
Demand Reduction	=	1,287 kW
		(@ system winter peak)
	=	329 kW
		(@ system summer peak)

10. COST / BENEFIT ANALYSIS

Benefit/cost ratios based on the best information available at the time of program design.

a.	Total Resource Cost	=	1.68
b.	Ratepayer Impact Measure	=	0.55
c.	Participant	=	2.78
d.	Utility Cost	=	1.65

F. RESIDENTIAL: Mobile Home New Construction Program

1. DESCRIPTION

During the first year of this program, Kentucky Power Company or an outside vendor ("Contractor") will study the market for new mobile homes in the utility's service area for the purpose of determining the energy implications of current design and installation practices. In addition, KPC/AEPSC or Contractor will analyze the cost-effectiveness of a range of energy-related mobile home design options and will attempt to determine the level of financial incentives that would be needed to cause energy-efficiency features to be included in mobile homes. During Years 2 and 3, KPC/AEPSC will develop educational programs to boost the market demand for energy-efficient mobile homes. In addition, if the market analysis identifies cost-effective incentives that can enhance the energy efficiency of mobile homes offered for sale in the utility's service area, the Collaborative will develop a proposed budget for targeted incentives for consideration by the Public Service Commission.

2. RATIONALE FOR PROGRAM

In the Kentucky Power service territory, a significant percentage of all new residential construction consists of manufactured homes, also known as HUD-code or mobile homes. The goal of this program will be to help transform the market for such homes to the extent that a higher percentage of new manufactured homes sold in the area contain optimum levels of cost-effective energy efficiency design and construction features. In order to accomplish this goal, the Collaborative will work with all the parties involved in the distribution chain: manufacturers, distributors, installers, developers, lending institutions, and home buyers.

3. ELIGIBLE CUSTOMERS

Residential retail customers in Kentucky Power service territory who are in the market for newly constructed mobile homes. In addition, educational activities/ programs may be directed to mobile home manufacturers and/or dealers.

4. IMPLEMENTATION PLAN

a. Promotion

Kentucky Power will develop relationships with trade allies (i.e., manufacturers, dealers, and contractors) in order to determine what would be necessary to transform this market. Findings may lead to the development of a program of targeted incentives.

b. Delivery

Kentucky Power representatives will work in conjunction with trade allies to promote the manufacturing of more energy-efficient mobile homes.

c. Quality Assurance

The program will be regularly reviewed by Company staff responsible for the program as well as the Company's DSM Collaborative residential customer class sub-group. The Company will maintain communication with trade allies as well as respond to any customer inquiries.

d. Evaluation

The evaluation will consist of a market analysis for further implementation of the program and will be performed by the Contractor with input from KPC/AEPSC.

The program evaluation objectives are as follows:

(1) Gain insight into the market potential, including the participant characteristics, participation rate, and customer awareness;

(2) Determine the program's projected load impact, including the energy savings and demand reduction; and

(3) Assess the effectiveness of the program delivery mechanism, including the efficiency of the program operation and marketing efforts and recommendations on program changes.

5. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation	11/95	10/99

6. ANNUAL BUDGET

	Year 1	Year 2	Year 3
Contract Services	$10,000		
Evaluation	3,000	$ 3,000	$ 3,000
Public Information/ Education and/or Incentives	10,000	17,000	17,000
TOTAL COSTS	$23,000	$20,000	$20,000

7. EXPECTED SAVINGS / BENEFITS

SPECIAL NOTE:

Because the Mobile Home New Construction Program is considered an educational tool for the customer, expected savings cannot be reasonably determined; therefore, a comprehensive cost/benefit analysis cannot be performed.

IV. COMMERCIAL PROGRAM DESIGN DOCUMENTS

See following pages for design documents.

A. COMMERCIAL: SMART Audit

1. DESCRIPTION

The SMART Audit Program is designed to provide a mechanism to assist commercial customers in identifying the measures that can be implemented into their operation to improve overall energy efficiency. Through this program, Kentucky Power offers the services of an energy consultant to perform an energy assessment of a facility's energy-consuming equipment. A detailed analysis is provided to the customer that discusses specific measures the customer can adopt, such as:

* lighting
* refrigeration
* heating/cooling systems
* ventilation
* motors
* water heating
* cooking equipment
* process heating.

SMART Audit could also be available to new construction by auditing the design plans and identifying energy-saving measures.

<u>Class 1 Analysis</u>

Customers receiving this level of analysis will generally be smaller commercial customers. This level of analysis is intended to be a walk-through survey to identify opportunities for energy efficiency, with the findings and recommendations normally presented during the same visit. This analysis will be a standardized checklist approach. In some cases, a further detailed engineering analysis of the energy-conserving measures may be recommended. The customer will not be charged for this analysis.

Class 2 Analysis

Customers receiving this level of analysis will generally be larger commercial customers. Kentucky Power will cover at least fifty percent (50%) of the audit cost, depending on the size of customer, determined by peak demand over the past year. For the larger commercial customers, an audit fee will be negotiated with each customer. KPC will reimburse the customer's contribution of the audit cost when:

1. The customer has implemented enough of the cost-effective measures to achieve at least half of the potential peak load reduction estimated by the analysis; and

2. These measures have been implemented within two years of the analysis.

It is anticipated that these commercial customers will realize a payback less than or equal to five (5) years (measured in projected dollar savings) on their investment in these energy conservation measures.

A Company representative will verify the implementations upon notification from the customer. The customer may combine this program with the SMART Financing Program offered by the Company.

2. RATIONALE FOR PROGRAM

The program is designed to educate commercial customers about energy and demand savings that can be realized from the implementation of energy-efficient technologies and cost-effective measures. The SMART Audit identifies specific measures which may be implemented by customers to achieve additional energy savings which, if implemented, should result in improved energy efficiency, as well as potential monetary savings for the customer.

3. PARTICIPATION GOALS

	Class 1	Class 2	Total Customers
Nov. 1995 thru Oct. 1996	250	50	300
Nov. 1996 thru Oct. 1997	250	50	300
Nov. 1997 thru Oct. 1998	250	50	300

4. ELIGIBLE CUSTOMERS

All existing commercial accounts with at least one (1) full year of billing history, located within Kentucky Power's service territory, are eligible for this program. SMART Audit could also be available to new construction by auditing the design plans and identifying energy-saving measures.

5. INCENTIVES

Kentucky Power is providing a no-cost/low-cost service to its commercial customers to encourage implementation of the SMART Audit. By incorporating the suggested measures, customers have the opportunity to reduce operating costs and become more competitive in their businesses.

6. IMPLEMENTATION PLAN

a. Promotion

Kentucky Power will present the SMART Audit Program to its commercial customers through: personal contact from company representatives; targeted program mailings; seminars; or response to specific customer inquiries.

b. Delivery

Upon inquiry or contact, a Kentucky Power representative will screen a customer to determine eligibility. The representative will contact the eligible customer to provide a program overview, including an information packet. The customer must then complete an application and submit it, accompanied by the customer fee, if applicable. Once the application is approved, the energy consultant will be notified to schedule an audit. After the audit, the energy consultant will provide a detailed report of the data collected (with recommendations) to the customer, as well as Kentucky Power. The customer, upon review of the report, has the responsibility to determine which recommendations, if any, to implement. Kentucky Power representatives will.work with the customer to assist in the implementation of the measures recommended.

c. Evaluation

Evaluation of program effectiveness regarding process evaluation, the program delivery mechanism, customer satisfaction, and market potential will be conducted. The major program evaluation objectives are as follows:

(1) Determine the level of satisfaction of program participants with the program, the audit, and the measures;

(2) Determine the effectiveness of program marketing and delivery systems and implementation of recommendations;

(3) Examine the planning, administration, management, communication links, and delivery mechanisms;

(4) Identify barriers to program participation and reasons for non-participation; and

(5) Gain insight into customer perceptions and priorities.

Information will be gathered from the facility energy auditor, as well as from satisfaction surveys of each audit participant and one-on-one interviews with a small number of participants, non-participants, and dropouts, where appropriate. Interviews of marketing representatives and staff will be conducted.

Because the SMART Audit Program is considered an educational tool for the customer, a detailed impact evaluation is not planned. However, the Company will identify participants by facility type and end-use and aggregate the opportunities identified by the audit.

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation	11/95	10/99

8. ANNUAL BUDGET

	Year 1	Year 2	Year 3
Contract Services*	$180,000	$180,000	$180,000
Evaluation	10,000	10,000	10,000
TOTAL COSTS	$190,000	$190,000	$190,000

* Some customer contributions may supplement the cost of their Class II analysis. Projected expenses for Classes I and II analyses are flexible between classes. Actual expenditures between classes will not exceed annual budgetary requirements.

9. COST / BENEFIT ANALYSIS

SPECIAL NOTE:

Accurate estimates of the load impacts and energy savings resulting from this proposed energy analysis program cannot be made at this time. As participating customers implement energy efficiency measures and these are verified, however, it will become more feasible over time to estimate program impacts and cost/benefit results.

B. COMMERCIAL: SMART Financing

1. DESCRIPTION

The SMART Financing Program is designed to assist commercial customers in making energy-efficient improvements to their facilities. The program creates an easy entrance into conservation and efficiency improvements for businesses while requiring an expenditure and commitment on the part of the customer who will benefit most. Kentucky Power will reduce the financial barriers to the implementation of energy efficiency measures by providing a streamlined process for obtaining energy efficiency loans, by offering cash rebates and/or buying down the interest rate faced by customers wishing to finance agreed-upon measures. These cost-effective measures may include, but are not limited to:

* lighting
* refrigeration
* heating/cooling systems
* ventilation
* motors
* process heating
* cooking equipment
* water heating.

Recognizing that there are significant opportunities for cost-effective energy-related modifications that can be made during the process of designing and constructing new commercial buildings, and that many of these opportunities may be lost as key decision points are passed by, the market for commercial new construction in the KPC service territory will be studied during the first year of the program. An attempt will be made to develop ways to bring energy efficiency information to the attention of key decision makers at the appropriate points during the design process. In addition, if the market analysis identifies cost-effective incentives that can encourage energy efficient design of new commercial buildings, the Collaborative will develop a proposed budget for targeted incentives for consideration by the Public Service Commission.

If appropriate, Kentucky Power may offer a rebate in lieu of the financing. With Company approval, the customer may utilize this program as a follow-up to the SMART Audit Program; however, the two programs may be utilized independently.

2. RATIONALE FOR PROGRAM

Two of the most common barriers preventing businesses from implementing energy-efficient improvements are the limited availability of up-front capital and long payback periods. This program will help overcome those obstructions by providing rebates or lower interest loans for cost-effective energy-efficient measures.

3. PARTICIPATION GOALS

	Existing Bldg	New Bldg	Total Customers
Nov. 1995 thru Oct. 1996	139	0	139
Nov. 1996 thru Oct. 1997	170	4	174
Nov. 1997 thru Oct. 1998	184	4	188

4. ELIGIBLE CUSTOMERS

All existing commercial accounts with at least one (1) full year of billing history, located within Kentucky Power's service territory, are eligible for this program. SMART Financing could also be available to new construction by auditing the design plans and identifying energy-saving measures.

5. INCENTIVES

Through this program, the customer will receive assistance in the financing of energy-efficient measures that will reduce operating costs and can result in a more profitable business.

6. IMPLEMENTATION PLAN

a. <u>Promotion</u>

Kentucky Power will present the SMART Financing Program to its commercial customers through: personal contact from company representatives; targeted program mailings; seminars; or response to specific customer inquiries.

b. <u>Delivery</u>

KPC will make arrangements with one or more financial institutions for the provision of standardized energy efficiency loans to qualifying commercial customers. The objective will be to streamline the procedure for obtaining financing and minimize the transaction costs (i.e., time, management attention) faced by customers when seeking loans to improve their businesses' energy efficiency.

Using the results of a SMART Audit, an energy audit performed by an outside party, or generally accepted energy estimation methods, the customer will fill out an application form listing those energy efficiency measures that the customer would be willing to implement if given an incentive. KPC will estimate the value of each measure in terms of its effect on the utility's peak load. The customer will qualify for an incentive if one or more of the measures offer the utility sufficient load reduction potential to pass a screening test.

In order to avoid lost opportunities, KPC will offer a higher incentive for implementing a complete package of energy efficiency measures than the sum of the incentives offered for the individual measures. Once KPC and the customer have reached agreement on the measures to be implemented and the incentives associated with them, KPC will give the customer a choice as to whether to receive the incentives in the form of a cash rebate or an interest rate buydown.

c. Quality Assurance

KPC representatives will be communicating with the participants to allow opportunity for feedback about the operation and the effectiveness of the program.

d. Evaluation

The program evaluation objectives are as follows:

(1) Assess participant satisfaction with energy-efficient technologies of measures installed, the service performed by the contractors, marketing representatives, and the program as a whole;

(2) Assess the effectiveness of the program delivery mechanism, including the efficiency of program operation and marketing efforts;

(3) Gain insight into market potential, including the participant and non-participant characteristics, participation rate, and customer awareness;

(4) Determine the program load impact, including the energy savings and demand reduction; measure persistence, snap-back effect, and free ridership; and

(5) Assess program cost-effectiveness based on the standard economic tests.

Information will be gathered from the input of contractors (facility energy auditors and installation contractors) as well as through quality-control surveys, customer demographic and baseline information surveys, customer billing histories, customer follow-up surveys, and load research and/or potentially end-use metering. Program evaluation will include process evaluation, market evaluation, and impact evaluation based on engineering algorithms and/or statistical models (billing analysis).

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation	11/95	10/99

8. ANNUAL BUDGET

	Year 1	Year 2	Year 3
Incentives (Rebates/Interest Buydowns)	$220,000	$286,100	$320,500
Evaluation	30,000	30,000	30,000
TOTAL COSTS	$250,000 *	$316,100 **	$350,500 ***

* Total cost expenditures are 100% existing buildings.

** Total cost expenditures consist of $12,100 new buildings and $304,000 existing buildings.

*** Total cost expenditures consist of $12,500 new buildings and $338,000 existing buildings.

9. EXPECTED PROGRAM SAVINGS / BENEFITS

Year	Summer Peak Demand (kW) Reduction	Winter Peak Demand (kW) Reduction	Annual Energy (MWh) Reduction
95/96	0	760	3,600
96/97	1,240	1,700	7,730
97/98	2,230	2,630	11,150

Projected energy savings and demand reductions are estimated based on the anticipated number of installations of various types of energy-efficient lighting, refrigeration, heating/cooling system, ventilation, motor, cooking, and process and/or water heating measures in the average commercial building. The estimated effects of freeriders and T&D losses are included.

The projected annual program effects at the end of the three-year period are an energy savings of 12,200 MWh and peak winter and summer demand reductions of 2,725 kW and 2,735 kW, respectively.

10. COST / BENEFIT ANALYSIS

a. Total Resource Cost = 1.9

b. Ratepayer Impact Measure = 0.5

c. Participant = 3.0

d. Utility Cost = 3.7

V. INDUSTRIAL PROGRAM DESIGN DOCUMENTS

See following pages for design documents.

A. INDUSTRIAL: SMART Audit

1. DESCRIPTION

The SMART Audit Program is designed to provide a mechanism to assist industrial customers in identifying the measures that can be implemented into their operation to improve overall energy efficiency. Through this program, Kentucky Power offers the services of an energy consultant to perform an energy audit of a facility's energy-consuming equipment. A detailed audit report is provided to the customer that discusses specific measures the customer can adopt, such as:

* lighting
* refrigeration
* heating/cooling systems
* ventilation
* motors
* water heating
* cooking equipment
* process heating
* compressed air systems.

SMART Audit could also be available to new construction by auditing the design plans and identifying energy-saving measures.

<u>Class 1 Analysis</u>

Customers receiving this level of analysis will generally be smaller industrial customers. This level of analysis is intended to be a walk-through survey to identify opportunities for energy efficiency, with the findings and recommendations normally presented during the same visit. This analysis will be a standardized checklist approach. In some cases, a further detailed engineering analysis of the energy-conserving measures may be recommended. No customer contribution would be required for this analysis.

Class 2 Analysis

Customers receiving this level of analysis will generally be larger industrial customers. Kentucky Power will cover at least fifty percent (50%) of the audit cost, depending on the size of customer, determined by peak demand over the past year. For the larger commercial customers, an audit fee will be negotiated with each customer. KPC will reimburse the customer's contribution of the audit cost when:

1. Implemented measures as a result of the audit have met at least half of the total anticipated load reduction; and

2. These measures have been implemented within two years of the audit.

It is anticipated that these industrial customers will realize a five-year payback (measured in projected dollar savings) on their investment in these energy conservation measures.

A Company representative will verify the implementations upon notification from the customer. The customer may combine this program with the SMART Financing Program offered by the Company.

2. RATIONALE FOR PROGRAM

The program is designed to educate industrial customers about energy and demand savings that can be realized from the implementation of energy-efficient technologies and cost-effective measures. The SMART Audit identifies specific measures which may be implemented by customers to achieve additional energy savings which, if implemented, should result in improved profitability for the customer.

3. PARTICIPATION GOALS

	Class 1	Class 2	Total Customers
Nov. 1995 thru Oct. 1996	105	25	130
Nov. 1996 thru Oct. 1997	105	25	130
Nov. 1997 thru Oct. 1998	105	25	130

4. ELIGIBLE CUSTOMERS

All industrial accounts with at least one (1) full year of billing history, located within Kentucky Power's service territory, are eligible for this program. Industrial customers who receive DSM benefits must remain in the Kentucky Power Company DSM Program for the full three years.

5. INCENTIVES

Kentucky Power is providing a no-cost/low-cost service to its industrial customers to encourage implementation of the SMART Audit's recommendations (measured in projected dollar savings). By incorporating the suggested measures, customers have the opportunity to reduce operating costs and become more competitive in their businesses.

6. IMPLEMENTATION PLAN

a. Promotion

Kentucky Power will present the SMART Financing Program to its industrial customers through: personal contact from company representatives; targeted program mailings; seminars; or response to specific customer inquiries.

b. Delivery

Upon inquiry or contact, a Kentucky Power representative will screen a customer to determine eligibility. The representative will contact the eligible customer to provide a program overview, including an information packet. The customer must then complete an application and submit it, accompanied by the customer fee, if applicable. Once the application is approved, the energy consultant will be notified to schedule an audit. After the audit, the energy consultant will provide a detailed report of the data collected (with recommendations) to the customer. The customer, upon review of the report, has the responsibility to determine which recommendations, if any, to implement.

c. Evaluation

Evaluation of program effectiveness regarding process evaluation, the program delivery mechanism, customer satisfaction, and market potential will be conducted. The major program evaluation objectives are as follows:

(1) Determine the level of satisfaction of program participants with the program, the audit, and the measures;

(2) Determine the effectiveness of program marketing and delivery systems and implementation of recommendations;

(3) Examine the planning, administration, management, communication links, and delivery mechanisms;

(4) Identify barriers to program participation and reasons for non-participation; and

(5) Gain insight into customer perceptions and priorities.

Information will be gathered from the facility energy auditor, as well as from satisfaction surveys of each audit participant and one-on-one interviews with a small number of participants, non-participants, and dropouts, where appropriate. Interviews of marketing representatives and staff will be conducted.

Because the SMART Audit Program is considered an educational tool for the customer, a detailed impact evaluation is not planned. However, the Company will identify participants by facility type and end-use and aggregate the opportunities identified by the audit.

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation	11/95	10/99

8. ANNUAL BUDGET

	Year 1	Year 2	Year 3
Contract Services*	$220,000	$220,000	$220,000
Evaluation	20,000	20,000	20,000
TOTAL COSTS**	$240,000	$240,000	$240,000

* Customer contributions will supplement audit expenses.

** Annual total cost expenditures will consist of $62,500 Class I expenses and $177,500 Class II expenses.

9. COST / BENEFIT ANALYSIS

SPECIAL NOTE:

Because the SMART Audit Program is considered an educational tool for the customer, kWh savings cannot be reasonably determined; therefore, a comprehensive cost/benefit analysis cannot be performed at this time.

B. INDUSTRIAL: SMART Financing

1. DESCRIPTION

The SMART Financing Program is designed to assist industrial customers in making energy-efficient improvements to their facilities. The program creates an easy entrance into conservation and efficiency improvements for businesses while requiring an expenditure and commitment on the part of the customer who will benefit most. Kentucky Power will assist customers in overcoming the barrier of limited up-front capital by buying down the interest at participating financial institutions for lower interest loans for a maximum of five years for approved energy-efficient upgrades. These cost-effective measures may include, but are not limited to:

* lighting
* refrigeration
* heating/cooling systems
* ventilation
* motors
* process heating
* cooking equipment
* water heating
* compressed air systems.

If appropriate, Kentucky Power may offer a rebate in lieu of the financing. With Company approval, the customer may utilize this program as a follow-up to the SMART Audit Program; however, the two programs may be utilized independently.

2. RATIONALE FOR PROGRAM

Two of the most common barriers preventing businesses from implementing energy-efficient improvements are the limited availability of up-front capital and long payback periods. This program will help overcome those obstructions by providing lower interest loans for cost-effective energy-efficient measures.

3. PARTICIPATION GOALS

	Total Customers
Nov. 1995 through Oct. 1996	36 *
Nov. 1996 through Oct. 1997	48 **
Nov. 1997 through Oct. 1998	60 ***

* Includes one (1) compressed air system

** Includes three (3) compressed air systems

*** Includes four (4) compressed air systems

4. ELIGIBLE CUSTOMERS

All industrial accounts with at least one (1) full year of billing history, located within Kentucky Power's service territory, are eligible for this program. Industrial customers who receive DSM benefits must remain in the Kentucky Power Company DSM Program for the full three years.

5. INCENTIVES

Through this program, the customer receives special lower interest financing for energy-efficient measures that will reduce operating costs and result in a more profitable business.

6. IMPLEMENTATION PLAN

a. Promotion

Kentucky Power will present the SMART Financing Program to its industrial customers through: personal contact from company representatives; targeted program mailings; seminars; or response to specific customer inquiries.

b. <u>Delivery</u>

KPC will make arrangements with one or more financial institutions for the provision of standardized energy efficiency loans to qualifying commercial customers. The objective will be to streamline the procedure for obtaining financing and minimize the transaction costs (i.e., time, management attention) faced by customers when seeking loans to improve their businesses' energy efficiency.

Using the results of a SMART Audit, an energy audit performed by an outside party, or generally accepted energy estimation methods, the customer will fill out an application form listing those energy efficiency measures that the customer would be willing to implement if given an incentive. KPC will estimate the value of each measure in terms of its effect on the utility's peak load. The customer will qualify for an incentive if one or more of the measures offer the utility sufficient load reduction potential to pass a screening test.
In order to avoid lost opportunities, KPC will offer a higher incentive for implementing a complete package of energy efficiency measures than the sum of the incentives offered for the individual measures. Once KPC and the customer have reached agreement on the measures to be implemented and the incentives associated with them, KPC will give the customer a choice as to whether to receive the incentives in the form of a cash rebate or an interest rate buydown.

c. <u>Quality Assurance</u>

KPC representatives will be communicating with the participants to allow opportunity for feedback about the operation and the effectiveness of the program.

d. Evaluation

The program evaluation objectives are as follows:

(1) Assess participant satisfaction with energy-efficient technologies of measures installed, the service performed by the contractors, marketing representatives, and the program as a whole;

(2) Assess the effectiveness of the program delivery mechanism, including the efficiency of program operation and marketing efforts;

(3) Gain insight into market potential, including the participant and non-participant characteristics, participation rate, and customer awareness;

(4) Determine the program load impact, including the energy savings and demand reduction; measure persistence, snap-back effect, and freeridership; and

(5) Assess program cost-effectiveness based on standard economic tests.

Information will be gathered from the input of contractors (facility energy auditors and installation contractors) as well as through quality-control surveys, customer demographic and baseline information surveys, customer billing histories, customer follow-up surveys, and load research and/or potentially end-use metering. Program evaluation will include process evaluation, market evaluation, and impact evaluation based on engineering algorithms and/or statistical models (billing analysis).

7. TIMELINE

Action	Start	End
Program Approval	08/95	10/95
Implementation	11/95	10/98
Evaluation	11/95	10/99

8. ANNUAL BUDGET

	Year 1	Year 2	Year 3
Incentives / Rebates	$ 97,500	$133,500	$170,200
Evaluation	20,000	20,000	20,000
TOTAL COSTS	$117,500 *	$153,500 **	$190,200 ***

* Total cost expenditures include $116,000 Smart Financing-General and $1,500 Smart Financing-Compressed Air Systems.

** Total cost expenditures include $149,000 Smart Financing-General and $4,500 Smart Financing-Compressed Air Systems.

*** Total cost expenditures include $184,000 Smart Financing-General and $6,200 Smart Financing-Compressed Air Systems.

9. EXPECTED PROGRAM SAVINGS / BENEFITS

Year	Summer Peak Demand (kW) Reduction	Winter Peak Demand (kW) Reduction	Annual Energy (MWh) Reduction
95/96	0	250	1,490
96/97	440	610	3,350
97/98	850	1,060	5,710

EXPECTED PROGRAM SAVINGS/BENEFITS (CON'T.)

Projected energy savings and demand reductions are estimated based on the anticipated number of installations of various types of energy-efficient lighting, refrigeration, heating/cooling system, ventilation, motor, cooking, and process and/or water heating measures in the average industrial building. The estimated effects of freeriders and T&D losses are included.

The projected annual program effects at the end of the three-year period are an energy savings of 5,917 MWh and peak winter and summer demand reductions of 1,112 kW and 1,131 kW, respectively.

10. COST / BENEFIT ANALYSIS

a.	Total Resource Cost	=	1.6
b.	Ratepayer Impact Measure	=	0.6
c.	Participant	=	2.4
d.	Utility Cost	=	3.1

VI. INDUSTRIAL: SELF-DIRECTED PROVISION

Kentucky Power Company
1701 Central Avenue
P. O. Box 1428
Ashland, KY 41105-1428
606-327-1111

AEP KENTUCKY POWER

May 1, 1995

SUBJECT: Demand-Side Management Program

Dear Customer:

On July 14, 1994, a statute encouraging utility companies to offer DSM programs became effective in Kentucky. Pursuant to this statute, a utility is allowed to recover costs of its DSM programs from the customer class benefiting from the programs. However, the statute also provides that the Commission shall allow individual industrial customers "with energy intensive processes" to implement cost-effective measures in lieu of measures (and programs) offered by the utility if the alternative measures are not subsidized by other customer classes.

The purpose of this letter is to determine: (1) whether you would be eligible for the Demand-Side Management (DSM) programs sponsored by Kentucky Power Company for its industrial customers; or (2) if you are an energy intensive customer, you can implement your own DSM programs in lieu of Kentucky Power's DSM programs. If you participate in the programs, you will subject to a surcharge. If you choose to implement your own, you will not have the benefit of the programs offered by Kentucky Power.

Kentucky Power and representatives of various customer classes are currently developing a Demand-Side Management (energy conservation) plan. This initial plan, to be filed with Kentucky's Commission, will cover a three-year period, with an estimated start date of September 1, 1995. Some examples of programs could involve replacing existing equipment with high-efficiency equipment, such as high-efficiency and/or compact fluorescent lighting, electronic ballasts, HID (high-intensity discharge) lighting, and high-efficiency motors.

Two barriers that impede businesses from implementing such improvements are: (1) identifying the most appropriate improvements; and (2) lengthy payback. To assist in these areas, Kentucky Power is proposing programs that include:

>> SMART Audit — Energy audits of industrial facilities which recommend measures that could reduce your energy demand, as well as reduce operating costs.

>> SMART Financing — Provide lower-interest loans for cost-effective energy-efficient measures.

It is anticipated that the costs associated with these Company-offered industrial DSM programs would be recovered by means of an industrial sector DSM surcharge based on kilowatthour usage during the three-year period. Preliminary estimates indicate that the surcharge would be approximately $0.0005 per Kwh. This estimate, however, does not reflect the bill savings resulting from your participation in these programs. By implementing some of the energy-saving measures, in actuality, your monthly bill could decrease. Further, the primary benefit to all of us is that you would be helping Kentucky Power Company defer the need for new power plant construction, thereby keeping your future rates lower.

You may qualify for the Self-Directed Provision. This provision is explained in more detail in Attachment 1. We need a preliminary estimate of possible participation in this provision, therefore, we ask that you indicate your preference by completing Attachment 2 and returning it in the enclosed envelope by **May 15, 1995**. Your actual election of the self-directed provision must be made by **June 30, 1995**. If you need additional information, please feel free to contact Lois Kellogg at 606/327-3150.

Sincerely,

G. Michael Taylor

G. Michael Taylor
Marketing & Customer Information Director

dlj

Attachments

IMPORTANT NOTE: **IF YOU HAVE MORE THAN ONE ELECTRIC BILLING ACCOUNT WITH KENTUCKY POWER, YOU WILL NEED TO RESPONSE ON ATTACHMENT #2 FOR <u>EACH</u> ACCOUNT NUMBER INDIVIDUALLY. THIS IS NECESSARY SO THAT WE MAY ACCURATELY CODE YOUR ACCOUNTS FOR APPROPRIATE ASSESSMENT OF THE DSM SURCHARGE.**

ATTACHMENT 1

KENTUCKY POWER COMPANY
INDUSTRIAL CLASS SELF-DIRECTED PROVISION
DEMAND-SIDE MANAGEMENT (DSM) PROGRAMS

The General Assembly of the Commonwealth of Kentucky has enacted Statute KRS 278.285 effective July 14, 1994 which encourages utility companies to offer DSM programs. Pursuant to this statute, the utility is allowed to recover costs of its DSM programs from the customer class benefiting from the programs. However, the statute also provides that the Kentucky Public Service Commission shall allow individual industrial customers "with energy-intensive processes" to implement cost-effective DSM measures in lieu of measures (and programs) offered by the utility if the alternative measures are not subsidized by other customer classes.

Industrial customers with energy-intensive processes that elect to implement their own measures in lieu of Kentucky Power Company's sponsored programs will be referred to as electing the "Self-Directed Provision." **If approved for the Self-Directed Provision, the customer will not be assessed the DSM surcharge.** Such customers are subject to the following filing procedure and approval process:

Filing Procedure

The documentation for election of the "Self-Directed Provision" consists of:

- o Sworn affidavit which contains the measures that have been performed or are planned to be performed;
- o Estimates (where available) of the achieved or expected kW and kWh savings of each measure, as well as the total costs of each measure and timing of their installation;
- o If estimates not available, the reason the industrial customer believes that they have complied with KRS 278.290 (3) and qualify for the Self-Directed Provision; and
- o Notice of election of the Self-Directed Provision to cover the Kentucky Power Company's DSM plan.

Approval Process

- o The industrial customer is to indicate (by submission of Attachment 1) to Kentucky Power Company by May 15, 1995 whether or not they intend to elect the Self-Directed Provision.
- o Affidavit with supporting information (indicating the customer's election of the Self-Directed Provision) to be submitted to Kentucky Power Company for review and recommendation to the Kentucky Public Service Commission.
- o Consistent with KRS 278.290 (3), approval of the customer's election of the Self-Directed Provision is made by the Commission. Such approval will be considered in the development of the industrial sector DSM surcharge initally applied at the beginning of Kentucky Power's three-year plan. **If approved for the Self-Directed Provision, the customer will not be assessed the DSM surcharge.**
- o If a customer initially elects the Self-Directed Provision but later decides it wishes to participate in the Company-sponsored DSM programs, the customer should notify Kentucky Power Company sixty (60) days prior to the beginning of the second or third year of the three-year plan. With the Company's approval, the customer would then be eligible for the Company's programs and subject to the industrial surcharge beginning in either the second or third fiscal year of the Company's three-year plan, as appropriate.

ATTACHMENT 2

PLEASE RETURN THIS ATTACHMENT BY MAY 15, 1995.

Return to:

**Lois Kellogg
Kentucky Power Company
P. O. Box 1428
Ashland, KY 41105-1428**

CUSTOMER NAME ______________________________
ADDRESS ______________________________
____
____

CUSTOMER CONTACT ______________________________
PHONE NUMBER ______________________________

PLEASE INDICATE BY AN "X" IN THE APPROPRIATE SPACE BELOW (CHOOSE ONLY ONE):

____ **We choose to be eligible for the Company-sponsored DSM programs expected to be offered beginning in the latter part of 1995.**

OR

____ **We will be electing the "Self-Directed Provision" and will provide Kentucky Power Company with the required Affidavit and supporting information by June 30, 1995 which serves as our initial election of this provision.**

VII. COST RECOVERY

A. Background

On April 7, 1994 the Governor signed into law House Bill No. 501 which provides utilities the opportunity to propose Demand-Side Management (DSM) plans including a mechanism to recover the full costs of Commission-approved DSM programs and revenues lost by implementing these programs and to obtain financial incentives intended to encourage utilities to implement cost-effective DSM programs.

The Kentucky Public Service Commission, in its July 14, 1994 order (in Administrative Case No. 341), stated that, "We have concluded that the utilities should consider and pursue cost-effective DSM in the development of future resource plans just as they would consider any supply resources." House Bill No. 501 has given the Commission the statutory authority to establish cost-recovery mechanisms and financial incentives to encourage such DSM efforts.

Additionally, House Bill No. 501 encourages involvement of customer representatives as well as the Office of the Attorney General in the development of a utility's DSM plans. In light of this, Kentucky Power Company ("KPCo") began formal discussions with various customer group representatives to determine their interest in participating in a collaborative effort regarding DSM plans of the Company.

On March 10, 1995, the By-Laws of the Kentucky Power Company DSM Collaborative ("Collaborative") were adopted. Membership in the Collaborative is representative of a cross-section of various customer groups of the Company, thus representing a significant customer block in the Company's service territory.

The founding members of the Collaborative representing the <u>residential class</u> are: Kentuckians for the Commonwealth; Community Action Agencies Group; and the Kentucky Power Customers Alliance. The founding members of the Collaborative representing the <u>commercial class</u> are: Coleman Oil Company; Kentucky Tech Northeast Region; and Cedar Knoll Galleria. The Kentucky Industrial Utility Customers (KIUC) group is the founding member of the Collaborative representing the <u>industrial class</u>.

All classes are represented by the Office of the Attorney General and Kentucky Power Company, who are voting founding members. All classes are further represented by the Kentucky Division of Energy, American Electric Power Service Corporation, and the Kentucky Department of Education, who are non-voting members.

B. Cost Recovery of Three-Year DSM Experiment

All prudently incurred DSM costs should be fully recovered from ratepayers through inclusion in the annual surcharge. DSM program costs cover costs incurred in all aspects of a program, including planning, implementation, evaluation, and measurement.

The Collaborative has agreed to include the Targeted Energy Fitness Program (a low-income weatherization program) as an integral part of its DSM application. This program, standing alone, does not have a cost effectiveness ratio of one or greater on Kentucky Power's Total Resource Cost (TRC) model, as do other programs. However, this program is justified under the provisions of House Bill No. 501 as a collaboratively designed program which assures that programs are available and affordable for all customers, including customers who are usually non-participants in DSM programs. This program is part of an integrated residential package of programs. Its inclusion is supported by the fact that, taken as a whole, the residential program portfolio included in this plan passes the Kentucky Power TRC test, as do the commercial and industrial program portfolios of this three-year plan, as follows:

	TRC Benefit/Cost Ratio
Residential Program Portfolio	1.37[2]
Commercial Program Portfolio	1.90[3]
Industrial Program Portfolio	1.60[4]

[2]Based on the total residential programs excluding the Mobile Home New Construction Program.

[3]Based on the total commercial programs excluding the Commercial SMART Audit Program.

[4]Based on the total industrial programs excluding the Industrial SMART Audit Program.

While the recovery of the direct costs of DSM programs is essential, the recovery of these costs alone will not place demand-side options on par with supply-side options. KPCo believes that positive incentives, to be earned by KPCo commensurate with conservation achievements, and the recovery of net lost revenues[5] are necessary to place demand-side options on par with supply-side options.

Further, the federal standard on DSM, as set forth in Section III of the Public Utility Regulatory Policies Act as amended by Title I of the Energy Policy Act of 1992, requires that rates be set to achieve net income neutrality. Specifically:

> "*Net income neutrality* means, in the case of energy conservation measures undertaken by an investor-owned utility whose rates are regulated by a state utility regulatory authority, rates and charges established by the State utility regulatory authority that ensure that the net income earned by the utility on its State-jurisdictional equity investment will be *no lower* as a consequence of its expenditures on cost-effective qualified energy conservation measures and any associated lost sales than it would have been had the utility not made such expenditures, or that the State utility regulatory authority has implemented a ratemaking approach designed to meet this objective."

Without certification of net income neutrality from the Secretary of Energy, a utility is not eligible to apply for conservation bonus allowances that are available under the Clean Air Act Amendments of 1990. To provide clear support for net income neutrality, KPCo believes that recovery of not only direct program costs, but also net lost revenues and incentives, is appropriate. Also, House Bill No. 501 provides for recovery of the three components of DSM; i.e., program costs, net lost revenues, and incentives, when it indicates that the Commission may determine the reasonableness of DSM plans proposed by any utility by

[5]Net Lost Revenues (lost revenues) are defined as the net revenue (gross revenue minus variable cost) a utility would have expected to receive if it were not for the implementation of a given DSM program. Under this definition, a utility will experience "lost revenue" when it implements efficient DSM programs whose impacts were not reflected in its last base rate case.

considering as a factor in this determination the following:

> "A utility's proposal to recover in rates the full costs of demand-side management programs, any net revenues lost due to reduced sales resulting from demand-side management programs, and incentives designed to provide positive financial rewards to a utility to encourage implementation of cost-effective demand-side management programs. . . . "

Full and timely recovery of all costs associated with cost-effective DSM programs, including appropriate incentives, is a necessary component of the regulatory framework required to achieve the appropriate balance of demand-side and supply-side resources.

Therefore, for the Kentucky Power Company's Three-Year DSM Experiment, the Collaborative proposes an annual surcharge recovery mechanism, with over- and under-recovery accounting consisting of three sector surcharges, one each for residential, commercial, and industrial sectors to recover all three components of DSM noted in House Bill No. 501: direct program costs; net lost revenues; and an incentive. With regard to the incentive component, the Collaborative proposes a shared-savings incentive plan consisting of one of the following elements:

1. The **Efficiency Incentive**, defined as 15 percent of the estimated net savings associated with the programs. Estimated net savings calculated are based on the California Standard Practice Manual's definition of the Total Resource Cost (TRC) test; or

2. The **Maximizing Incentive**, defined as 5 percent of actual program expenditures.

The Efficiency Incentive encourages the Company to promote cost-effective conservation and load management programs with increased rewards provided for those programs which provide the greatest overall benefits as determined by the TRC test. KPCo will earn 15 percent of the estimated savings, with the remaining 85 percent benefiting all ratepayers.

The Maximizing Incentive encourages the Company to maintain a high level of program activity and provides an incentive for those programs which may not produce calculable net savings, such as informational programs.

Combining these two incentive components provides a well-balanced sliding-scale incentive mechanism. The Efficiency Incentive motivates the Company to spend monies on cost-effective conservation and load management programs, and the Maximizing Incentive motivates the Company to maintain a high level of activity and to properly inform as many customers as possible of the availability and benefits of the conservation and load management programs.

The Collaborative has agreed that for each program, the Company will receive either 15% shared savings if a program's savings can be measured or 5% of program expenditures if the program's savings cannot be measured. As shown on Exhibit C, the calculation of the proposed surcharge ranges, are incentives of $304,920 for residential, $278,528 for commercial, and $100,527 for industrial sectors for the three-year period, which include the efficiency incentive (15% shared savings per participant calculations shown on Page 5 of Exhibit C).

The proposed surcharge ranges calculated on Exhibit C also include estimated net lost revenues resulting from the DSM programs recommended herein for the three-year period based on the assumption that the current base rates remain in effect during that period.

Included in Exhibit C, the calculation of the proposed surcharge ranges, are net lost revenues of approximately $765,095 for residential, $662,870 for commercial, and $276,330 for industrial sectors for the three-year period based on the annual kWh savings for each program shown on Pages 2, 3, and 4 of Exhibit C. Surcharge recovery of net lost revenues is necessary to prevent the under-recovery of fixed costs until the next base rate case and to place demand-side options on a basis equivalent to supply-side options.

Also in Exhibit C are program expenses of approximately $2,991,000 for residential, $1,486,600 for commercial, and $1,181,200 for industrial sectors for the three-year period. Any additional costs for consultants and other outside entities retained by a customer class sub-group(s) shall be recovered only from that customer class sub-group(s). See also Pages 2, 3, and 4 of Exhibit C for the program costs by year for the three-year period.

If, in fact, KPCo files a base rate case and begins collecting new base rates that recognize the revenues lost as a result of DSM programs, then the lost kWh associated with these DSM programs would theoretically be reflected in the billing determinants used to establish those new base rates. Under those circumstances, continued surcharge recovery of net lost revenues would result in a double collection. Therefore, coincident with the implementation of new base rates, net lost revenues for the existing participants of KPCo's DSM programs will cease to be collected through the surcharge. However, if during the three-year period, there is no change in Kentucky Power's base rates, the Collaborative has agreed to a sunset provision with respect to net lost revenues. The sunset provision provides that the first year's net lost revenues will no longer be recovered in Year 4 absent a base rate case. The second year's net lost revenues would cease to be recovered in Year 5 absent a base rate case, and so forth.

By the offering of the Industrial Class Self-Directed Provision (see Section VI), Kentucky Power anticipates that industrial customers with energy-intensive processes will be encouraged to engage in cost-effective, energy-efficient improvements. For customers who elect this provision, the DSM surcharge will not be assessed. Such customers' related annual kWh usage estimated at 2,137,898,900 kWh is shown on Exhibit C, Page 6 (line titled "Less Opt-Out Customers kWh") for the industrial sector calculation of KWh Before Lost Revenue Impacts. The 2.1 billion kWh is based on the twelve months ended May 1995 usage. These customers have elected to expend funds to implement cost-effective measures directly into their own facilities in lieu of paying via the sector surcharge under which they could choose to (or not to) participate in the Company's DSM programs. This provision assists in the elimination of cross-subsidization within the industrial class, as do the sector surcharges assist to eliminate cross-subsidization between classes. Additionally, the provision addresses customer concerns regarding competition within their specific industry, while still promoting cost-effective DSM. On the other hand, because the Company has made this provision available, such customers exercising the option to participate in such programs are making a commitment to engage in cost-effective energy-efficient improvements which will benefit all customers through the deferral of future capacity additions.

C. Derivation of DSM Surcharge Factor Ranges

The Collaborative proposes three sector surcharges, one for residential customers allowing recovery of residential DSM program costs and associated net lost revenues and incentives; and similar surcharges for the commercial and industrial sectors recovering DSM program costs and associated net lost revenues and incentives for the three year period as shown on Exhibit C, Page 1. The sector surcharge factors (Exhibit C, page 1) were derived by dividing the Total Estimated Amount To Be Recovered by the Adjusted Estimated Sector KWh. The Adjusted Estimated Sector KWhs for the three-year period are calculated on Exhibit C, Page 6. This calculation reflects the DSM program load impact reductions and the effect of the industrial sector opt-out provision.

The Kentucky Power DSM Collaborative proposes in this proceeding a surcharge range for the three year period for each sector, since flexible surcharges within defined ranges provide the Company the ability to adjust the sector surcharges to avoid significant over- or under-recovery of the program components, and eliminate the need to accrue interest income/expense on deferred balances.

Once the surcharge factors are established, they will remain in effect for at least three months. The Collaborative proposes that these surcharges be effective for bills rendered on and after November 1, 1995. KPCo will notify the Kentucky Public Service Commission of any proposed changes in the level of the surcharge ten (10) days prior to implementation. See Exhibit G for an example of the information which will be filed ten (10) days prior to implementation.

In Year 1, the Collaborative proposes an initial surcharge factor of 0.000566 dollars per kWh for the residential sector. Further, the Collaborative proposes for the three-year period a range with a floor of 0.000000 dollars per kWh and a ceiling value of 0.001100 dollars per kWh for the residential sector. See Exhibit C, Page 1 for the calculation of the initial surcharge factor and the three-year range.

With respect to the commercial sector, in Year 1 the Collaborative proposes an initial surcharge factor of 0.000514 dollars per kWh. The Collaborative proposes for the three-year period a range with a floor of 0.000000 dollars per kwh and a ceiling value of 0.001300 dollars per kWh for the commercial sector. See Exhibit C, Page 1 for the calculation of the initial surcharge factor and the three-year range.

Lastly, with respect to the industrial sector, in Year 1 the initial surcharge factor would be 0.000490 dollars per kwh. Also, for the three-year period a range with a floor of 0.000000 dollars per kwh and a ceiling value of 0.001100 dollars per kwh would be used for the industrial sector. See Exhibit C, Page 1 for the calculation of the initial surcharge factor and the three-year range.

For each sector, the proposed initial surcharge factors for Years 2 and 3 (see Exhibit C, Page 1) are shown only for purposes of determining the proposed three-year surcharge range for each sector and do not necessarily reflect the surcharge which will be billed beginning in Years 2 and 3. As previously noted, the Company through its notification to the Commission will adjust the surcharge factors within the three-year range for each sector to minimize the over/under recovery balances.

The Collaborative requests the Kentucky Public Service Commission's approval of the Experimental Demand-Side Management Tariff as shown in Exhibit F.

D. Program Reconciliations

1. ANNUAL TRUE-UP

The Kentucky Power Company Collaborative will file its initial comprehensive reconciliation within three months following the conclusion of the first twelve months operation of the Plan. For Years 2 and 3 of the three-year plan, the Company will also file the comprehensive reconciliation within three months following the conclusion of that year's twelve months operation. This action will allow for timely review and reconciliation of KPCo's DSM programs conducted during the three-year plan. Each reconciliation will include the calculated over/under recovery balances of program costs, net lost revenues, and incentives as of the end of the program year. These balances will be rolled into the sector surcharges for the recovery period. If at the end of the three-year period the DSM experiment ceases, any over/under-recovery balances will be recovered over a period not to exceed six (6) months (see Exhibit G).

2. RECONCILIATION REPORTS

A detailed report covering all DSM programs will be submitted at the time of the reconciliation. The detailed report will include a comparison of actual versus estimated program costs, net lost revenues and incentives, number of participants, status on evaluation plans, and copies of any completed evaluations.

E. <u>Accounting for DSM Plan</u>

The accounting for Kentucky Power Company's Three-Year Demand-Side Management Experiment will be in accordance with the journal entries shown on Exhibit D. Section C of Exhibit D pertains to both the Maximizing and the Efficiency Incentive components.

VIII. PROGRAM MONITORING

The Collaborative will monitor the activity of each demand-side management program to ensure the best performance practicable.

A. Reporting

The Kentucky Power Demand-Side Management Collaborative will prepare an annual report. The purpose of the annual report is to provide basic descriptive information about the status of program implementation. Examples of data included in the report are: number of participants; number of measures installed; program costs; program progress; and estimated savings in kWh consumption.

Additionally, quarterly updates providing information about the status of program implementation will be reviewed by the Collaborative.

B. Evaluation

All programs will be assessed by the Collaborative to determine their benefits and costs according to detailed evaluation plans. These evaluation plans will be reviewed by an independent consultant, who will also provide comments to the Collaborative on the preliminary estimates of load impacts prepared for purposes of program design, initial net lost revenues, and initial shared savings calculations. Furthermore, the consultant may be retained to review post-installation impact evaluation results. Results of the assessments and evaluations will be available to interested parties.

Within the first eighteen months of the three-year plan, preliminary evaluation results for each DSM program will be reviewed by the Collaborative. With regard to the commercial and industrial SMART Financing programs, net lost revenues will be based on the summation of the estimated savings for measures implemented from individual customers' SMART Audits or customer-provided audits. Sample evaluations will be performed to determine the accuracy of the savings estimated in the audits. With Collaborative approval, the Company will retroactively adjust its initial engineering estimated values of the Efficiency Incentive and net lost revenue kWh impacts per participant (see Exhibit E) and apply such ex post updates prospectively. Any further ex post evaluation updates for a program approved by the Collaborative will be applied only prospectively. The Collaborative will notify the Commission of such updates.

C. Plan Modifications

The Collaborative agreed that once a program is established, the terms of the program may be changed only by unanimous consent of the customer sub-group which considered and/or created it. Such changes will be addressed during the quarterly Collaborative meetings.

The Collaborative will propose plan modifications in written documents submitted to the Commission for approval prior to the implementation of a significant change in the scope of a program. For example, a significant change would include the discontinuance of an ineffective program or the addition of a new cost-effective program.

IX. EXHIBITS

EXHIBIT A
PAGE 1 OF 4

KENTUCKY POWER COMPANY
PROJECTED DEMAND-SIDE MANAGEMENT PROGRAM EXPENSES
FOR THE 1995-96, 1996-97, AND 1997-98 PROGRAM YEARS

LINE	DESCRIPTION	1995-96 PROGRAM EXPENSES	1996-97 PROGRAM EXPENSES	1997-98 PROGRAM EXPENSES	TOTAL PROGRAM EXPENSES
1	DIRECT COSTS:				
2	CONTRACT SERVICES	$ 1,078,000	$ 1,068,000	$ 1,068,000	$ 3,214,000
3	PUBLIC INFORMATION/ EDUCATION AND/OR INCENTIVES	10,000	17,000	17,000	44,000
4	EXPENSES	225,000	225,000	225,000	675,000
5	PROMOTION	2,000	2,000	2,000	6,000
6	INCENTIVES/REBATES	97,500	133,500	170,200	401,200
7	EXPENSES/INCENTIVES	225,000	291,100	325,500	841,600
8	EVALUATION	159,000	159,000	159,000	477,000
	TOTAL DIRECT COSTS	$ 1,796,500	$ 1,895,600	$ 1,966,700	$ 5,658,800

EXHIBIT A
PAGE 2 OF 4

KENTUCKY POWER COMPANY
PROJECTED DEMAND-SIDE MANAGEMENT PROGRAM EXPENSES
FOR THE 1995-96 PROGRAM YEAR

	DESCRIPTION	ENERGY FITNESS	TARGETED ENERGY FITNESS	COMPACT FLUORESCENT BULBS	HIGH-EFFICIENCY HEAT PUMP	HIGH-EFFICIENCY HEAT PUMP - MOBILE HOME	MOBILE HOME NEW CONSTRUCTION PROGRAM	COMMERCIAL SMART AUDIT	COMMERCIAL SMART FINANCING	INDUSTRIAL SMART AUDIT	INDUSTRIAL SMART FINANCING	TOTAL
1	DIRECT COSTS:											
2	CONTRACT SERVICES	110,000	558,000				10,000	180,000		220,000		1,078,000
3	PUBLIC INFO/ EDUCATION AND/OR INCENTIVES						10,000					10,000
4	EXPENSES				75,000	150,000						225,000
5	PROMOTION			2,000								2,000
6	INCENTIVES/ REBATES										97,500	97,500
7	EXPENSES/ INCENTIVES			5,000					220,000			225,000
8	EVALUATION	11,000	35,000	3,000	14,000	13,000	3,000	10,000	30,000	20,000	20,000	159,000
9	TOTAL DIRECT COSTS	121,000	593,000	10,000	89,000	163,000	23,000	190,000	250,000	240,000	117,500	1,796,500
10	PROJECTED ACTIVITY	500	510	1,000	1,000	300	--	300	139	130	36	3,915

EXHIBIT A
PAGE 3 OF 4

KENTUCKY POWER COMPANY
PROJECTED DEMAND-SIDE MANAGEMENT PROGRAM EXPENSES
FOR THE 1996-97 PROGRAM YEAR

	DESCRIPTION	ENERGY FITNESS	TARGETED ENERGY FITNESS	COMPACT FLUORESCENT BULBS	HIGH-EFFICIENCY HEAT PUMP	HIGH-EFFICIENCY HEAT PUMP - MOBILE HOME	MOBILE HOME NEW CONSTRUCTION PROGRAM	COMMERCIAL SMART AUDIT	COMMERCIAL SMART FINANCING	INDUSTRIAL SMART AUDIT	INDUSTRIAL SMART FINANCING	TOTAL
1	DIRECT COSTS:											
2	CONTRACT SERVICES	110,000	558,000					180,000		220,000		1,068,000
3	PUBLIC INFO/ EDUCATION AND/OR INCENTIVES						17,000					17,000
4	EXPENSES				75,000	150,000						225,000
5	PROMOTION			2,000								2,000
6	INCENTIVES/ REBATES										133,500	133,500
7	EXPENSES/ INCENTIVES			5,000					286,100			291,100
8	EVALUATION	11,000	35,000	3,000	14,000	13,000	3,000	10,000	30,000	20,000	20,000	159,000
9	TOTAL DIRECT COSTS	121,000	593,000	10,000	89,000	163,000	20,000	190,000	316,100	240,000	153,500	1,895,600
10	PROJECTED ACTIVITY	500	510	1,000	1,000	300	--	300	174	130	48	3,962

EXHIBIT A
PAGE 4 OF 4

KENTUCKY POWER COMPANY
PROJECTED DEMAND-SIDE MANAGEMENT PROGRAM EXPENSES
FOR THE 1997-98 PROGRAM YEAR

	DESCRIPTION	ENERGY FITNESS	TARGETED ENERGY FITNESS	COMPACT FLUORESCENT BULBS	HIGH-EFFICIENCY HEAT PUMP	HIGH-EFFICIENCY HEAT PUMP - MOBILE HOME	MOBILE HOME NEW CONSTRUCTION PROGRAM	COMMERCIAL SMART AUDIT	COMMERCIAL SMART FINANCING	INDUSTRIAL SMART AUDIT	INDUSTRIAL SMART FINANCING	TOTAL
1	DIRECT COSTS:											
2	CONTRACT SERVICES	110,000	558,000					180,000		220,000		1,068,000
3	PUBLIC INFO/ EDUCATION AND/OR INCENTIVES						17,000					17,000
4	EXPENSES				75,000	150,000						225,000
5	PROMOTION			2,000								2,000
6	INCENTIVES/ REBATES										170,200	170,200
7	EXPENSES/ INCENTIVES			5,000					320,500			325,500
8	EVALUATION	11,000	35,000	3,000	14,000	13,000	3,000	10,000	30,000	20,000	20,000	159,000
9	TOTAL DIRECT COSTS	121,000	593,000	10,000	89,000	163,000	20,000	190,000	350,500	240,000	190,200	1,966,700
10	PROJECTED ACTIVITY	500	510	1,000	1,000	300	--	300	188	130	60	3,988

EXHIBIT B

KENTUCKY POWER COMPANY
PLAN SUMMARY: ACTIVITY, BUDGET, AND ENERGY SAVINGS

	FOR THE 3-YEAR PLAN		ANNUAL
PROGRAM	ACTIVITY PROPOSED	BUDGET PROPOSED	KWH SAVINGS PROPOSED
ENERGY FITNESS	1,500	363,000	4,439,000
TARGETED ENERGY EFFICIENCY	1,530	1,779,000	6,147,000
COMPACT FLUORESCENT BULB	3,000	30,000	205,000
HIGH-EFFICIENCY HEAT PUMP	3,000	267,000	5,095,000
HIGH-EFFICIENCY HEAT PUMP -- MOBILE HOME	900	489,000	2,138,000
MOBILE HOME NEW CONSTRUCTION	--	63,000	N/A
COMMERCIAL SMART AUDIT	900	570,000	N/A
COMMERCIAL SMART FINANCING	501	916,600	12,200,000
INDUSTRIAL SMART AUDIT	390	720,000	N/A
INDUSTRIAL SMART FINANCING *	144	461,200	5,917,000
TOTALS	11,865	5,658,800	36,141,000

* INCLUDES 8 COMPRESSED-AIR CUSTOMERS

KENTUCKY POWER COMPANY
DERIVATION OF 3 SECTOR SURCHARGES FOR 3 YR EXPERIMENT

FILE:xteehyr1.SSF
EXHIBIT C
PAGE 1 OF 6

RESIDENTIAL SECTOR	YEAR 1	YEAR 2	YEAR 3	TOTAL
PROGRAM EXPENSES	$999,000	$996,000	$996,000	$2,991,000
LOST REVENUES	$85,011	$255,032	$425,052	$765,095
INCENTIVES	$101,740	$101,590	$101,590	$304,920
TOTAL ESTIMATED AMOUNT TO BE RECOVERED	$1,185,751	$1,352,622	$1,522,642	$4,061,015
ADJ. ESTIMATED SECTOR KWH	2,096,778,650	2,116,204,450	2,134,634,750	
PROPOSED INITIAL SURCHARGE ($ PER KWH)	0.000566	0.000639	0.000713	
PROPOSED SURCHARGE RANGE ($ PER KWH) FLOOR	0.000000	0.000000	0.000000	
CEILING	0.001000	0.001000	0.001100	

COMMERCIAL SECTOR	YEAR 1	YEAR 2	YEAR 3	TOTAL
PROGRAM EXPENSES	$440,000	$506,100	$540,500	$1,486,600
LOST REVENUES	$65,712	$212,889	$384,269	$662,870
INCENTIVES	$79,881	$95,779	$102,868	$278,528
TOTAL ESTIMATED AMOUNT TO BE RECOVERED	$585,593	$814,768	$1,027,637	$2,427,998
ADJ. ESTIMATED SECTOR KWH	1,138,307,500	1,159,745,800	1,180,616,900	
PROPOSED INITIAL SURCHARGE ($ PER KWH)	0.000514	0.000703	0.000870	
PROPOSED SURCHARGE RANGE ($ PER KWH) FLOOR	0.000000	0.000000	0.000000	
CEILING	0.000900	0.001100	0.001300	

INDUSTRIAL SECTOR*	YEAR 1	YEAR 2	YEAR 3	TOTAL
PROGRAM EXPENSES	$357,500	$393,500	$430,200	$1,181,200
LOST REVENUES	$26,243	$85,679	$164,408	$276,330
INCENTIVES	$23,281	$35,126	$42,120	$100,527
TOTAL ESTIMATED AMOUNT TO BE RECOVERED	$407,024	$514,305	$636,728	$1,558,057
ADJ. ESTIMATED SECTOR KWH	831,005,200	866,324,700	902,136,500	
PROPOSED INITIAL SURCHARGE ($ PER KWH)	0.000490	0.000594	0.000706	
PROPOSED SURCHARGE RANGE ($ PER KWH) FLOOR	0.000000	0.000000	0.000000	
CEILING	0.000900	0.001000	0.001100	

	YEAR 1	YEAR 2	YEAR 3	TOTAL
TOTAL ESTIMATED AMOUNT TO BE RECOVERED	$2,178,368	$2,681,695	$3,187,007	$8,047,070

*Reflect industrial opt-outs with associated kwh usage of 2.1 billion kwh.

Kentucky Power Company
Estimated Sector Surcharges for 3 yr program

FILE:xteehyr2.SSF

EXHIBIT C
PAGE 2 OF 6

YEAR 1 PROGRAM DESCRIPTIONS	NEW PARTICIPANT NUMBER (1)	CUMULATIVE PARTICIPANT NUMBER (2)	TOTAL ESTIMATED PROGRAM COSTS PER PARTICIPANT (3)	TOTAL EST. PROGRAM COSTS (1)X(3)=(4)	NET LOST REV/YR (KWH/PARTIC) (5)	TOTAL ENERGY SAVINGS KWH/YR (2)X(5)=(6)	NET LOST REVENUE (CENTS/KWH) (7)	TOTAL NET LOST REVENUES (6)X(7)=(8)	EFFICIENCY INCENTIVE (EXH. C,PG5) (9)	MAXIMIZING INCENTIVE (5% of Costs) (4)X 5%=(10)	TOTAL INCENTIVE (9)+(10)=(11)	TOTAL EST. COSTS TO BE RECOVERED (4)+(8)+(11) (12)
RESIDENTIAL PROGRAMS												
Energy Fitness	500	250	$242.00	$121,000	2,690	672,500	$0.03114	$20,942	$39,110		$39,110	$181,052
Targeted Energy Fitness - All Electric	310	155	$1,812.26	$561,800	5,570	863,350	$0.03113	$26,876	$0	$28,090	$28,090	$616,766
- Non-All Electri	200	100	$156.00	$31,200	680	68,000	$0.03124	$2,124	$1,942		$1,942	$35,266
Compact Fluorescent Bulb	1,000	500	$10.00	$10,000	62	31,000	$0.03097	$960	$1,580		$1,580	$12,540
High-Efficiency Heat Pump-Resistance Ht	500	250	$89.00	$44,500	2,275	568,750	$0.03112	$17,700	$9,865		$9,865	$72,065
-Non Resistance Ht	500	250	$89.00	$44,500	813	203,250	$0.03114	$6,329	$8,345		$8,345	$59,174
High-Efficiency Heat Pump - Mobile Home	300	150	$543.33	$163,000	2,160	324,000	$0.03111	$10,080	$11,658		$11,658	$184,738
Mobile Home New Construction	0	0		$23,000	0	0				$1,150	$1,150	$24,150
TOTAL RESIDENTIAL PROGRAMS	3,310	1,655		$999,000		2,730,850		$85,011	$72,500	$29,240	$101,740	$1,185,751
COMMERCIAL PROGRAMS												
Smart Audit - Class 1	250	125	$220.00	$55,000	0	0			$0	$2,750	$2,750	$57,750
- Class 2	50	25	$2,700.00	$135,000	0	0			$0	$6,750	$6,750	$141,750
Smart Financing - Existing Building	139	70	$1,798.56	$250,000	22,000	1,540,000	$0.04267	$65,712	$70,381		$70,381	$386,093
Smart Financing - New Building	0	0		$0	30,600	0	$0.04267	$0	$0	$0	$0	$0
TOTAL COMMERCIAL PROGRAMS	439	220		$440,000		1,540,000		$65,712	$70,381	$9,500	$79,881	$585,593
INDUSTRIAL PROGRAMS (w/EST. OPT-OUTS REMOVED)												
Smart Audit - Class 1	105	53	$595.24	$62,500	0	0			$0	$3,125	$3,125	$65,625
Smart Audit - Class 2	25	13	$7,100.00	$177,500	0	0			$0	$8,875	$8,875	$186,375
Smart Financing - General	36	18	$3,222.22	$116,000	28,200	507,600	$0.04108	$20,852	$6,431		$6,431	$143,283
Smart Financing - Compressed Air System	1	1	$1,500.00	$1,500	164,800	164,800	$0.03271	$5,391	$4,850		$4,850	$11,741
TOTAL INDUSTRIAL PROGRAMS	166	84		$357,500		672,400		$26,243	$11,281	$12,000	$23,281	$407,024
Total Company	3,915	1,959		$1,796,500		4,943,250		$176,966	$154,162	$50,740	$204,902	$2,178,368

Kentucky Power Company
Estimated Sector Surcharges for 3 yr program

FILE:xteehyr2.ssf

EXHIBIT C
PAGE 3 OF 6

YEAR 2 PROGRAM DESCRIPTIONS	NEW PARTICIPANT NUMBER (1)	CUMULATIVE PARTICIPANT NUMBER (2)	TOTAL ESTIMATE PROGRAM COSTS PER PARTICIPAN (3)	TOTAL EST. PROGRAM COSTS (1)X(3)=(4)	NET LOST REV/YR (KWH/PARTIC) (5)	TOTAL ENERGY SAVINGS KWH/YR (2)X(5)=(6)	NET LOST REVENUE (CENTS/KWH) (7)	TOTAL NET LOST REVENUES (6)X(7)=(8)	EFFICIENCY INCENTIVE (EXH. C,PG5) (9)	MAXIMIZING INCENTIVE (5% of Costs) (4)X 5%=(10)	TOTAL INCENTIVE (9)+(10)=(11)	TOTAL EST. COSTS TO BE RECOVERED (4)+(8)+(11) (12)
RESIDENTIAL PROGRAMS												
Energy Fitness	500	750	$242.00	$121,000	2,690	2,017,500	$0.03114	$62,825	$39,110		$39,110	$222,935
Targeted Energy Fitness - All Electric	310	465	$1,812.26	$561,800	5,570	2,590,050	$0.03113	$80,628	$0	$28,090	$28,090	$670,518
- Non-All Electri	200	300	$156.00	$31,200	680	204,000	$0.03124	$6,373	$1,942		$1,942	$39,515
Compact Fluorescent Bulb	1,000	1500	$10.00	$10,000	62	93,000	$0.03097	$2,880	$1,580		$1,580	$14,460
High-Efficiency Heat Pump-Resistance Ht	500	750	$89.00	$44,500	2,275	1,706,250	$0.03112	$53,099	$9,865		$9,865	$107,464
-Non Resistance Ht	500	750	$89.00	$44,500	813	609,750	$0.03114	$18,988	$8,345		$8,345	$71,833
High-Efficiency Heat Pump - Mobile Home	300	450	$543.33	$163,000	2,160	972,000	$0.03111	$30,239	$11,658		$11,658	$204,897
Mobile Home New Construction	0	0		$20,000	0	0			$0	$1,000	$1,000	$21,000
TOTAL RESIDENTIAL PROGRAMS	3,310	4,965		$996,000		8,192,550		$255,032	$72,500	$29,090	$101,590	$1,352,622
COMMERCIAL PROGRAMS												
Smart Audit - Class 1	250	375	$220.00	$55,000	0	0			$0	$2,750	$2,750	$57,750
- Class 2	50	75	$2,700.00	$135,000	0	0			$0	$6,750	$6,750	$141,750
Smart Financing - Existing Building	170	224	$1,788.24	$304,000	22,000	4,928,000	$0.04267	$210,278	$86,078		$86,078	$600,356
Smart Financing - New Building	4	2	$3,025.00	$12,100	30,600	61,200	$0.04267	$2,611	$201		$201	$14,912
TOTAL COMMERCIAL PROGRAMS	474	676		$506,100		4,989,200		$212,889	$86,279	$9,500	$95,779	$814,768
INDUSTRIAL PROGRAMS (w/EST. OPT-OUTS REMOVED)												
Smart Audit - Class 1	105	158	$595.24	$62,500	0	0			$0	$3,125	$3,125	$65,625
Smart Audit - Class 2	25	38	$7,100.00	$177,500	0	0			$0	$8,875	$8,875	$186,375
Smart Financing - General	48	60	$3,104.17	$149,000	28,200	1,692,000	$0.04108	$69,507	$8,575		$8,575	$227,082
Smart Financing - Compressed Air System	3	3	$1,500.00	$4,500	164,800	494,400	$0.03271	$16,172	$14,551		$14,551	$35,223
TOTAL INDUSTRIAL PROGRAMS	178	256		$393,500		2,186,400		$85,679	$23,126	$12,000	$35,126	$514,305
Total Company	3,962	5,897		$1,895,600		15,368,150		$553,600	$181,905	$50,590	$232,495	$2,681,695

Kentucky Power Company
Estimated Sector Surcharges for 3 yr program

FILE:xteehyr2.ssf

EXHIBIT C
PAGE 4 OF 6

YEAR 3 PROGRAM DESCRIPTIONS	NEW PARTICIPANT NUMBER (1)	CUMULATIVE PARTICIPANT NUMBER (2)	TOTAL ESTIMATE PROGRAM COSTS PER PARTICIPAN (3)	TOTAL EST. PROGRAM COSTS (1)X(3)=(4)	NET LOST REV/YR (KWH/PARTIC) (5)	TOTAL ENERGY SAVINGS KWH/YR (2)X(5)=(6)	NET LOST REVENUE (CENTS/KWH) (7)	TOTAL NET LOST REVENUES (6)X(7)=(8)	EFFICIENCY INCENTIVE (EXH. C,PG5) (9)	MAXIMIZING INCENTIVE (5% of Costs) (4)X 5%=(10)	TOTAL INCENTIVE (9)+(10)=(11)	TOTAL EST. COSTS TO BE RECOVERED (4)+(8)+(11) (12)
RESIDENTIAL PROGRAMS												
Energy Fitness	500	1250	$242.00	$121,000	2,690	3,362,500	$0.03114	$104,708	$39,110		$39,110	$264,818
Targeted Energy Fitness - All Electric	310	775	$1,812.26	$561,800	5,570	4,316,750	$0.03113	$134,380	$0	$28,090	$28,090	$724,270
- Non-All Electri	200	500	$156.00	$31,200	680	340,000	$0.03124	$10,622	$1,942		$1,942	$43,764
Compact Fluorescent Bulb	1,000	2500	$10.00	$10,000	62	155,000	$0.03097	$4,800	$1,580		$1,580	$16,380
High-Efficiency Heat Pump-Resistance Ht	500	1250	$89.00	$44,500	2,275	2,843,750	$0.03112	$88,498	$9,865		$9,865	$142,863
-Non Resistance Ht	500	1250	$89.00	$44,500	813	1,016,250	$0.03114	$31,646	$8,345		$8,345	$84,491
High-Efficiency Heat Pump - Mobile Home	300	750	$543.33	$163,000	2,160	1,620,000	$0.03111	$50,398	$11,658		$11,658	$225,056
Mobile Home New Construction	0	0		$20,000	0	0		$0	$0	$1,000	$1,000	$21,000
TOTAL RESIDENTIAL PROGRAMS	3,310	8,275		$996,000		13,654,250		$425,052	$72,500	$29,090	$101,590	$1,522,642
COMMERCIAL PROGRAMS												
Smart Audit - Class 1	250	625	$220.00	$55,000	0	0			$0	$2,750	$2,750	$57,750
- Class 2	50	125	$2,700.00	$135,000	0	0			$0	$6,750	$6,750	$141,750
Smart Financing - Existing Building	184	401	$1,836.96	$338,000	22,000	8,822,000	$0.04267	$376,435	$93,167		$93,167	$807,602
Smart Financing - New Building	4	6	$3,125.00	$12,500	30,600	183,600	$0.04267	$7,834	$201		$201	$20,535
TOTAL COMMERCIAL PROGRAMS	488	1,157		$540,500		9,005,600		$384,269	$93,368	$9,500	$102,868	$1,027,637
INDUSTRIAL PROGRAMS (W/EST. OPT-OUTS REMOVED)												
Smart Audit - Class 1	105	263	$595.24	$62,500	0	0			$0	$3,125	$3,125	$65,625
Smart Audit - Class 2	25	63	$7,100.00	$177,500	0	0			$0	$8,875	$8,875	$186,375
Smart Financing - General	60	114	$3,066.67	$184,000	28,200	3,214,800	$0.04108	$132,064	$10,719		$10,719	$326,783
Smart Financing - Compressed Air System	4	6	$1,550.00	$6,200	164,800	988,800	$0.03271	$32,344	$19,401		$19,401	$57,945
TOTAL INDUSTRIAL PROGRAMS	190	440		$430,200		4,203,600		$164,408	$30,120	$12,000	$42,120	$636,728
Total Company	3,988	9,872		$1,966,700		26,863,450		$973,729	$195,988	$50,590	$246,578	$3,187,007

KENTUCKY POWER COMPANY
DERIVATION FOR 3 YEAR DSM EXPERIMENT
CALCULATION OF EFFICIENCY INCENTIVE

EXHIBIT C
PAGE 5 OF 6

PROGRAM DESCRIPTIONS	EFFICIENCY INCENTIVE $/PARTICIPANT	NEW PARTICIPANT NUMBER YEAR 1	YEAR 2	YEAR 3	EFFICIENCY INCENTIVES YEAR 1	YEAR 2	YEAR 3
RESIDENTIAL PROGRAMS							
Energy Fitness	$78.22	500	500	500	$39,110	$39,110	$39,110
Targeted Energy Fitness- All Electric	$0.00	310	310	310	$0	$0	$0
- Non-All Electric	$9.71	200	200	200	$1,942	$1,942	$1,942
Compact Fluorescent Bulb	$1.58	1,000	1,000	1,000	$1,580	$1,580	$1,580
High-Efficiency Heat Pump-Resistance Heat	$19.73	500	500	500	$9,865	$9,865	$9,865
-Non Resistance Ht	$16.69	500	500	500	$8,345	$8,345	$8,345
High-Efficiency Heat Pump - Mobile Home	$38.86	300	300	300	$11,658	$11,658	$11,658
Mobile Home New Construction	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TOTAL RESIDENTIAL PROGRAMS					$72,500	$72,500	$72,500
COMMERCIAL PROGRAMS							
Smart Audit - Class 1	$0.00	250	250	250	$0	$0	$0
Smart Audit - Class 2	$0.00	50	50	50	$0	$0	$0
Smart Financing - Existing Building	$506.34	139	170	184	$70,381	$86,078	$93,167
Smart Financing - New Building	$50.33	0	4	4	$0	$201	$201
TOTAL COMMERCIAL PROGRAMS					$70,381	$86,279	$93,368
INDUSTRIAL PROGRAMS							
Smart Audit - Class 1	$0.00	105	105	105	$0	$0	$0
Smart Audit - Class 2	$0.00	25	25	25	$0	$0	$0
Smart Financing - General	$178.65	36	48	60	$6,431	$8,575	$10,719
Smart Financing - Compressed Air System	$4,850.21	1	3	4	$4,850	$14,551	$19,401
TOTAL INDUSTRIAL PROGRAMS					$11,281	$23,126	$30,120
ANNUAL SHARED SAVINGS ($)					$154,162	$181,905	$195,988

File:A:\xteehyr4

KENTUCKY POWER COMPANY
FORECAST OF 1996-98 KENTUCKY RETAIL ENERGY SALES IN KWH
FOR RESIDENTIAL, COMMERCIAL AND INDUSTRIAL SECTORS

EXHIBIT C
PAGE 6 OF 6

PROGRAM YR 1 - 1996

LINE NO.	YEAR	RESIDENTIAL SECTOR	COMMERCIAL SECTOR	INDUSTRIAL SECTOR
1	TOTAL ULTIMATE SALES (KWH)*	2,109,000,000	1,145,000,000	2,983,000,000
2	LESS NON-METERED **	9,490,500	5,152,500	13,423,500
3	TOTAL ESTIMATED RETAIL KWH SALES	2,099,509,500	1,139,847,500	2,969,576,500
	LESS OPT - OUT CUSTOMERS KWH	0	0	2,137,898,900
	KWH BEFORE LOST REVENUE IMPACTS	2,099,509,500	1,139,847,500	831,677,600
	LOST REVENUE IMPACTS	2,730,850	1,540,000	672,400
	ADJUSTED KWH BY SECTOR	2,096,778,650	1,138,307,500	831,005,200

PROGRAM YR 2 - 1997

LINE NO.	YEAR	RESIDENTIAL SECTOR	COMMERCIAL SECTOR	INDUSTRIAL SECTOR
1	TOTAL ULTIMATE SALES (KWH)*	2,134,000,000	1,170,000,000	3,020,000,000
2	LESS NON-METERED **	9,603,000	5,265,000	13,590,000
3	TOTAL ESTIMATED RETAIL KWH SALES	2,124,397,000	1,164,735,000	3,006,410,000
	LESS OPT - OUT CUSTOMERS KWH	0	0	2,137,898,900
	KWH BEFORE LOST REVENUE IMPACTS	2,124,397,000	1,164,735,000	868,511,100
	LOST REVENUE IMPACTS	8,192,550	4,989,200	2,186,400
	ADJUSTED KWH BY SECTOR	2,116,204,450	1,159,745,800	866,324,700

PROGRAM YR 3 - 1998

LINE NO.	YEAR	RESIDENTIAL SECTOR	COMMERCIAL SECTOR	INDUSTRIAL SECTOR
1	TOTAL ULTIMATE SALES (KWH)*	2,158,000,000	1,195,000,000	3,058,000,000
2	LESS NON-METERED **	9,711,000	5,377,500	13,761,000
3	TOTAL ESTIMATED RETAIL KWH SALES	2,148,289,000	1,189,622,500	3,044,239,000
	LESS OPT - OUT CUSTOMERS KWH	0	0	2,137,898,900
	KWH BEFORE LOST REVENUE IMPACTS	2,148,289,000	1,189,622,500	906,340,100
	LOST REVENUE IMPACTS	13,654,250	9,005,600	4,203,600
	ADJUSTED KWH BY SECTOR	2,134,634,750	1,180,616,900	902,136,500

* SOURCE: PRELIMINARY 1995 LOAD FORECAST COMPILED BY AEP SYSTEM PLANNING DEPARTMENT.

** .45% ESTIMATED TO BE NON-METERED (OL) -- DETERMINED FROM BILLED JURISDICTIONAL TARIFF SUMMARY FOR 12 MOS. ENDED MAY 1995.

FILE:xteehyr3.SSF

KENTUCKY POWER COMPANY
PROPOSED ACCOUNTING FOR DSM PROGRAMS
BASED ON AN ANNUAL SURCHARGE RECOVERY MECHANISM

Assuming the conditions of the EITF Issue No. 92-7 are met, including the use of a tariff surcharge, the appropriate accounting journal entries for DSM Programs are listed below in three sections applicable to DSM program expenditures, net lost revenues and shared savings:

A. DSM Program Expenditures

DSM Program Expenditures will be charged to Account 908 - Customer Assistance Expense as incurred. In the month of incurrence, KPCo will record the following journal entries to defer the DSM expenditures and associated tax benefits:

(1)

Account No.	Description	Debit	Credit
182.3	Other Regulatory Assets - DSM Programs	$ xxx	
908	Customer Assistance Expense - DSM Programs		$ xxx
	To defer as a regulatory asset DSM Program expenditures for future recovery.		

(2)

Account No.	Description	Debit	Credit
410.1	Provision for Deferred Federal Income Taxes. Utility Operating Income	$ xxx	
283	Accum. Deferred Federal Income Taxes - Other		$ xxx
	To defer the current Federal Income Tax benefit on deferred DSM expenditures.		

As the DSM surcharge is billed to customers, KPCo will record the resulting revenues with the following monthly journal entry:

(3)

Account No.	Description	Debit	Credit
142	Customer Accounts Receivable	$ xxx	
456	Other Electric Revenues		$ xxx
	To record other electric revenues related to the recovery of DSM program expenditures resulting from the application of the DSM surcharge to customers' billings for the current month.		

Commensurate with the recovery of DSM program expenditures through rates, as recorded in journal entry (3), KPCo will record the following journal entries to amortize deferred DSM program expenditures and associated deferred taxes:

(4)

Account No.	Description	Debit	Credit
908	Customer Assistance Expense - DSM Programs	$ xxx	
182.3	Other Regulatory Assets - DSM Programs		$ xxx
	To amortize the deferred DSM program expenditures commensurate with their recovery in rates.		

(5)

Account No.	Description	Debit	Credit
283	Accum. Deferred Federal Income Taxes - Other	$ xxx	
411.1	Provision for Deferred Federal Income Taxes - Credit, Utility Operating Income		$ xxx
	To reverse the deferred taxes established on the deferred DSM program expenditures commensurate with their recovery in rates.		

B. DSM Net Lost Revenues

As DSM measures and services are delivered to program participants, KPCo will record the following journal entries to accrue a regulatory asset for the future recovery of DSM net lost revenues and associated deferred Federal income taxes:

(6)

Account No.	Description	Debit	Credit
182.3	Other Regulatory Assets - DSM Programs	$ xxx	
456	Other Electric Revenues		$ xxx
	To record a regulatory asset for future recovery in rates for net lost revenues related to DSM Programs.		

(7)

Account No.	Description	Debit	Credit
410.1	Provision for Deferred Federal Income Taxes, Utility Operating Income	$ xxx	
283	Accum. Deferred Federal Income Taxes - Other		$ xxx
	To accrue Federal income tax expense on the net lost revenues related to DSM Programs.		

As the DSM surcharge is billed to customers, KPCo will record the resulting revenues with the following monthly journal entry:

(8)

Account No.	Description	Debit	Credit
142	Customer Accounts Receivable	$ xxx	
456	Other Electric Revenues		$ xxx
	To record other electric revenues related to the recovery of DSM net lost revenues resulting from the application of the DSM surcharge to customers' billings for the current month.		

Commensurate with the recovery of DSM net lost revenues through rates, as recorded in journal entry (8), KPCo will record the following journal entries to reverse previously recorded net lost revenues and associated deferred taxes:

(9)

Account No.	Description	Debit	Credit
456	Other Electric Revenues	$ xxx	
182.3	Other Regulatory Assets - DSM Programs		$ xxx
	To reverse the deferred net lost revenues related to DSM Programs commensurate with their recovery in rates.		

(10)

Account No.	Description	Debit	Credit
283	Accum. Deferred Federal Income Taxes - Other	$ xxx	
411.1	Provision for Deferred Federal Income Taxes - Credit, Utility Operating Income		$ xxx
	To reverse the deferred Federal income taxes associated with the amortization of net lost revenues commensurate with their recovery in rates.		

C. DSM Shared Savings

As DSM measures and services are delivered to program participants, KPCo will record the following journal entries to accrue a regulatory asset for the future recovery of DSM shared savings and associated deferred Federal income taxes:

(11)

Account No.	Description	Debit	Credit
182.3	Other Regulatory Assets - DSM Programs	$ xxx	
456	Other Electric Revenues		$ xxx
	To record a regulatory asset for future recovery in rates for incentives related to DSM Programs.		

(12)

Account No.	Description	Debit	Credit
410.1	Provision for Deferred Federal Income Taxes, Utility Operating Income	$ xxx	
283	Accum. Deferred Federal Income Taxes - Other		$ xxx
	To accrue Federal income taxes associated with the recordation in Account 182.3 of a regulatory asset for future recovery in rates of shared savings related to DSM Programs.		

As the DSM surcharge is billed to customers, KPCo will record the resulting revenues with the following monthly journal entry:

(13)

Account No.	Description	Debit	Credit
142	Customer Accounts Receivable	$ xxx	
456	Other Electric Revenues		$ xxx
	To record other electric revenues related to the recovery of DSM shared savings resulting from the application of the DSM surcharge to customers' billings for the current month.		

Commensurate with the recovery of DSM shared savings through rates, as recorded in journal entry (13), KPCo will record the following journal entries to reverse previously recorded shared savings and associated deferred taxes:

(14)

Account No.	Description	Debit	Credit
456	Other Electric Revenues	$ xxx	
182.3	Other Regulatory Assets - DSM Programs		$ xxx
	To reverse the deferred shared savings related to DSM Programs commensurate with their recovery in rates.		

(15)

Account No.	Description	Debit	Credit
283	Accum. Deferred Federal Income Taxes - Other	$ xxx	
411.1	Provision for Deferred Federal Income Taxes - Credit, Utility Operating Income		$ xxx
	To reverse deferred Federal income taxes associated with the amortization of shared savings commensurate with their recovery in rates.		

EXHIBIT E

KENTUCKY POWER COMPANY
DERIVATION FOR THREE-YEAR DSM EXPERIMENT
COLLABORATIVE AGREED UPON INITIAL VALUES

PROGRAM DESCRIPTIONS	EFFICIENCY INCENTIVE $/PARTICIPANT *	MAXIMIZING INCENTIVE ##	NET LOST REVENUE/YEAR KWH/PARTICIPANT **	NET LOST REVENUES $/KWH #
RESIDENTIAL				
Energy Fitness	78.22	N/A	2,690	0.03114
Targeted Energy Efficiency				
- All Electric	0.00	SEE ##	5,570	0.03113
- Non All Electric	9.71	N/A	680	0.03124
Compact Fluorescent Bulb	1.58	N/A	62	0.03097
High-Efficiency Heat Pump				
- Resistance Heat	19.73	N/A	2,275	0.03112
- Non Resistance Heat	16.69	N/A	813	0.03114
High-Efficiency Heat Pump - Mobile Home	38.86	N/A	2,160	0.03111
Mobile Home New Construction	N/A	SEE ##	N/A	N/A
Commercial				
SMART Audit -- Class 1	N/A	SEE ##	N/A	N/A
SMART Audit -- Class 2	N/A	SEE ##	N/A	N/A
SMART Financing -- Existing Building	506.34	N/A	22,000	0.04267
SMART Financing -- New Building	50.33	N/A	30,600	0.04267
Industrial				
SMART Audit -- Class 1	N/A	SEE ##	N/A	N/A
SMART Audit -- Class 2	N/A	SEE ##	N/A	N/A
SMART Financing -- General	178.65	N/A	28,200	0.04108
SMART Financing -- Compressed Air System	4,850.21	N/A	164,800	0.03271

* Efficiency incentive defined as 15% of estimated net savings based on the TRC test.

** These annual kWh per participant values reflect (exclude) the estimated effects of freeriders in each program.

\# Net lost revenues per kWh where net revenues are defined as gross revenues minus variable costs based on the company's current rates in effect.

\#\# The maximizing incentive is defined as 5% of actual program costs.

EXPERIMENTAL DEMAND-SIDE MANAGEMENT ADJUSTMENT CLAUSE
(Tariff Experimental D.S.M.C.)

N

APPLICABLE.

To Tariffs R.S., R.S.-L.M.-T.O.D., Experimental R.S.-T.O.D., S.G.S., M.G.S., Experimental M.G.S.-T.O.D., L.G.S., Q.P., C.I.P.-T.O.D., I.R.P., and M.W.

RATE.

1. The Demand-Side Management (DSM) clause shall provide for periodic adjustment per kwh of sales equal to the DSM costs per kwh by customer sector according to the following formula:

$$\text{Adjustment Factor} = \frac{DSM\ (c)}{S\ \ (c)}$$

Where DSM is the cost by customer sector of demand-side management programs, net lost revenues, incentives, and any over/under recovery balances; (c) is customer sector; and S is the adjusted KWH sales by customer sector.

2. Demand-side Management (DSM) costs shall be the most recent forecasted cost plus any over/under recovery balances recorded at the end of the previous period.

   a. Program costs are any costs the Company incurred associated with demand-side management which were approved by the Kentucky Power Company DSM Collaborative. Examples of costs to be included are contract services, allowances, promotion, expenses, evalulation, lease expense, etc. by customer sector.

   b. Net lost revenues are the calculated net lost revenues by customer sector resulting from the implementation of the DSM programs.

   c. Incentives are a shared-savings incentive plan consisting of one of the following elements: The efficiency incentive which is defined as 15 percent of the estimated net savings associated with the programs. Estimated net savings are calculated based on the California Standard Practice Manual's definition of the Total Resources Cost (TRC) test, or the maximizing incentive which is defined as 5 percent of actual program expenditures if program savings cannot be measured.

   d. Over/under recovery balances are the total of the differences between the following:

      (i) the actual program costs incurred versus the program costs recovered through the DSM adjustment clause, and

      (ii) the calculated net lost revenues realized versus the net lost revenues recovered through the DSM adjustment clause, and

      (iii) the calculated incentive to be recovered versus the incentive recovered through the DSM adjustment clause.

3. Sales (S) shall be the total ultimate KWH sales by customer sector less non-metered, opt-out and lost revenue impact KWHs by customer sector.

4. The provisions of the Experimental Demand-Side Management Adjustment Clause will be effective for at least three years, but in no event beyond May 31, 1999.

5. The DSM adjustment shall be filed with the Commission ten (10) days before it is scheduled to go into effect, along with all the necessary supporting data to justify the amount of the adjustments which shall include data and information as may be required by the Commission.

(Cont'd on Sheet No. 22-2)

DATE OF ISSUE September 27, 1995 DATE EFFECTIVE November 1, 1995

ISSUED BY E. K. Wagner E. K. WAGNER ACCOUNTING, RATES & PLANNING DIRECTOR ASHLAND, KENTUCKY
NAME TITLE ADDRESS

KENTUCKY POWER COMPANY

ORIGINAL SHEET NO. 22-2
CANCELLING SHEET NO.

P.S.C. ELECTRIC NO. 6

EXPERIMENTAL DEMAND-SIDE MANAGEMENT ADJUSTMENT CLAUSE, continued
(Tariff Experimental D.S.M.C.)

6. Copies of all documents required to be filed with the Commission under this regulation shall be open and made available for public inspection at the office of the Public Service Commission pursuant to the provisions of KRS 61.870 to 61.884.

7. The resulting range for each customer sector per KWH during the three-year Experimental Demand-Side Management Plan is as follows:

		CUSTOMER SECTOR		
		RESIDENTIAL ($ Per KWH)	COMMERCIAL ($ Per KWH)	INDUSTRIAL ($ Per KWH)
Floor Factor	=	.000000	.000000	.000000
Ceiling Factor	=	.001100	.001300	.001100

8. The initial DSM Adjustment Clause factor ($ per KWH) for each customer sector which fall within the range defined in Item 7 above is as follows:

	CUSTOMER SECTOR		
	RESIDENTIAL	COMMERCIAL	INDUSTRIAL
DSM (c) / S (c)	$ 1,185,751 / 2,096,778,650	$ 585,593 / 1,138,307,500	$ 407,024 / 831,005,200
Initial Adjustment Factor =	$ .000566	$ .000514	$ .000490

DATE OF ISSUE September 27, 1995 DATE EFFECTIVE November 1, 1995

ISSUED BY E. K. WAGNER ACCOUNTING, RATES & PLANNING DIRECTOR ASHLAND, KENTUCKY
NAME TITLE ADDRESS

Kentucky Power Company
DSM Adjustment Clause Schedule
($ per KWH)

A. Residential

DSM Cost Schedule ($)	1,185,751	
Sales Schedule (KWH)	2,096,778,650	
Proprosed Rate		0.000566
Floor Rate		0.000000
Celing Rate		0.001100

B. Commercial

DSM Cost Schedule ($)	585,593	
Sales Schedule (KWH)	1,138,307,500	
Proposed Rate		0.000514
Floor Rate		0.000000
Celing Rate		0.001300

C. Industrial

DSM Cost Schedule ($)	407,024	
Sales Schedule (KWH)	831,005,200	
Proposed Rate		0.000490
Floor Rate		0.000000
Celing Rate		0.001100

Effective Date for Billing: November 1, 1995

Summitted By: ______________________________

Title: Accounting, Rates, and Planning Director

Date Sumitted: ______________________________

Kentucky Power Company
DSM Recoverable Costs Schedule
For Period: Nov, 1, 1995 through Oct. 31, 1996
($)

Line #			
	Residential Class:		
	A. Forcasted Costs:		
1	Program Expenditures	999,000	
2	Net Lost Revenues	85,011	
3	Incentives	101,740	
4	Sub-Total	1,185,751	
5	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	0	
6	Total DSM Recoverable Cost (line 4 - 5)		1,185,751
	Commercial Class:		
	A. Forcasted Costs:		
7	Program Expenditures	440,000	
8	Net Lost Revenues	65,712	
9	Incentives	79,881	
10	Sub-Total	585,593	
11	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	0	
12	Total DSM Recoverable Cost (line 10 - 11)		585,593
	Industrial Class:		
	A. Forcasted Costs:		
13	Program Expenditures	357,500	
14	Net Lost Revenues	26,243	
15	Incentives	23,281	
16	Sub-Total	407,024	
17	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	0	
18	Total DSM Recoverable Cost (line 16 - 17)		407,024

Kentucky Power Company
DSM KWH Sales Schedule
For Period: Nov. 1, 1995 through Oct. 31, 1996

Line #			
	Residential Class:		
1	Total Ultimate Sales	2,109,000,000	
2	Less: Non Metered	9,490,500	
3	Total Estimated Retail Sales	2,099,509,500	
4	Lost Revenue Impact	2,730,850	
5	Adjusted Sales		2,096,778,650
	Commercial Class:		
6	Total Ultimate Sales	1,145,000,000	
7	Less: Non Metered	5,152,500	
8	Total Estimated Retail Sales	1,139,847,500	
9	Lost Revenue Impact	1,540,000	
10	Adjusted Sales		1,138,307,500
	Industrial Class:		
11	Total Ultimate Sales	2,983,000,000	
12	Less: Non Metered	13,423,500	
13	Total Estimated Retail Sales	2,969,576,500	
14	Less: Opt-Out Sales	2,137,898,900	
15	Sales Before Lost Revenue Impact	831,677,600	
16	Lost Revenue Impact	672,400	
17	Adjusted Sales		831,005,200

Kentucky Power Company
Over/(Under) Recovery Schedule
Balances as of Oct. 31, 1995 *
($)

Line #		Actual Recoveries (1)	Actual Expenditures (2)	Over/(Under) Recovery (1-2) (3)
	Residential Class:			
1	Program Expenditures	0	0	0
2	Net Lost Revenues	0	0	0
3	Incentives	0	0	0
4	Total	0	0	0
	Commercial Class:			
5	Program Expenditures	0	0	0
6	Net Lost Revenues	0	0	0
7	Incentives	0	0	0
8	Total	0	0	0
	Industrial Class:			
9	Program Expenditures	0	0	0
10	Net Lost Revenues	0	0	0
11	Incentives	0	0	0
12	Total	0	0	0

* The 3-year DSM plan is proposed to commence on 11/01/95.

Kentucky Power Company
DSM Adjustment Clause Schedule
($ per KWH)

A. Residential

DSM Cost Schedule ($)		1,351,702	
Sales Schedule (KWH)		2,116,204,450	
	Proprosed Rate		0.000639
	Floor Rate		0.000000
	Celing Rate		0.001100

B. Commercial

DSM Cost Schedule ($)		856,140	
Sales Schedule (KWH)		1,159,745,800	
	Proposed Rate		0.000738
	Floor Rate		0.000000
	Celing Rate		0.001300

C. Industrial

DSM Cost Schedule ($)		305,295	
Sales Schedule (KWH)		866,324,700	
	Proposed Rate		0.000352
	Floor Rate		0.000000
	Celing Rate		0.001100

Effective Date for Billing: Dec. 1, 1996

Summitted By: ______________________

Title: Accounting, Rates, and Planning Director

Date Sumitted: ______________________

Period 2

Kentucky Power Company
DSM Recoverable Costs Schedule
For Period: Nov. 1, 1996 through Oct. 31, 1997
($)

Line #			
	Residential Class:		
	A. Forcasted Costs:		
1	Program Expenditures	996,000	
2	Net Lost Revenues	255,032	
3	Incentives	101,590	
4	Sub-Total	1,352,622	
5	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	920	
6	Total DSM Recoverable Cost (line 4 - 5)		1,351,702
	Commercial Class:		
	A. Forcasted Costs:		
7	Program Expenditures	506,100	
8	Net Lost Revenues	212,889	
9	Incentives	95,779	
10	Sub-Total	814,768	
11	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	(41,372)	
12	Total DSM Recoverable Cost (line 10 - 11)		856,140
	Industrial Class:		
	A. Forcasted Costs:		
13	Program Expenditures	393,500	
14	Net Lost Revenues	85,679	
15	Incentives	35,126	
16	Sub-Total	514,305	
17	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	209,010	
18	Total DSM Recoverable Cost (line 16 - 17)		305,295

Period 2

Kentucky Power Company
DSM KWH Sales Schedule
For Period: Nov. 1, 1996 through Oct. 31, 1997

Line #			
	Residential Class:		
1	Total Ultimate Sales	2,134,000,000	
2	Less: Non Metered	9,603,000	
3	Total Estimated Retail Sales	2,124,397,000	
4	Lost Revenue Impact	8,192,550	
5	Adjusted Sales		2,116,204,450
	Commercial Class:		
6	Total Ultimate Sales	1,170,000,000	
7	Less: Non Metered	5,265,000	
8	Total Estimated Retail Sales	1,164,735,000	
9	Lost Revenue Impact	4,989,200	
10	Adjusted Sales		1,159,745,800
	Industrial Class:		
11	Total Ultimate Sales	3,020,000,000	
12	Less: Non Metered	13,590,000	
13	Total Estimated Retail Sales	3,006,410,000	
14	Less: Opt-Out Sales	2,137,898,900	
15	Sales Before Lost Revenue Impact	868,511,100	
16	Lost Revenue Impact	2,186,400	
17	Adjusted Sales		866,324,700

Period 2

Kentucky Power Company
Over/(Under) Recovery Schedule
Balances as of Oct. 31, 1996
($)

Line #		Actual Recoveries (1)	Actual Expenditures (2)	Over/(Under) (1-2) Recovery (3)
	Residential Class:			
1	Program Expenditures	859,357	897,258	(37,901)
2	Net Lost Revenues	159,753	205,782	(46,029)
3	Incentives	187,500	102,650	84,850
4	Total	1,206,610	1,205,690	920
	Commercial Class:			
5	Program Expenditures	351,762	399,528	(47,766)
6	Net Lost Revenues	148,309	141,328	6,981
7	Incentives	81,400	81,987	(587)
8	Total	581,471	622,843	(41,372)
	Industrial Class:			
9	Program Expenditures	582,285	348,297	233,988
10	Net Lost Revenues	36,894	50,985	(14,091)
11	Incentives	10,500	21,387	(10,887)
12	Total	629,679	420,669	209,010

Period 3

Kentucky Power Company
DSM Adjustment Clause Schedule
($ per KWH)

A. Residential

DSM Cost Schedule ($)	1,571,190	
Sales Schedule (KWH)	2,134,634,750	
Proprosed Rate		0.000736
Floor Rate		0.000000
Celing Rate		0.001100

B. Commercial

DSM Cost Schedule ($)	949,930	
Sales Schedule (KWH)	1,180,616,900	
Proposed Rate		0.000805
Floor Rate		0.000000
Celing Rate		0.001300

C. Industrial

DSM Cost Schedule ($)	456,630	
Sales Schedule (KWH)	902,136,500	
Proposed Rate		0.000506
Floor Rate		0.000000
Celing Rate		0.001100

Effective Date for Billing: Dec. 1, 1997

Summitted By: ______________________________

Title: Accounting, Rates, and Planning Director

Date Sumitted: ______________________________

Period 3

Kentucky Power Company
DSM Recoverable Costs Schedule
For Period: Nov. 1, 1997 through Oct. 31, 1998
($)

Line #			
	Residential Class:		
	A. Forcasted Costs:		
1	Program Expenditures	996,000	
2	Net Lost Revenues	425,052	
3	Incentives	101,590	
4	Sub-Total	1,522,642	
5	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	(48,548)	
6	Total DSM Recoverable Cost (line 4 – 5)		1,571,190
	Commercial Class:		
	A. Forcasted Costs:		
7	Program Expenditures	540,500	
8	Net Lost Revenues	384,269	
9	Incentives	102,868	
10	Sub-Total	1,027,637	
11	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	77,707	
12	Total DSM Recoverable Cost (line 10 – 11)		949,930
	Industrial Class:		
	A. Forcasted Costs:		
13	Program Expenditures	430,200	
14	Net Lost Revenues	164,408	
15	Incentives	42,120	
16	Sub-Total	636,728	
17	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	180,098	
18	Total DSM Recoverable Cost (line 16 – 17)		456,630

Kentucky Power Company
DSM KWH Sales Schedule
For Period: Nov. 1, 1997 through Oct. 31, 1998

Line #			
	Residential Class:		
1	Total Ultimate Sales	2,158,000,000	
2	Less: Non Metered	9,711,000	
3	Total Estimated Retail Sales	2,148,289,000	
4	Lost Revenue Impact	13,654,250	
5	Adjusted Sales		2,134,634,750
	Commercial Class:		
6	Total Ultimate Sales	1,195,000,000	
7	Less: Non Metered	5,377,500	
8	Total Estimated Retail Sales	1,189,622,500	
9	Lost Revenue Impact	9,005,600	
10	Adjusted Sales		1,180,616,900
	Industrial Class:		
11	Total Ultimate Sales	3,058,000,000	
12	Less: Non Metered	13,761,000	
13	Total Estimated Retail Sales	3,044,239,000	
14	Less: Opt-Out Sales	2,137,898,900	
15	Sales Before Lost Revenue Impact	906,340,100	
16	Lost Revenue Impact	4,203,600	
17	Adjusted Sales		902,136,500

Period 3

Kentucky Power Company
Over/(Under) Recovery Schedule
Balances as of Oct. 31, 1997
($)

Line #		Actual Recoveries (1)	Actual Expenditures (2)	Over/(Under) Recovery (1-2) (3)
	Residential Class:			
1	Program Expenditures	1,096,247	1,205,873	(109,626)
2	Net Lost Revenues	359,678	298,579	61,099
3	Incentives	98,257	98,278	(21)
4	Total	1,554,182	1,602,730	(48,548)
	Commercial Class:			
5	Program Expenditures	498,254	525,187	(26,933)
6	Net Lost Revenues	398,254	287,291	110,963
7	Incentives	90,459	96,782	(6,323)
8	Total	986,967	909,260	77,707
	Industrial Class:			
9	Program Expenditures	499,254	305,458	193,796
10	Net Lost Revenues	98,387	115,428	(17,041)
11	Incentives	40,125	36,782	3,343
12	Total	637,766	457,668	180,098

Period 4

Kentucky Power Company
DSM Adjustment Clause Schedule *
($ per KWH)

A. Residential

DSM Cost Schedule ($) / Sales Schedule (KWH)	36,251 / 1,081,926,875	
Proprosed Rate		0.000034

B. Commercial

DSM Cost Schedule ($) / Sales Schedule (KWH)	84,404 / 604,482,300	
Proposed Rate		0.000140

C. Industrial

DSM Cost Schedule ($) / Sales Schedule (KWH)	(66,016) / 469,182,400	
Proposed Rate		−0.000141

Effective Date for Billing: Dec. 1, 1998 through May 31, 1999

Summitted By: ______________________

Title: Accounting, Rates, Tariffs and Planning Director

Date Sumitted: ______________________

* Assumes the 3 year DSM Experiment ceases at Oct. 31, 1998

Kentucky Power Company
DSM Recoverable Costs Schedule
For Period: Nov. 1, 1998 through April 30, 1999
($)

Line #			
	Residential Class:		
	A. Forcasted Costs:		
1	Program Expenditures	0	
2	Net Lost Revenues	0	
3	Incentives	0	
4	Sub−Total	0	
5	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	(36,251)	
6	Total DSM Recoverable Cost (line 4 − 5)		36,251
	Commercial Class:		
	A. Forcasted Costs:		
7	Program Expenditures	0	
8	Net Lost Revenues	0	
9	Incentives	0	
10	Sub−Total	0	
11	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	(84,404)	
12	Total DSM Recoverable Cost (line 10 − 11)		84,404
	Industrial Class:		
	A. Forcasted Costs:		
13	Program Expenditures	0	
14	Net Lost Revenues	0	
15	Incentives	0	
16	Sub−Total	0	
17	B. Total Company Over/(Under) Recovery (See Page 4 of 4)	66,016	
18	Total DSM Recoverable Cost (line 16 − 17)		(66,016)

Kentucky Power Company
DSM KWH Sales Schedule
For Period: Nov. 1, 1998 through April 30, 1999

Line #			
	Residential Class:		
1	Total Ultimate Sales	1,091,000,000	
2	Less: Non Metered	4,909,500	
3	Total Estimated Retail Sales	1,086,090,500	
4	Lost Revenue Impact	4,163,625	
5	Adjusted Sales		1,081,926,875
	Commercial Class:		
6	Total Ultimate Sales	610,000,000	
7	Less: Non Metered	2,745,000	
8	Total Estimated Retail Sales	607,255,000	
9	Lost Revenue Impact	2,772,700	
10	Adjusted Sales		604,482,300
	Industrial Class:		
11	Total Ultimate Sales	1,548,000,000	
12	Less: Non Metered	6,966,000	
13	Total Estimated Retail Sales	1,541,034,000	
14	Less: Opt-Out Sales	1,069,162,000	
15	Sales Before Lost Revenue Impact	471,872,000	
16	Lost Revenue Impact	2,689,600	
17	Adjusted Sales		469,182,400

Period 4

Kentucky Power Company
Over/(Under) Recovery Schedule
Balances as of Oct. 31, 1998
($)

Line #		Actual Recoveries (1)	Actual Expenditures (2)	Over/(Under) Recovery (1-2) (3)
	Residential Class:			
1	Program Expenditures	972,425	965,987	6,438
2	Net Lost Revenues	520,397	509,452	10,945
3	Incentives	89,258	142,892	(53,634)
4	Total	1,582,080	1,618,331	(36,251)
	Commercial Class:			
5	Program Expenditures	542,678	539,248	3,430
6	Net Lost Revenues	470,198	528,387	(58,189)
7	Incentives	150,852	180,497	(29,645)
8	Total	1,163,728	1,248,132	(84,404)
	Industrial Class:			
9	Program Expenditures	350,000	418,684	(68,684)
10	Net Lost Revenues	351,818	210,583	141,235
11	Incentives	52,156	58,691	(6,535)
12	Total	753,974	687,958	66,016

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_29 Please refer to Witness Nolen's Testimony, p. 20, lines 10-18. If a commercial customer participates in Year 1, will they be permitted to participate again in subsequent years?
a.: If the customer is permitted to do so, will they be eligible again for the full incentive amount?
b.: If the customer is permitted to participate again in subsequent years, will their participation be limited to new measures that were

not available in the earlier program years, or will the full complement of measures be available to them?
c.: If the customer is permitted to participate again in subsequent years, must they wait a specific amount of time before reapplying to the program?

RESPONSE

a. Yes, the customer who participates in Year 1 would be eligible again for the full incentive amount each year if the application is for a new project.

b. The full complement of measures would be available to customers in subsequent years if the application is for a new project.

c. Each customer would be eligible to receive a maximum incentive amount of $25,000 per program year. If that incentive level is reached, they will have to wait until the next program year to apply again.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_30 For the HEIP and Commercial Energy Solutions Program, will the energy audits be performed by TRC Company or subcontracting auditors?
a.: Will the energy auditors be required to undergo any trainings or possess any specific certifications or qualifications?

RESPONSE

Energy audits will be a part of the HEIP and will be performed by subcontracting auditors under TRC. In working with customers for the Commercial Energy Solutions Program, TRC and its Outreach Manager will perform walk-throughs to help identify eligible prescriptive measures while training and empowering local trade allies to market the program and assist in identifying eligible customer projects.

a. Yes, the energy auditors for the HEIP will be required to possess BPI certification or equivalent industry standard.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_31 Please refer to Witness Nolen's Testimony, p. 19, lines 10-16. For the HEIP, who will be responsible for recruiting and evaluating "participating dealer[s]" of HVAC equipment and qualifying weatherization measures?
a.: What are the eligibility criteria for dealers to participate?
b.: Will participating dealers be required to undergo any trainings or possess any specific certifications or qualifications?
c.: Will the Company offer a post-audit inspection as planned for the Commercial Energy Solutions Program? Why or why not?
d.: Will there be any mechanism for customer complaint resolution regarding installation of measures in this program?

RESPONSE

TRC will be responsible for recruiting and evaluating the program's participating dealers and trade allies.

a. Dealers will be required to complete a participation agreement, hold the appropriate business license, and provide proof of insurance in order to participate in the HEIP program.

b. Yes, participating dealers will undergo orientation and safety training. The agreement will ensure they understand program guidelines, maintain the appropriate business licensing and uphold the standards and customer experience defined by TRC and Kentucky Power.

c. The Company will complete a post-audit inspection for a minimum of 10% of Commercial Energy Solutions Program projects. This will be done for quality assurance and quality control purposes.

d. TRC will establish a call center to resolve customer inquiries related to the programs. Kentucky Power will train its Customer Operations Center agents on the programs and provide the correct referral information to direct customers to internal staff and/or TRC to resolve customer inquiries.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_32 Please refer to Witness Nolen's Testimony, p. 20, lines 8-10. For the Commercial Energy Solutions Program, who will be responsible for recruiting and evaluating "participating contractor[s]" for installation of eligible measures?
a.: What are the eligibility criteria for contractors to participate?
b.: Will participating contractors be required to undergo any trainings or possess any specific certifications or qualifications?

RESPONSE

TRC will be responsible for recruiting and evaluating the program's participating dealers and trade allies.

a. Dealers will be required to complete a participation agreement, hold the appropriate business license, and provide proof of insurance to participate in the Commercial Energy Solutions Program.

b. Yes, participating contractors will undergo program training and are encouraged to have BPI certification or equivalent industry standard certification.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_33 Please state whether the net lost revenues resulting from the DSM programs incorporated into the DSM Surcharge Factor is limited to first-year savings.
a.: If not, please explain why not, and over what time frame savings are incorporated into the DSM surcharge factor.

RESPONSE

The net lost revenues resulting from the DSM programs, incorporated into the DSM Surcharge Factor, is not limited to first year savings; it has been the Company's practice that net lost revenues are cumulative for up to three-years absent an intervening base case.

a. Please see KPCO_R_JI_1_28_Attachment1 for the 1995 application, which discusses how net lost revenues were determined.

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_34 Please refer to Witness Nolen's Testimony, p. 4, lines 1-4.
a.: Please identify how the inclusion of the two proposed new DSM programs (Home Energy Improvement Program and the Commercial Energy Solutions Program) assists in eliminating the need to build additional generation?
b.: Please detail whether these proposed DSM programs are funded at sufficient levels to defer or eliminate the need to build additional generation.

RESPONSE

a. and b. The Company objects to this request on the basis that it mischaracterizes Company Witness Nolen's testimony. In support of the objection the Company states it never indicated in this filing that the proposed DSM programs were designed to eliminate the need to build additional generation. Subject to and without waiving this objection, as stated in Company Witness Nolen's testimony starting on page 4, lines 16 through 18, "[t]he DSM proposals in this case are consistent with the Company's aims at customer affordability and rate stability while maintaining grid sustainability." Additionally, the proposed programs were discussed at multiple stakeholder meetings where the Joint Intervenors were present.

Witness: Tanner S. Wolffram

Preparer: Counsel

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_35 Please explain whether the Company believes that the proposed DSM portfolio provides programs that will be available, affordable, or useful to all customers?
a.: If so, please explain why.
b.: Please detail the possible or foreseen gaps in participation (e.g., participation opportunities for residents of manufactured housing; participation by residents with health and safety barriers, renters, those located in the flood plain, etc.).

RESPONSE

a. The programs in the proposed DSM portfolio will be available, affordable, and useful to all customer classes included in the DSM surcharge. The HEIP will be available to all residential tariff customers while program funds are available regardless of renter/owner status, housing type, or location of the home inside the Company's territory. The Commercial Energy Solutions Program will be available to all commercial class customers in the Company's service territory while program funds are available.

b. As explained in Company Witness Nolen's Direct Testimony on pages 12-13, the programs do not include any component for certain Industrial customers. However, the Company does not view this as a gap in participation as it has received feedback from those customers they are not interested in DSM, as they can make those investments themselves. Please see the response to JI 1_35 for additional information on the HEIP process for customers with a health and safety barrier.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_36 Please refer to Witness Nolen's Testimony p. 4, lines 12-18.
a.: Please detail how the Company determined what was achievable regarding its portfolio of DSM programs?
b.: Please detail the Company's desired range for the DSM surcharge and the reasoning behind it.
c.: Please detail how this level of DSM investment is providing rate stability and maintaining grid reliability.

RESPONSE

a. The Company utilized GDS to determine what was achievable. In the market potential study process, GDS evaluated the technical, economic, and achievable potential of DSM programs in Kentucky Power's service territory. The achievable potential, or amount of energy that can be saved, takes into account such factors as customers' willingness to participate which was gathered from surveys, cost-effectiveness tests, market barriers and financial constraints.

b. Please see the Company's response to JI 1-37.

c. The Company proposed a level of programs that were cost effective while being mindful of the impact on customers' bills in the DSM surcharge. Please also see the Company's response to JI 1-35.

Witness: Tanner S. Wolffram

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_37 Please detail the level of benefits (primary benefits such as electric savings, secondary benefits water, gas, propane, etc.) the Company is trying to procure through the DSM program, and please break down the level of benefits by source.
a.: Please detail the Company's acceptable range for the impact of the DSM surcharge on customers' monthly bills. Please explain how the Company determined this range and provide supporting workpapers, if any.

RESPONSE

The Company is not attempting to procure any certain level of benefit through its DSM proposal. The Company is proposing cost-effective programs that are focused on customer affordability and rate stability while maintaining grid sustainability as explained by Company Witness Nolen.

a. The Company did not have a pre-determined "acceptable range" for change in the DSM surcharge on customers' monthly bills. However, as part selecting the proposed DSM programs, the Company considered multiple variables, including but not limited to historic customer participation in its DSM programs, the Commission's orders related to the Company's previous DSM programs, what the realistic achievable potential was for DSM programs in its service territory, and the associated bill impacts. Ultimately, the Company, in consultation with GDS, decided it was the most prudent course of action to gradually roll out DSM programs to ensure adequate resources to implement the programs, ensure there is customer interest, and to prevent rate shock.

Witness: Barrett L. Nolen

Witness: Tanner S. Wolffram

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_38 Regarding the HEIP, please answer the following:
a.: Can a low-income customer participate in the HEIP instead of or in addition to the TEE Program?
i.: If so, are any of the weatherization measures discounted further?
b.: Will the program treat homes within the flood plain?

RESPONSE

a. A low-income residential customer could opt to participate in the HEIP instead of the TEE program. However, participation in a certain measure in one program would prohibit them from participating in that same measure in another program. For example, if a customer receives assistance under the TEE program and a new heat pump is installed by the CAA, the customer would not be eligible to receive an additional heat pump incentive under the HEIP.

b. Yes, HEIP will treat homes within the flood plain.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_39 For the HEIP, please detail the level of health and safety funding and/or measures that will be offered under the program to address health and safety barriers.

RESPONSE

The Company is not proposing a level of health and safety funding or measures for HEIP. Instead, the proposed HEIP program provides incentives for upgrading to a more efficient piece of equipment that provides savings to the customer. However, health and safety upgrades are proposed for the TEE program to supplement the DOE's Weatherization Readiness Fund to assist low-income customers.

A health and safety check will be performed during the HEIP home audit. If a home requires repair, the customer will be notified that it is their responsibility to correct the issue before any further energy efficiency/weatherization work can occur. Installations that can be made safely may be performed even if a health and safety issue is present. For example, if a customer's roof is leaking, attic insulation will not be incentivized, but showerheads may be installed, if applicable.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_40 Regarding eligibility for the Company's TEE program:
a.: Please detail how the Company determined that 700 kWh was the appropriate average minimum usage requirement.
b.: Please detail how income-qualified customers that do not have electric heat receive weatherization.
c.: Please detail whether homes/accounts that are eligible based upon usage and income requirements but are in the flood plain and can receive services through the TEE program.
i.: Does the Company know how many homes/accounts are eligible based upon usage and income requirements but are in the flood plain? If so, please provide that estimate, explain how it was derived, and produce supporting workpapers or documentation, if any. If not, please explain why not.
ii.: Would the Company be opposed to offering services to homes located in the flood plain? Please explain in full.

RESPONSE

a. The 700 kWh average minimum usage level requirement was placed into effect upon the TEE program's inception in 1996 and is the minimum usage for the program to be cost effective. In 2015, the Company filed a ten-year Demand Side Management ("DSM") Program Plan as part of its DSM Filing in Case No. 2015-00271. In the 2015 Program Plan, the third-party evaluator re-affirmed the 700kWh eligibility requirement.

b. Customers without primary electric heating are eligible for hot water heater conservation measures such as low-flow showerheads, insulation jacket and pipe insulation and efficient lighting if they electric water heating and use an average of 700 kWh per month from November through March.

c. Customers in the flood plain are eligible for weatherization assistance through the WAP and TEE program, but WAP guidelines state that the total weatherization funding for the home between all funding sources cannot equal 50% or more of the home's value.

ci. The Company is not in possession of the requested information and relies on the agency's implementation of the WAP to qualify customers based on income for its TEE program.

cii. Please see response to subpart c.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_41 For each of the HEIP and TEE programs, does the Company have an estimate of the number of barriered homes that would not be able to accept efficiency measures due to health and safety barriers? If so, please provide each such estimate, explain how the estimate was calculated, and produce supporting documentation, if any.

RESPONSE

No, the Company does not have an estimate of the number of barriered homes that would not be able to accept efficiency measures due to health and safety barriers.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_42 Please detail whether the TEE program provides funding and/or financing for HVAC upgrades from electric baseboard heating to heat pumps?

RESPONSE

Customers with electric baseboard heating would qualify for the largest heat pump incentive of $3,000 per customer under the TEE program since it is a primary heat system that utilizes electric resistance heat. Customers with electric baseboard heating would require the installation of a ductwork system (if not already present for a central A/C system) to accommodate a heat pump and, according to agency feedback, this additional cost may lower the cost effectiveness of the measure below the required level of 1.0 per the DOE's WAP guidelines. The proposed addition of ductless mini-split heat pumps to the program presents a good alternative in these situations where a customer has electric baseboard heating because it will allow the installation of a more efficient heat pump system without the need and added cost of ductwork installation.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_43 Please detail whether the HEIP provides funding and/or financing for HVAC upgrades from electric baseboard heating to heat pumps?

RESPONSE

Customers with electric baseboard heating would qualify for all heat pump incentives under the HEIP. Like the response to JI 1_42, the installation of a traditional heat pump would require the customer to install ductwork if not already installed for a central A/C unit. If approved, the addition of ductless heat pumps to the HEIP would present customers with another efficient option to replace inefficient baseboard heating.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_44 Please refer to Witness Nolen's Testimony p. 11, lines 17-20. Please detail which measures the Company will provide funding for under the TEE program.

RESPONSE

Under the TEE program, the Company currently provides funding for air sealing, duct sealing, attic insulation, sidewall insulation, floor insulation, window and door replacement, ductwork insulation, high efficiency heat pumps, hot water heater measures such as pipe insulation, insulation jacket and low-flow showerheads, and efficient lighting. If approved, the Company is proposing to offer funding for ENERGY STAR room air conditioners, ductless heat pumps, and heat pump water heaters.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_45 In reference to commercial and industrial new construction, does the Company work with the potential customer to encourage buildings to be built above current code adoptions and to incorporate renewables?
a.: If so, when does this process begin and what measures are encouraged?
b.: If not, why has the Company not offered such services to industries, such as data centers and cryptocurrency facilities, which could benefit from the avoided costs from building more efficient buildings?

RESPONSE

a. The Company works with commercial and industrial customers to promote energy efficiency and efficient technologies. Key account managers are involved with customers from the initial conversations when new installation orders are placed for large load additions and existing customer expansions. They discuss load sheets with the customers which help our engineers design the new service and appropriately size the transformer(s) and protection devices. Key account managers are trained to discuss the benefits of efficient technologies such as electric forklifts, electric vehicles and charging infrastructure, electric arc furnaces, variable speed drives on large motors, HVAC, and lighting.

Commercial and industrial customers can find additional information on the Company's at https://www.kentuckypower.com/savings/business/.

b. N/A

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_46 Please refer to Witness Nolen's Testimony p. 14, lines 15-17. Please explain whether the reference to the CAAs' estimates for deferrals is based solely on Kentucky Power's service territory or is it statewide?

RESPONSE

The deferral estimate was based solely on feedback from the community action agencies in Kentucky Power's service territory.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_47 Please detail how the proposed programs can address manufactured housing within the Company's service territory.

RESPONSE

All customers, including those with manufactured housing, are eligible to participate in the HEIP program. Additionally, income-qualifying customers with manufactured housing are eligible for the TEE program.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_48 Please refer to Witness Nolen's Testimony p. 16, line 3, through p. 17, line
22.
a.: Please clarify whether the increased customer energy education and administrative expenses address CAA activities relevant only to the ratepayer-funded TEE Program components, to the federally funded programs, or some combination of both.
b.: If some portion of the increased customer energy education and administrative expenses support the CAAs' federally funded program activities, please provide a rationale for using Kentucky Power Company ratepayer funds to support federally funded activities.

RESPONSE

a.-b. The administrative and customer education expenses are limited to the Company's TEE program.

The administrative expenses account for agency time to complete required paperwork for the Company's TEE program which outlines the incentive levels and measures installed in each customer's home. The energy education expense covers agency time spent with the customer going over conservation tips such as recommended thermostat settings and the importance of lower wattage fixtures and efficient appliances.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_49 Please refer to Witness Nolen's Testimony p. 18, lines 15-18. Please explain whether the Company has a plan to manage the HEIP program funding so that it lasts the entire program year in order to avoid disruptions to the program's implementation?
a.: If so, please describe.

RESPONSE

The Company will have regular update calls with the proposed implementation contractor, TRC, to evaluate budget and savings performance. The marketing budgets were designed to coincide with the participation and savings targets to manage overall program budgets as efficiently as possible.

a. The Company and TRC will evaluate the budget closely to determine the best course of action. It is the Company's position to adhere to the filed budget for year one as closely as possible to limit the DSM surcharge impact. If customer uptake outpaces forecasted spend, a decision will be made to place customers on a waitlist until the next program year. Constant evaluation of the budget and customer demand will be important and may provide justification to increase the forecasted spend in subsequent filings to match customer demand.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_50 Please describe Kentucky Power's effort to identify or align financing offerings to complement its program offerings for both its residential and commercial customers.

RESPONSE

Please see the Company's response to JI 1_2 related to the Company's evaluation of the PAYS program and why it was not ultimately selected. Further, the Company previously explained in its most recent base rate proceeding, it is not viable for the Company to take a role in financing customer-installed DSM/EE measures due to its financial condition. Instead, the proposed DSM program aims to remove barriers to entry for customers and create an easier path towards efficiency and bill savings for customers.

Witness: Barrett L. Nolen

DATA REQUEST

JI 1_51 Regarding the Company's Commercial Energy Solutions Program, please answer the following:
a.: Please explain the rationale for the annual roll out of measures (Year 1 - Lighting, Year 2 – HVAC, and Year 3 – Food Service).
b.: Please confirm that incentives available in Year 1 of the program will continue to be available in Years 2 and 3. If anything but confirmed, please explain in full.
c.: Please confirm that incentives first available in Year 2 of the program will continue to be available in Year 3. If anything but confirmed, please explain in full.

RESPONSE

a. The Commercial Energy Solutions Program design includes a phased approach which permits the program team to develop unique trade ally training and networks in each market while maintaining a cost-effective level of administrative staffing. This approach was recommended in the market potential study to gradually ramp up activities and limit the impact to the DSM surcharge from costs associated with startup, administration, training, and marketing. The front loading of the lighting incentives was also intentional to maximize the savings in the first five years of the program as the lighting market continues to evolve and manufacturers shift production entirely to LED technologies.

b. Confirmed.

c. Confirmed.

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_52 Please refer to Witness Nolen's Testimony, p. 28, Table 3 and the anticipated annual budgets provided in Exhibits BLN-2 and BLN-3.
a.: Please explain why the HEIP budget decreases in Year 2 and in Year 3 is still below the budget for Year 1.
b.: Please detail why the Commercial Energy Solutions program budget decreases in Year 3.

RESPONSE

a. Please see response to KPSC 1_8 subpart a.

b. Please see response to KPSC 1_8 subpart b.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_53 Please refer to Witness Nolen's Testimony, p. 28, lines 3-20, and answer the following requests.
a.: Please detail the Company's rationale for issuing an RFP for an EM&V consultant in 2026.
b.: Please explain why the Company believes issuing an RFP for an EM&V consultant in 2026 would allow sufficient time for evaluations to occur and to have the data ready to influence the development of the next three-year plan to be filed in 2027.

RESPONSE

a. The Company believes 2026 is appropriate timeline for issuing an RFP for an EM&V consultant because it provides the Company a full-year worth of data from the programs for the EM&V consultant to utilize.

b. The Company believes the proposed timeline is sufficient to allow the Company to file its next three-year plan in 2027.

Witness: Barrett L. Nolen

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_54 Does the Company plan to have a prospective or retrospective technical reference manual? Please explain your response.

RESPONSE

Under the current scale of the energy efficiency programs, the Company will leverage existing technical reference manuals and make appropriate updates to savings algorithms to reflect jurisdiction-specific conditions. The Illinois technical reference manual (available here: https://www.ilsag.info/technical-reference-manual/) is an example of a document that receives robust annual updates and can be updated using Company-specific weather conditions.

Witness: Barrett L. Nolen

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_55 In lieu of an established EM&V process, please identify and produce any documents or manuals the Company relied upon for the projected annual DSM portfolio savings provided in direct testimony and exhibits.

RESPONSE

The Company will have an established EM&V process.

The market potential study's sector-level energy efficiency measure lists were informed by a range of sources including the Michigan Energy Measures Database ("MEMD"), the Illinois and Indiana technical reference manuals ("TRMs"), and current Kentucky Power program offerings.

Chapter five of the market potential study outlines the processes, guiding principles, and market research used for general program design and incentive structure.

Witness: Barrett L. Nolen

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_56 In lieu of an established EM&V process, what documents or manuals will the Company rely upon for savings assumptions going forward?

RESPONSE

The Company will utilize a combination of savings algorithms based upon the initial filing assumptions, regional technical reference manuals, and site-specific algorithms to estimate energy savings at measure, project, and program levels. The Company will have an established EM&V process to assess the savings performance and implement suggested program improvements.

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_57 What are the estimated costs associated with EM&V efforts?

RESPONSE

The Company is unable to answer the question as it has not yet issued the RFP for the EM&V.

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_58 Please refer to the Program Budget information provided in Exhibits BLN- 2 and BLN-3, and answer the following questions:
a.: Please itemize the anticipated "Information Technology" expenses in each budget year for the Home Energy Improvement Program and provide the rationale for needing to incur each itemized expense. If an itemized list of Information Technology expenses does not exist, please explain how this expense line item was derived.
b.: Please itemize the anticipated "Information Technology" expenses in each budget year for the Commercial Energy Solutions Program and provide the rationale for needing to incur each itemized expense. If an itemized list of Information Technology expenses does not exist, please explain how this expense line item was derived.
c.: Please provide a description of the marketing efforts for each program, including type of media and potential schedule of marketing activities.

RESPONSE

a. Kentucky Power solicited RFP responses from multiple vendors. TRC was ultimately awarded the bid. Please see KPCO_R_JI_58 Attachment1 for the itemized IT expenses for the Home Energy Improvement Program that TRC indicated would be necessary for them to implement and track the success of the program.

b. Kentucky Power solicited RFP responses from multiple vendors. TRC was ultimately awarded the bid. Please see KPCO_R_JI_58 Attachment2 for the itemized IT expenses for the Commercial Energy Solutions Program that TRC indicated would be necessary for them to implement and track the success of the program.

c. HEIP marketing initiatives may include efforts such as email marketing, direct mail, bill inserts, social media, community events, digital advertising, and collateral that drives customers to the website and an online application. TRC will develop relationships with the community action agencies in the Company's territory to educate their staff on the program to encourage them to solicit potential participants and assist in signing customers up for a home assessment that may not qualify for the TEE program.

Commercial Energy Solutions Program marketing efforts may include email marketing, direct mail, LinkedIn campaigns, digital advertising, and collateral that drives customers to the website and an online application. TRC will produce marketing campaigns to recruit trade allies into the network and educate them on the benefits of the program where they can, in turn, market eligible measures to their customers.

Witness: Barrett L. Nolen

Witness: Tanner S. Wolffram

Home Energy Improvement Program					
2025		2026		2027	
Web and Database Server Infrastructure provisioning for multi-tenant hosting	$19,891.00	Web and Database Server Infrastructure hosting	$2,924.55	Web and Database Server Infrastructure hosting	$1,950.30
Web Portal Development and Intergration with HEIP Program	$7,956.40	2 System Releases to Captures Application	$13,891.61	2 System Releases to Captures Application	$9,263.93
CRM DataSystem Setup	$15,912.80	CRM Database System Support	$13,891.61	CRM Database System Support	$9,263.93
Program Measure ingest Programming Interface Configuration	$15,912.80	Update Programming Interfaces	$13,891.61	Update Programming Interfaces	$9,263.93
Setup Program Measure/Site Modules	$19,891.00	Update Measures	$5,556.65	Update Measures	$3,705.57
Web Interface/Content Modules	$7,956.40	Update Web Interface/Content Modules	$2,778.32	Update Web Interface/Content Modules	$1,852.79
Role Based Access Management for System Users	$3,182.56	System Release Functional Testing	$2,778.32	System Release Functional Testing	$1,852.79
External User Account Setup	$3,978.20	IT Team Coordination/Planning	$2,778.32	IT Team Coordination/Planning	$1,852.79
End-to-end System and Functional Testing	$3,978.20				
IT Team Coordination/Planning	$795.64				
	$99,455		$58,491		$39,006

Commerical Energy Solutions Program					
2025		2026		2027	
Web and Database Server Infrastructure provisioning for multi-tenant hosting	$19,891.00	Web and Database Server Infrastructure hosting	$2,924.55	Web and Database Server Infrastructure hosting	$1,950.30
Web Portal Development and Intergration with HEIP Program	$7,956.40	2 System Releases to Captures Application	$13,891.61	2 System Releases to Captures Application	$9,263.93
CRM DataSystem Setup	$15,912.80	CRM Database System Support	$13,891.61	CRM Database System Support	$9,263.93
Program Measure ingest Programming Interface Configuration	$15,912.80	Update Programming Interfaces	$13,891.61	Update Programming Interfaces	$9,263.93
Setup Program Measure/Site Modules	$19,891.00	Update Measures	$5,556.65	Update Measures	$3,705.57
Web Interface/Content Modules	$7,956.40	Update Web Interface/Content Modules	$2,778.32	Update Web Interface/Content Modules	$1,852.79
Role Based Access Management for System Users	$3,182.56	System Release Functional Testing	$2,778.32	System Release Functional Testing	$1,852.79
External User Account Setup	$3,961.20	IT Team Coordination/Planning	$2,778.32	IT Team Coordination/Planning	$1,852.79
End-to-end System and Functional Testing	$3,978.20				
IT Team Coordination/Planning	$795.64				
	$99,438		$58,491		$39,006

DATA REQUEST

JI 1_59 Please refer to Exhibits BLN-2 and BLN-3 and answer the following questions:
a.: For the overall proposed portfolio, please provide a breakdown of the costs to include administrative, marketing, evaluation, labor, and incentives.
b.: Please identify costs that can be shared across programs and detail how the Company plans to allocate shared costs across programs.
c.: Please provide a list of eligible measures by program, and incentive amounts for each measure.
d.: Please detail to what extent, if any, Kentucky Power is relying on sister companies from AEP to implement successful DSM programs.
e.: Does the Company have any proposed reporting requirements or report formats for the providing results on the programs?

RESPONSE

The Company objects to this request on the basis that it is vague and ambiguous. Specifically, the request references Exhibits BLN-2 and BLN-3, which are specific to the Company's newly proposed programs, then asks for the overall proposed portfolio information. Thus, the Company interprets this request as seeking information specific to the programs identified in Exhibits BLN-2 and BLN-3.

a. Exhibits BLN-2 and BLN-3 already provide the requested information. Note that labor is included within "Administration" category and any "Evaluation" costs are not available until the programs begin.

b. Shared program costs across the HEIP and Commercial Energy Solutions Program include program management, marketing, IT, and call center expenses.

c. Please see the response to KPSC 1_5 and KPSC 1_6.

d. The Company is not relying on its sister AEP operating companies to implement successful DSM programs. Nonetheless, there are economies of scale such as already developed IT infrastructure and established dealer networks in the region.

The Company will continue reporting on its proposed DSM programs in line with its current DSM program. This is a vetted process which provides the Commission annual review of the programs.

Witness: Barrett L. Nolen

Witness: Tanner S. Wolffram

Preparer: Counsel

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_60 Please refer to Exhibit BLN-1, the 2023 MPS.
a.: Please provide the documents and/or links to documents that GDS leveraged to support the market potential study, including the Michigan Energy Measures Database, and the technical resource manuals for Indiana and Illinois.

b.: Please provide all workpapers for the market potential study in fully functional Excel format with formulas intact.

RESPONSE

a. GDS used the following documents to support the market potential study:

- Illinois TRM: https://www.ilsag.info/technical-reference-manual/

- Michigan Energy Measures Database: https://www.michigan.gov/mpsc/regulatory/ewr/michigan-energy-measures-database

- Indiana TRM is provided as KPCO_R_JI_1_60_Attachment1.

b. The requested information is confidential and proprietary information of GDS that the Company does not have full access to. The Company cannot provide this information to Joint Intervenors prior to the Joint Intervenors executing a non-disclosure agreement that would protect GDS' confidential and proprietary information. Upon execution of such non-disclosure agreements, the Company will supplement this response.

Preparer: Counsel (subpart b)

Witness: Warren Hirons (GDS Associates)

Indiana Technical Reference Manual Version 2.2

July 28, 2015

Prepared for the:
Indiana Demand Side Management Coordination Committee EM&V Subcommittee

CADMUS · Opinion Dynamics · Integral Analytics · BuildingMetrics Incorporated

This page left blank.

Prepared by:

Cadmus

Indiana Statewide Evaluation Team

Table of Contents

Acronyms

Acronym	Definition
ASHP	Air-source heat pump
CDD	Cooling degree days
DEER	Database of Energy Efficiency Resources
DHW	Domestic hot water
DSMCC	Demand Side Management Coordination Committee
ECM	Electronically commuted motor
EISA	Energy Independence and Security Act of 2007
HDD	Heating degree days
HERS	Home Energy Rating System
HID	High-intensity discharge
HPWH	Heat pump water heater
IECC	International Energy Conservation Code
MEF	Modified energy factor
O&M	Operations and maintenance
RESNET	Residential Energy Services Network
SHGC	Solar Heat Gain Coefficient
SRCC	Solar Rating and Certification Company
TRM	Technical Reference Manual
UDRH	User Defined Reference Home

Introduction

This technical reference manual (TRM) was developed at the request of the Indiana Demand Side Management Coordination Committee (DSMCC). It is based on the *Draft Ohio TRM* developed by the Vermont Energy Investment Corporation (VEIC) under contract to the Public Utility Commission of Ohio (PUCO). The DSMCC directed Indiana utilities to use the *Draft Ohio TRM* to develop program plans and *ex-ante* savings estimates. This project was to update the *Draft Ohio TRM* with Indiana-specific data for climate-sensitive measures and parameters, add additional measures as needed to support the DSMCC, and update all measures with more current information.

The savings estimates are expected to serve as representative, recommended values for calculating savings based on program-specific information. All information is presented on a per-unit basis. When using the measure-specific TRM information, it is helpful to keep the following notes in mind:

- The TRM clearly identifies whether the measure impacts pertain to retrofit, time of sale,[1] or early retirement program designs.
- Additional information about the program design is sometimes included in the measure description when it can affect savings and other parameters.
- Savings algorithms are provided for each measure. Several measures provide prescriptive values for each variable along with the output from the algorithm. That output is the deemed savings assumption. Other measures provide prescriptive values for only some variables, directing to use the actual value for other variables. In these cases of deemed calculations,– users should input actual efficiency program data (e.g., capacities or rated efficiencies of central air conditioners) to compute savings. Note that the TRM often provides example calculations for measures requiring actual values for illustrative purposes only.
- All estimates are for annual savings; however, parameters for calculating Lifetime savings (such as measure life) are also included.
- Unless otherwise noted, the measure life is defined as the life of an energy consuming measure, including its equipment life and measure persistence.
- Where provided, deemed values represent average savings that could be expected from the average measures installed that year.
- For non-weather-sensitive measures, peak savings are estimated whenever possible as the average of savings between 3:00 p.m. and 6:00 p.m. across all summer weekdays (the Indiana summer on-peak period).
- Wherever possible, savings estimates and other assumptions are based on Indiana or regional data. However, a number of assumptions are based on sources from other regions of the country. While this information is not perfectly transferable (due to differences in the definition

[1] In some jurisdictions, this is called replace on burn-out. We use the term time of sale because not all new equipment purchases take place when older, existing equipment reaches the end of its life.

of peak periods as well as in geography, climate, and customer mix), it was used because it was the most transferable and usable source available at the time.

- This TRM presents a combination of engineering equations and building energy simulation results. Engineering equations convey information clearly and transparently, and are widely accepted in the industry. The equations provide flexibility for users to substitute locally specific information and update some or all parameters as they become available on an ad hoc basis. One limitation is that certain interaction effects between end uses, such as how reductions in waste heat impact space conditioning, are not universally captured in this TRM. Such interactive factors are included in calculations for lighting measures. For measures where simple engineering equations do not adequately predict energy savings, simulation model results are presented. Engineering equations may also use parameters derived from simulation modeling. A description of the prototypical building models used in the simulations is shown in Appendix A.
- Many commercial and industrial measures are based on building energy simulations. This was typically done for complex, highly interactive measures, such as envelope improvements or chilled water resets. The building prototype assumptions are primarily based on California DEER prototypes, with adjustments based on data published by the U.S. Energy Information Administration *Commercial Building Energy Consumption Survey*.
- Early replacement measures show two levels of savings:
  - For an initial period during which the existing inefficient unit would have continued to be used had it not been replaced (with savings claimed between the existing unit and the efficient replacement).
  - For the remainder of the measure life, where the existing unit would have been replaced with a standard baseline unit (so savings are claimed between the standard baseline and the efficient replacement).

  We assume that accounting for this step-down adjustment in annual savings is possible in the utilities' tracking systems. This TRM also provides the impact of the deferred replacement payment that would have occurred at the end of the useful life of the existing equipment.
- In general, the baselines are intended to represent average conditions in Indiana. Some baselines are from Indiana specific data, such as household consumption characteristics being provided by the Energy Information Administration. Other baselines are extrapolated from secondary sources, when Indiana data are not available. When weather adjustments were needed in extrapolations, weather conditions in all major Indiana cities were generally used as representative for their regions.

TRM Updating Process

Updates to the Indiana TRM should be initiated when:

1. Indiana impact evaluations have established sufficient evidence to suggest that a change to a specific calculation or variable;
2. When a code or standard has changed at the state or federal level; or
3. If the energy industry has adopted a new value, such as the uniformed methods project (UMP).

As such, it is not recommended that a change be initiated unless agreed upon by the Evaluation Administrator and Subcommittee based on evidence that is consistent.

Following Subcommittee instructions, at the end of each program cycle, the Evaluation Administrator will compare the TRM estimated gross *ex ante* impacts with the *ex post* evaluated energy impact results to assess whether savings levels are statistically different. If the measure-specific savings are statically different, and the cause of that difference is associated with typical installation, use conditions, a change in baseline conditions, or with a change in the efficiency level, the Evaluation Administrator will develop and recommend a new *ex ante* estimation approach to the Subcommittee. A majority vote by the Subcommittee is required to accept the recommendation and update the TRM.

Each change to the TRM will be documented similarly to the change documentation approach for updating the Indiana Evaluation Framework. That is, each change will be recorded in a *TRM Changes and Updates* located in Appendix E.

TRM Changes and Updates

Measure	Edit #	Major Edit Description	Date

Adding New Measures to the TRM

The third-party Program Administrator or independent Evaluation Administrator can recommend to the Subcommittee to add new measures to the TRM. Likewise, based on a majority vote, the Subcommittee can instruct the Evaluation Administrator to include a new measure in the TRM. New measures can be added to the TRM at any time, subject to Subcommittee approval.

Each measure section of the TRM presents the *ex-ante* calculation approach for estimating the projected energy impacts from program implementation efforts undertaken following the release date of this document.

Residential Market Sector

Appliances

Refrigerator and/or Freezer Retirement (Early Retirement)

	Measure Details
Official Measure Code	Res-Appl-Refrig/Freez-Recycle-1
Measure Unit	Per refrigerator or freezer
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by appliance
Peak Demand Reduction (kW)	Varies by appliance
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by appliance
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	0
Incremental Cost	Varies by appliance
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the removal of an existing inefficient primary or secondary refrigerator or freezer from service, prior to its natural end of life (early retirement).[2] This measure target units greater than 10 years old, though it is expected that the average age will be greater than 20 years based on other similar program performance. Savings are calculated for the estimated energy consumption during the remaining life of the existing unit.

Definition of Efficient Equipment

The efficient condition is removal of an existing inefficient primary or secondary refrigerator or freezer from service.

---

[2] This measure assumes that a mix of primary and secondary units will be replaced (and the savings are reduced accordingly). By definition, a kitchen refrigerator that satisfies the majority of the household demand for refrigeration is the primary refrigerator. One or more additional refrigerators in the household that satisfy supplemental needs for refrigeration are secondary units.

Definition of Baseline Equipment

The baseline condition is an existing, inefficient unit that is in working order prior to being removed from service.

Deemed Lifetime of Efficient Equipment

The remaining useful life of the retired unit is 8 years.[3]

Deemed Measure Cost

The incremental cost for this measure is the actual cost associated with removing and recycling the retired unit.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = UEC_{RETIRED} * F_{RUN\ TIME}$$

Refrigerators

$$UEC_{RETIRED}{}^{4} = 365.25 * [0.769 + (0.008 * Age) + (0.827 * F_{BEFORE\ 1990}) + (0.083 * Size) + (-1.316 * F_{SINGLE\ DOOR}) + (0.862 * F_{SIDE-BY-SIDE}) + (0.642 * F_{PRIMARY}) + (0.031 * CDD * F_{OUTDOOR}) + (-0.049 * HDD * F_{OUTDOOR})]$$

Where:

$UEC_{RETIRED}$	=	Average *in situ* energy consumption of retired unit
365.25	=	Days of operation per year
$F_{RUN\ TIME}$	=	Run time adjustment factor
Age	=	Unit age in years
$F_{BEFORE\ 1990}$	=	Percentage of units manufactured before 1990
Size	=	Unit size in cubic feet
$F_{SINGLE\ DOOR}$	=	Percentage of units with a single door
$F_{SIDE-BY-SIDE}$	=	Percentage of side-by-side units

---

3 KEMA. *Residential Refrigerator Recycling Ninth Year Retention Study*. 2004.

4 Regression model developed by Cadmus for the 2006-2008 California Appliance Recycling Program evaluation. See: Cadmus. *Residential Retrofit High Impact Measure Evaluation Report*. 2010. Available online: http://www.calmac.org/publications/FinalResidentialRetroEvaluationReport_11.pdf. Summary of model constants are in the Reference Tables section for this measure.

$F_{PRIMARY}$ = Percentage of units that are for primary use

CDD = Local cooling degree days per day

$F_{OUTDOOR}$ = Fraction of units that are located in garages or outdoors

HDD = Local heating degree days per day

For example, refrigerator model parameters derived for the NIPSCO Appliance Recycling Program are shown in the table below.[5]

Refrigerator Model Parameters for NIPSCO Appliance Recycling Program

Parameter	Value
Age	18.78
Before 1990	0.27
Size	20.17
Single door	0.11
Side-by-side	0.13
Primary	0.33
CDD	2.225
HDD	17.244
Outdoor	0.62
Run-time adjustment	0.828

This leads to the following savings:

$$\text{Refrigerator } \Delta\text{kWh} = 365.25 * [0.769 + (0.008 * 18.78) + (0.827 * 0.27) + (0.083 * 20.17) + (-1.316 * 0.11) + (0.862 * 0.13) + (0.642 * 0.33) + (0.031 * 2.225 * 0.62) + (-0.049 * 17.244 * 0.62)] * 0.828 = 761 \text{ kWh}$$

Freezers

$$UEC_{RETIRED}{}^{6} = 365.25 * [-0.372 + (0.036 * Age) + (0.632 * F_{BEFORE\ 1990}) + (0.107 * Size) + (-0.293 * F_{CHEST}) + (0.047 * CDD * F_{OUTDOOR}) + (-0.052 * HDD * F_{OUTDOOR})]$$

Where:

F_{CHEST} = Percentage of chest freezer units

5 TecMarket Works. *Evaluation of the NIPSCO Appliance Recycling Program*. 2012.

6 Regression model developed by Cadmus for the 2006-2008 California Appliance Recycling Program evaluation. See: Cadmus. *Residential Retrofit High Impact Measure Evaluation Report.* 2010. Available online: http://www.calmac.org/publications/FinalResidentialRetroEvaluationReport_11.pdf. Summary of model constants are in the Reference Tables section for this measure.

This approach was applied to recycling program evaluations for NIPSCO, Vectren, and I&M. The unit energy-savings values varied in each program due to characteristics of the recycled units. The results are shown below.

Unit Energy Saving Results for Several Program Evaluations

Utility	Refrigerator (kWh/unit)	Freezer (kWh/unit)
NIPSCO	761	886
I&M	1,068	946
Vectren	1,093	993
Average	**1,036**	**942**

This TRM uses the average of the above values as the statewide savings estimate.

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{\Delta\, kWh}{8{,}760} * TAF * LSAF$$

Where:

TAF = Temperature adjustment factor (= 1.21)[7]

LSAF = Load shape adjustment factor (= 1.063)[8]

This approach was applied to recycling program evaluations for NIPSCO, Vectren, and I&M. The unit demand reduction values vary due to characteristics of the recycled units. The results are shown in the table below.

Unit Demand Reduction Results for Several Program Evaluations

Utility	Refrigerator (kW/unit)	Freezer (kW/unit)
NIPSCO	0.112	0.130
I&M	0.157	0.139
Vectren	0.160	0.146
Average	**0.152**	**0.138**

This TRM uses the average of these values as the statewide savings estimate.

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

7 Blasnik, Michael. *Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study*. July 29, 2004. (p. 47 assumes that 85% of homes have air conditioning).

8 Ibid. (p. 48, extrapolated by taking the ratio of existing summer to existing annual profile for hours ending 16 through 18, and multiplying by new annual profile).

Reference Tables

Regression Model Coefficients for Refrigerators*

Independent Variables	Coefficient	p-Value	VIF
Regression Model Intercept	0.769	<.0001	0
Age Coefficient (years)	0.008	0.016	2
Dummy: Unit Manufactured Pre-1990 Coefficient	0.827	<.0001	1.7
Size Coefficient (cubic feet)	0.083	<.0001	1.9
Dummy: Single Door Coefficient	-1.316	<.0001	1.3
Dummy: Side-by-Side Coefficient	0.862	<.0001	1.6
Dummy: Primary Appliance Coefficient	0.642	<.0001	1.5
CDD * Fraction Outdoor Coefficient	0.031	<.0001	1.3
HDD * Fraction Outdoor Coefficient	-0.049	<.0001	1.2

* Cadmus estimated this model for Vectren based on monitored data in California and Michigan.

Regression Model Coefficients for Freezers*

Independent Variables	Coefficient	p-Value	VIF
Regression Model Intercept	-0.372	0.043	0
Age Coefficient (years)	0.036	<.0001	2
Dummy: Unit Manufactured Pre-1990 Coefficient	0.632	<.0001	2.1
Size Coefficient (cubic feet)	0.107	<.0001	1.2
Dummy: Chest Freezer Coefficient	-0.293	<.0001	1.2
CDD * Fraction Outdoor Coefficient	0.047	<.0001	1.1
HDD * Fraction Outdoor Coefficient	-0.052	<.0001	1

* Cadmus estimated this model for Vectren based on monitored data in California and Michigan.

Efficient Refrigerator – ENERGY STAR and CEE TIER 2 (Time of Sale)

	Measure Details
Official Measure Code	Res-Appl-Refrig/Freez-TOS-1
Measure Unit	Per refrigerator
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by appliance
Peak Demand Reduction (kW)	Varies by appliance
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by appliance
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	17
Incremental Cost	Varies by appliance
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a new refrigerator meeting either ENERGY STAR or CEE TIER 2 specifications (defined as requiring ≥ 20% and ≥25% less energy consumption than an equivalent unit meeting federal standard requirements, respectively).

Definition of Efficient Equipment

The efficient condition is a new refrigerator meeting either the ENERGY STAR or CEE TIER 2 efficiency standards.

Definition of Baseline Equipment

The baseline condition is a new refrigerator meeting the minimum federal efficiency standard for refrigerators.

Deemed Lifetime of Efficient Equipment

The measure life is 17 years.[9]

[9] This is consistent with Efficiency Vermont and New Jersey TRMs.

Deemed Measure Cost

The incremental cost for this measure is $30.00[10] for an ENERGY STAR unit and $140.00[11] for a CEE Tier 2 unit.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta\text{kWh} = UEC_{BASE} - UEC_{ES}$$

Where:

UEC_{BASE} = Annual energy consumption of baseline unit[12]

Bottom Freezer	=	650 kWh
Top Freezer	=	415 kWh
Side-by-Side	=	729 kWh

UEC_{ES} = Annual energy consumption of ENERGY STAR unit (= 20% less than baseline)

Bottom Freezer	=	520 kWh
Top Freezer	=	332 kWh
Side-by-Side	=	583 kWh

Or

= Annual energy consumption of CEE Tier 2 unit (= 25% less than baseline)

Bottom Freezer	=	488 kWh
Top Freezer	=	311 kWh
Side-by-Side	=	547 kWh

10 From ENERGY STAR calculator: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls

11 Based on weighted average of units participating in Efficiency Vermont program and retail cost data provided in: U.S. Department of Energy. *TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers*. October 2005. Available online: http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/refrigerator_report_1.pdf

12 This is the approximate average consumption of a typical baseline refrigerator at federal standard efficiency levels; see: http://www.energystar.gov/index.cfm?fuseaction=refrig.display_products_excel

The above equation leads to these savings from ENERGY STAR units:

Bottom Freezer = 650 – 520 (= 130 kWh)

Top Freezer = 415 – 332 (= 83 kWh)

Side-by-Side = 729 – 583 (= 146 kWh)

The above equation leads to these savings from CEE Tier 2 units:

Bottom Freezer = 650 – 488 (= 162 kWh)

Top Freezer = 415 – 311 (= 104 kWh)

Side-by-Side = 729 – 547 (= 182 kWh)

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{\Delta\, kWh}{8{,}760} * TAF * LSAF$$

Where:

TAF = Temperature adjustment factor (= 1.21)[13]

LSAF = Load shape adjustment factor (= 1.124)[14]

The above equation leads to these demand reductions from ENERGY STAR units:

Bottom Freezer = $\frac{130}{8{,}760} * 1.21 * 1.124$ = 0.020 kW

Top Freezer = $\frac{83}{8{,}760} * 1.21 * 1.124$ = 0.013 kW

Side-by-Side = $\frac{146}{8{,}760} * 1.21 * 1.124$ = 0.023 kW

The above equation leads to these demand reductions from CEE Tier 2 units:

Bottom Freezer = $\frac{162}{8{,}760} * 1.21 * 1.124$ = 0.025 kW

Top Freezer = $\frac{104}{8{,}760} * 1.21 * 1.124$ = 0.016 kW

Side-by-Side = $\frac{182}{8{,}760} * 1.21 * 1.124$ = 0.028 kW

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

13 Blasnik, Michael. *Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study*. July 29, 2004. (p. 47 assumes that 85% of homes have central air conditioning).

14 Ibid. (p. 48, extrapolated by taking the ratio of existing summer to existing annual profile for hours ending 16 through 18, and multiplying by new annual profile).

Reference Table

Deemed Measure Savings

Efficiency Level	Refrigerator Configuration	Average Annual kWh Savings per Unit	Average Summer Peak Coincident kW Savings per Unit	Average Annual Fossil Fuel Heating MMBtu Savings per Unit
ENERGY STAR	Bottom Freezer	130	0.020	n/a
	Top Freezer	83	0.013	
	Side-by-Side	146	0.023	
CEE Tier 2	Bottom Freezer	162	0.025	n/a
	Top Freezer	104	0.016	
	Side-by-Side	182	0.028	

Refrigerator Replacement (Low Income, Early Replacement)

	Measure Details
Official Measure Code	Res-Appl-Refrig-LI-1
Measure Unit	Per refrigerator
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by measure age
Peak Demand Reduction (kW)	Varies by measure age
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by measure age
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	17
Incremental Cost	$490.73
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the early removal of an existing inefficient refrigerator from service, prior to its natural end of life, and replacement with a new ENERGY STAR-qualifying unit. This measure is suitable for low income and home performance programs. Savings are calculated for the estimated energy consumption during the remaining life of the existing unit.

Definition of Efficient Equipment

The efficient condition is a new replacement refrigerator meeting the ENERGY STAR efficiency standard (defined as requiring ≥ 20% less energy consumption than an equivalent unit meeting federal standard requirements).

Definition of Baseline Equipment

The baseline condition is the existing inefficient refrigerator being used for the remaining assumed useful life of the unit. Then, for the remainder of the measure life, the baseline becomes a new refrigerator meeting the minimum federal efficiency standard.

Deemed Lifetime of Efficient Equipment

The measure life is 17 years.[15]

---

15 This is consistent with Efficiency Vermont and New Jersey TRMs.

The assumed remaining useful life of the existing refrigerator being replaced is 8 years.[16]

Deemed Measure Cost

The net present value of the deferred replacement cost (the cost associated with replacing the existing unit with a standard unit that would have had to occur in 8 years had the existing unit not been replaced) is $490.73.[17]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta\text{kWh for remaining life of existing unit (first 8 years)} = UEC_{EXISTING} - UEC_{ES}$$

$$\Delta\text{kWh for remaining measure life (next 9 years)} = UEC_{BASE} - UEC_{ES}$$

Where:

$UEC_{EXISTING}$	=	Unit energy consumption of existing refrigerator (= 1,696 kWh)[18]
UEC_{ES}	=	Unit energy consumption of new ENERGY STAR refrigerator (= 397 kWh)[19]
UEC_{BASE}	=	Unit energy consumption of new baseline refrigerator (= 453 kWh)[20]

16 KEMA. *Residential Refrigerator Recycling Ninth Year Retention Study*. 2004.

17 Determined by calculating the net present value (with a 5% discount rate) of the annuity payments from years 9 to 17 of a deferred replacement of a standard efficiency unit costing $1,150.00 (from ENERGY STAR calculator, available online: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls).

18 Navigant Consulting. *AEP Ohio Energy Efficiency/Demand Response Plan Year 1 (1/1/2009-12/31/2009) Program Year Evaluation Report: Appliance Recycling Program*. March 9, 2010. (Used regression-based savings estimates and part-use factors for primary refrigerators, multiplied by an in situ factor of 0.85 as discussed in the Refrigerator and/or Freezer Retirement (Early Retirement) measure section.)

19 Approximate average consumption of typical ENERGY STAR refrigerator: http://www.energystar.gov/index.cfm?fuseaction=refrig.display_products_excel

20 Approximate average consumption of typical baseline refrigerator at federal standard efficiency levels: http://www.energystar.gov/index.cfm?fuseaction=refrig.display_products_excel

$$\Delta\text{kWh for remaining life of existing unit (first 8 years)} = 1{,}696 - 397 = 1{,}299 \text{ kWh}$$

$$\Delta\text{kWh for remaining measure life (next 9 years)} = 453 - 397 = 56 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta\text{kW} = \frac{\Delta kWh}{8{,}760} * TAF * LSAF$$

$$\Delta\text{kW for existing unit remaining life (first 8 years)} = \left[\left(\frac{UEC_{EXISTING}}{8760} * LSAF_{EXIST}\right) - \left(\frac{UEC_{ES}}{8{,}760} * LSAF_{NEW}\right)\right] * TAF$$

$$\Delta\text{kW for remaining measure life (next 9 years)} = \left(\frac{UEC_{EXISTING} - UEC_{ES}}{8{,}760}\right) * TAF * LSAF_{NEW}$$

Where:

TAF = Temperature adjustment factor (= 1.21)[21]

$LSAF_{exist}$ = Load shape adjustment factor for existing unit (= 1.063)[22]

$LSAF_{new}$ = Load shape adjustment factor for new unit (= 1.124)[23]

$$\Delta\text{kW for existing unit remaining life (first 8 years)} = \frac{1{,}696}{8{,}760} * 1.21 * 1.063 - \frac{397}{8{,}760} * 1.21 * 1.124 = 0.187 \text{ kW}$$

$$\Delta\text{kW for remaining measure life (next 9 years)} = \frac{56}{8{,}760} * 1.21 * 1.124 = 0.009 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

21 Blasnik, Michael. *Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study*. July 29, 2004. (p. 47 assumes 85% of homes have central air conditioning).

22 Ibid. p. 48. Assumed existing unit summer average LSAF for hours ending 16 through 18.

23 Ibid. p. 48. Extrapolated daily load shape adjustment factor by taking the ratio of existing summer to existing annual profile for hours ending 16 through 18, multiplied by the new annual profile.

Clothes Washer – ENERGY STAR and CEE TIER 3 (Time of Sale)

	Measure Details
Official Measure Code	Res-Appl-CloWash-1
Measure Unit	Per clothes washer
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by efficiency level
Peak Demand Reduction (kW)	Varies by efficiency level
Annual Fossil Fuel Savings (MMBtu)	Varies by efficiency level
Lifetime Energy Savings (kWh)	Varies by efficiency level
Lifetime Fossil Fuel Savings (MMBtu)	Varies by efficiency level
Water Savings (gal/yr)	Varies by efficiency level
Effective Useful Life (years)	11
Incremental Cost	Varies by efficiency level
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is purchasing (time of sale) and installing a clothes washer exceeding either the ENERGY STAR or CEE Tier 2 minimum qualifying efficiency standards presented in the table below.

Minimum Qualifying ENERGY STAR or CEE Tier 2 Efficiency Standards

Efficiency Level	Modified Energy Factor	Water Factor
Federal Standard	≥ 1.26	No requirement
ENERGY STAR (as of January 1, 2011)	≥ 2.00	≤ 6.0
CEE Tier 2	≥ 2.20	≤ 4.5

The MEF measures the total energy consumption of the laundry cycle (washing and drying). It indicates the number of cubic feet of laundry that can be washed and dried with one kilowatt-hour of electricity; the higher the number, the greater the efficiency.

The water factor is the number of gallons needed for each cubic foot of laundry. A lower number indicates lower consumption and a more efficient use of water.

Definition of Efficient Equipment

The efficient condition is a clothes washer meeting either the ENERGY STAR or CEE Tier 2 efficiency criteria presented in the table above.

Definition of Baseline Equipment

The baseline condition is a clothes washer at the minimum federal baseline efficiency presented in the table above.

Deemed Lifetime of Efficient Equipment

The measure life is 11 years.[24]

Deemed Measure Cost

The incremental cost is $210.12 for an ENERGY STAR unit and $215.90 for a CEE Tier 2 unit.[25]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

Savings are determined by applying the proportion of consumption used for water heating and clothes washer and clothes dryer operation to MEF assumptions, then to the mix of DHW heating fuels and dryer fuels (while factoring in savings from reduced water usage).

The key assumptions and their sources are:

Washer Volume	=	3.23 cubic feet[26]
Baseline MEF	=	1.26
ENERGY STAR MEF	=	2.0
CEE Tier 2 MEF	=	2.2
Number of cycles per year	=	320[27]
Percentage of energy consumption for water heating and clothes washer and dryer operation	=	26%, 7%, and 67% (respectively)[28]

24 "ENERGY STAR Certified Products." http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW

25 Itron, Inc. 2010-2012 WO017 Ex Ante Measure Cost Study Final Report. May 27, 2014. Submitted to the California Public Utilities Commission.

26 Average unit size from Efficiency Vermont program.

27 U.S. Energy Information Administration. 2005 Residential Energy Consumption Survey (RECS) for East North Central Census Division. Available online: http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/hc8waterheating/pdf/tablehc12.8.pdf (weighted average).

28 U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. Clothes Washer Technical Support Document. Chapter 4 Engineering Analysis, Table 4.1, Page 4-5. Available online: http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/chapter_4_engineering.pdf

Average gallons of water savings per load[29] = ENERGY STAR = 19.6; CEE Tier 2= 22.4

Community/municipal water and wastewater pump savings per gallon water saved = 0.0039 kWh[30]

Indiana Domestic Hot Water Fuel Mix

Fuel	Percentage of Homes*
Electric	27%
Natural Gas	63%
Other	10%

* U.S. Energy Information Administration. *2005 Residential Energy Consumption Survey (RECS) for East North Central Census Division*. Available online: http://www.eia.doe.gov/emeu/recs/recs2005/ hc2005_tables/hc8waterheating/pdf/tablehc12.8.pdf

Indiana Dryer Fuel Mix

Fuel	Percentage of Homes*
Electric	66%
Natural Gas	34%

* U.S. Energy Information Administration. *2005 Residential Energy Consumption Survey (RECS) for East North Central Census Division*. Available online: http://www.eia.doe.gov/emeu/recs/recs2005/ hc2005_tables/hc8waterheating/pdf/tablehc12.8.pdf

$$\Delta kWh_{ENERGY\ STAR} = 202\ kWh$$

$$\Delta kWh_{CEE\ TIER\ 2} = 233\ kWh$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{Hours} * CF$$

29 Determined by dividing gallons per load assumption from ENERGY STAR calculator by water factor (gallons per cubic foot) to determine cubic feet assumption, then multiplying by each efficient case water factor.

30 Efficiency Vermont. (Analysis revealed 0.0024 kWh pump energy consumption per gallon of water supplied, and 0.0015 kWh consumption per gallon for waste water treatment.)

Where:

Hours = Assumed run hours of clothes washer (= 320)[31]

CF = Summer peak coincidence factor (= 0.045)[32]

$$\Delta kW_{\text{ENERGY STAR}} = \frac{202}{320} * 0.045 = 0.028 \text{ kW}$$

$$\Delta kW_{\text{CEE TIER 2}} = \frac{233}{320} * 0.045 = 0.033 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

Fossil fuel savings are based on the mix of DHW heating fuels and dryer fuels.

- ENERGY STAR unit savings = 0.447 MMBtu
- CEE Tier 2 unit savings = 0.516 MMBtu

Water Impact Descriptions and Calculation

- ENERGY STAR unit savings = 6,265 gallons
- CEE Tier 2 unit savings = 7,160 gallons

Reference Table

Deemed Measure Savings

	Average Annual kWh Savings per Unit	Average Summer Peak Coincident kW Savings per Unit	Average Annual Fossil Fuel Heating MMBtu Savings per Unit	Average Annual Water Gallon Savings per Unit
ENERGY STAR	202	0.028	0.447	6,265
CEE Tier 2	233	0.033	0.516	7,160

31 U.S. Energy Information Administration. *2005 Residential Energy Consumption Survey (RECS) for East North Central Census Division.* Available online: http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/hc10homeappliaceindicators/pdf/tablehc11.10.pdf (used weighted average number of cycles from CW worksheet and 1 hour average per cycle).

32 Calculated from Itron eShapes, which is 8,760 hourly data by end use for Upstate New York, adjusted for Ohio peak definitions.

ENERGY STAR Dishwasher

	Measure Details
Official Measure Code	Res-Appl-DishWash-1
Measure Unit	Per dishwasher
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	77 (natural gas water heater) 150 (electric water heater)
Peak Demand Reduction (kW)	0.027 (natural gas water heater) 0.052 (electric water heater)
Annual Fossil Fuel Savings (MMBtu)	1.3
Lifetime Energy Savings (kWh)	777 (natural gas water heater) 1,650 (electric water heater)
Lifetime Fossil Fuel Savings (MMBtu)	14.3
Water Savings (gal/yr)	TBD
Effective Useful Life (years)	11
Incremental Cost	$211.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is a residential dishwasher meeting the minimum ENERGY STAR qualifying efficiency standards. These dishwashers are assumed to be located within a residential unit.

Definition of Efficient Equipment

The efficient condition is a new dishwasher meeting the ENERGY STAR Tier 2 requirements (EF ≥ 0.68).

Definition of Baseline Equipment

The baseline condition is a new dishwasher meeting minimum federal appliance standards (EF = 0.46).

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 11 years.

Deemed Measure Cost

The incremental cost for this measure is $211.00.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

Energy savings and demand reduction were determined using the U.S. Environmental Protection Agency ENERGY STAR dishwasher calculator.[33]

Annual kWh Savings = 77 kWh (natural gas water heater)
= 150 kWh (electric water heater)

Summer Peak Coincident Demand Reduction

Summer peak coincident factor savings = 0.027 kW (natural gas water heater)
= 0.052 kW (electric water heater)

Fossil Fuel Impact Descriptions and Calculation

Annual MMBtu savings = 1.300 (natural gas water heater only)

33 Available online: www.energystar.gov

ENERGY STAR Dehumidifier (Time of Sale)

	Measure Details
Official Measure Code	Res-Appl-ES Dehumid-1
Measure Unit	Per dehumidifier
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by capacity
Peak Demand Reduction (kW)	Varies by capacity
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by capacity
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	$45.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is purchasing and installing a dehumidifier meeting the minimum ENERGY STAR qualifying efficiency standard established on October 1, 2006 in a residential setting in place of a unit that meets the minimum federal standard efficiency.

Definition of Efficient Equipment

To qualify, the new dehumidifier must meet the ENERGY STAR standards as of October 1, 2006, outlined in the table below.

Minimum ENERGY STAR Dehumidifier Standards

Capacity (pints/day)	ENERGY STAR Criteria (L/kWh)
≤ 25	≥ 1.20
> 25 to ≤ 35	≥ 1.40
> 35 to ≤ 45	≥ 1.50
> 45 to ≤ 54	≥ 1.60
> 54 to ≤ 75	≥ 1.80
> 75 to ≤ 185	≥ 2.50

Definition of Baseline Equipment

The baseline condition is a new dehumidifier that meets the federal efficiency standards outlined in the table below.

Minimum Federal Dehumidifier Standards

Capacity (pints/day)	Federal Standard Criteria (L/kWh)
≤ 25	≥ 1.10
> 25 to ≤ 35	≥ 1.20
> 35 to ≤ 45	≥ 1.20
> 45 to ≤ 54	≥ 1.23
> 54 to ≤ 75	≥ 1.55
> 75 to ≤ 185	≥ 1.90

Deemed Lifetime of Efficient Equipment

The assumed lifetime of the measure is 12 years.[34]

Deemed Measure Cost

The assumed incremental capital cost for this measure is $45.00.[35]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = C * \frac{0.473}{24} * \frac{Hours}{\frac{L}{kWh}}$$

Where:

C = Average capacity of dehumidifier in pints per day

0.473 = Constant to convert pints to liters

24 = Hours in a day

Hours = Run hours per year (= 1,620)[36]

L/kWh = Liters of water consumed per kilowatt-hour (= based on capacity; see tables above)

---

34 ENERGY STAR Dehumidifier Calculator http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls

35 Based on available data from the U.S. Department of Energy's lifecycle cost analysis spreadsheet available from: http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/lcc_dehumidifier.xls

36 ENERGY STAR Dehumidifier Calculator http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls

The annual kilowatt-hour calculation results for each capacity class are presented in the table below.

Annual Dehumidifier Savings by Capacity

Capacity Range	Pints Used Per Day	ENERGY STAR	Federal Standard	Savings (kWh)
≤ 25	22.4	596	650	54
> 25 to ≤ 35	30	684	798	114
> 35 to ≤ 45	40	851	1,064	213
> 45 to ≤ 54	49.5	988	1,285	297
> 54 to ≤ 75	64.5	1,144	1,329	185
> 75 to ≤ 185	92.8	1,185	1559	374

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{Hours} * CF$$

Where:

CF = Summer peak coincidence factor (= 0.37)[37]

The peak coincident demand calculation results for each capacity class is presented in the table below.

Summer Peak Coincident Demand Reduction by Capacity

Capacity Range	Pints Used per Day	ENERGY STAR	Federal Standard	Demand Reduction (kW)
≤ 25	22.4	0.136	0.148	0.012
> 25 to ≤ 35	30	0.156	0.182	0.027
> 35 to ≤ 45	40	0.194	0.242	0.048
> 45 to ≤ 54	49.5	0.225	0.293	0.068
> 54 to ≤ 75	64.5	0.261	0.303	0.042
> 75 to ≤ 185	92.8	0.270	0.355	0.085

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

[37] Based on usage being evenly distributed day vs. night and weekend vs. weekday, and dehumidifier being used from April through September (for 4,392 possible hours). The ENERGY STAR Dehumidifier Calculator lists 1,620 operating hours; therefore the summer peak coincidence is: 1,620/4,392 = 36.9%.

ENERGY STAR Room Air Conditioner (Time of Sale)

	Measure Details
Official Measure Code	Res-Appl-ES RAC-TOS-1
Measure Unit	Per air conditioning unit
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	9
Incremental Cost	
Important Comments	$40.00
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is purchasing and installing a room air conditioning unit that meets either the ENERGY STAR or CEE Tier 1 minimum qualifying efficiency specifications, in place of a baseline unit meeting minimum federal standard efficiency ratings presented in the table below.

Minimum Qualifying Room Air Conditioner Efficiency Specifications

Product Class (Btu/hr)	Federal Standard (EER)	ENERGY STAR (EER)	CEE Tier 1 (EER)
8,000 to 13,999	≥ 10.9	≥ 11.3	≥ 11.3

Definition of Efficient Equipment

The efficient condition is a new room air conditioning unit meeting either the ENERGY STAR of CEE Tier 1 efficiency standards presented in the table above.

Definition of Baseline Equipment

The baseline condition is a new room air conditioning unit meeting the minimum federal efficiency standards presented in the table above.

Deemed Lifetime of Efficient Equipment

The measure life is 9 years.[38]

Deemed Measure Cost

Until 2013, the incremental cost was $40.00 for an ENERGY STAR unit and $80.00 for a CEE Tier 1 unit.[39] Now that each share efficiency standards, the incremental cost for each is determined to be $40.00

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = EFLH_{COOL} * Btuh * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}}{1{,}000}$$

Where:

$EFLH_{COOL}$ = Equivalent full load hours of room air conditioning unit (= depends on location;[40] see table below)

Equivalent Full Load Hours by City

City	$EFLH_{COOL}$
Indianapolis	332
South Bend	288
Evansville	445
Ft. Wayne	257
Terre Haute	391

38 This value was based on the ENERGY STAR value for room air conditioners: www.energystar.gov

39 Based on field study conducted by Efficiency Vermont.

40 Based on CDD adjusted values from: RLW Analytics. *Final Report Coincidence Factor Study Residential Room Air Conditioners.* June 23, 2008.

Btuh = Average size of rebated unit (=11,357)[41]

EER_{BASE} = Efficiency of baseline unit (= 10.9)[42]

EER_{EE} = Efficiency of new unit (= 11.3 for ENERGY STAR; = 11.3 for CEE Tier 1)[43]

For example, the energy savings from installing a room air conditioning unit in Indianapolis would be:

$$\Delta kWh_{ENERGY\ STAR} = 332 * 11{,}357 * \frac{\frac{1}{10.9} - \frac{1}{11.3}}{1{,}000} = 12$$

$$\Delta kWh_{CEE\ TIER\ 1} = 332 * 11{,}357 * \frac{\frac{1}{10.9} - \frac{1}{11.3}}{1{,}000} = 12$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = Btuh * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{eEE}}}{1{,}000} * CF$$

Where:

CF = Summer peak coincidence factor (= 0.3)[44]

For example, the energy savings from installing a room air conditioning unit in Indianapolis would be:

$$\Delta kW_{ENERGY\ STAR} = 11{,}357 * \frac{\frac{1}{10.9} - \frac{1}{11.3}}{1{,}000} * 0.3 = 0.011\ kW$$

$$\Delta kW_{CEE\ TIER\ 1} = 11{,}357 * \frac{\frac{1}{10.9} - \frac{1}{11.3}}{1{,}000} * 0.3 = 0.011\ kW$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

41 ENERGY STAR. "ENERGY STAR Certified Room Air Conditioners." http://www.energystar.gov/productfinder/product/certified-room-air-conditioners/.

42 Minimum Federal Standard for capacity range. 2015 Federal Energy Conservation Standard for Room ACs (e-CFR Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32)

43 This is the minimum qualifying standards. http://library.cee1.org/sites/default/files/library/9296/CEE_ResApp_RoomAirConditionerSpecification_2003_Updated_Again.pdf

44 RLW Analytics. *Final Report Coincidence Factor Study Residential Room Air Conditioners*. June 23, 2008. Available online: http://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/117_RLW_CF%20Res%20RAC.pdf

ENERGY STAR Room Air Conditioner Replacement (Low Income, Early Replacement)

	Measure Details
Official Measure Code	Res-Appl-ES RAC-LI-1
Measure Unit	Per air conditioning unit
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	Varies by efficiency rating
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the early removal of an existing inefficient room air conditioner unit from service, prior to its natural end of life, and replacing with a new ENERGY STAR qualifying unit. This measure is suitable for low income and home performance programs. Savings are calculated as the difference between existing unit and efficient unit consumption during the remaining life of the existing unit, and between the new baseline unit and efficient unit consumption for the remainder of the measure life.

Definition of Efficient Equipment

The efficient condition is a new replacement room air conditioning unit meeting the ENERGY STAR efficiency standard (i.e., an efficiency rating greater than or equal to 10.8 EER).

Definition of Baseline Equipment

The baseline condition is the existing inefficient room air conditioning unit for the remaining assumed useful life of the unit; then, for the remainder of the measure life, the baseline becomes a new replacement unit meeting the minimum federal efficiency standard (i.e., an efficiency rating greater than or equal to 9.8 EER).

Deemed Lifetime of Efficient Equipment

The measure life is 12 years.[45]

For dual baseline purposes, the assumed remaining useful life of the existing room air conditioning unit being replaced is 3 years.[46]

Deemed Measure Cost

The actual measure cost for removing the existing unit and installing the new unit should be used.

Deemed O&M Cost Adjustments

The net present value of the deferred replacement cost (the cost associated with replacing the existing unit with a standard unit that would have occurred within three years had the existing unit not been replaced) should be calculated as:

Cost of ENERGY STAR unit - $50 (incremental cost of ENERGY STAR unit over baseline unit)[47] * 69%[48]

Savings Algorithm

Energy Savings

$$\Delta kWh \text{ for remaining life of existing unit (first 3 years)} = EFLH_{COOL} * BtuH * \frac{\frac{1}{EER_{EXIST}} - \frac{1}{EER_{EE}}}{1{,}000}$$

$$\Delta kWh \text{ for remaining measure life (next 9 years)} = EFLH_{COOL} * BtuH * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}}{1{,}000}$$

45 GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

46 Based on Connecticut TRM; Connecticut Energy Efficiency Fund; CL&P and UI Program Savings Documentation for2008 Program Year

47 Per the ENERGY STAR calculator, ENERGY STAR units are $220.00 while baseline units are $170.00; see http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerRoomAC.xls

48 This 69% is the ratio of the net present value (with a 5% discount rate) of the annuity payments from years 4 to 12 of a deferred replacement of a standard efficiency unit costing $170.00, divided by the standard efficiency unit cost (also $170.00). The calculation allows for use of the known ENERGY STAR replacement cost to calculate an appropriate baseline replacement cost.

Where:

$EFLH_{COOL}$ = Equivalent full load hours of room air conditioning unit (= dependent on location;[49] see table below)

Equivalent Full Load Hours by Location

City	$EFLH_{COOL}$
Indianapolis	332
South Bend	288
Evansville	445
Ft. Wayne	257
Terre Haute	391

Btuh = Average size of rebated unit (= 11,357)[50]

EER_{EXIST} = Efficiency of existing unit (= 7.7)[51]

EER_{BASE} = Efficiency of baseline unit that will be replacing exiting unit (= 10.9)[52]

EER_{EE} = Efficiency of ENERGY STAR unit (= 11.3)[53]

For example, the energy savings from installing a room air conditioner in Indianapolis would be:

$$\Delta kWh \text{ for remaining life of existing unit (first 3 years)} = 332 * 11{,}357 * \frac{\frac{1}{7.7} - \frac{1}{11.3}}{1{,}000} = 156 \text{ kWh}$$

$$\Delta kWh \text{ for remaining measure life (next 9 years)} = 332 * 11{,}357 * \frac{\frac{1}{10.9} - \frac{1}{11.3}}{1{,}000} = 12 \text{ kWh}$$

---

49 Based on CDD adjusted values from: RLW Analytics. *Final Report Coincidence Factor Study Residential Room Air Conditioners.* June 23, 2008. Available online: http://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/117_RLW_CF%20Res%20RAC.pdf

50 ENERGY STAR. "ENERGY STAR Certified Room Air Conditioners." http://www.energystar.gov/productfinder/product/certified-room-air-conditioners/

51 Nexus Market Research Inc. and RLW Analytics. *Impact, Process, and Market Study of the Connecticut Appliance Retirement Program: Overall Report*. December 2005.

52 Minimum Federal Standard for capacity range. 2015 Federal Energy Conservation Standard for Room ACs (e-CFR Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32)

53 This is the minimum qualifying ENERGY STAR standard. http://www.energystar.gov/index.cfm?c=roomac.pr_crit_room_ac

Summary Peak Coincident Demand Reduction

$$\Delta kW \text{ for remaining life of existing unit (first 3 years)} = BtuH * \frac{\frac{1}{EER_{EXIST}} - \frac{1}{EER_{EE}}}{1{,}000} * CF$$

$$\Delta kW \text{ for remaining measure life (next 9 years)} = BtuH * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}}{1{,}000} * CF$$

Where:

CF = Summer peak coincidence factor (= 0.3)[54]

$$\Delta kW \text{ for remaining life of existing unit (1}^{st}\text{ 3 years)} = 11{,}357 * \frac{\frac{1}{7.7} - \frac{1}{11.3}}{1{,}000} * 0.3 = 0.141 \text{ kW}$$

$$\Delta kW \text{ for remaining measure life (next 9 years)} = 11{,}357 * \frac{\frac{1}{10.9} - \frac{1}{11.3}}{1{,}000} * 0.3 = 0.011 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

54 RLW Analytics. *Final Report Coincidence Factor Study Residential Room Air Conditioners.* June 23, 2008.

ENERGY STAR Room Air Conditioner Recycling (Early Retirement)

	Measure Details
Official Measure Code	Res-Appl-ES RAC-Recycle-1
Measure Unit	Per air conditioning unit
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	3
Incremental Cost	$129.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is a drop-off service that takes existing inefficient room air conditioner units from service prior to their natural end of life. The measure savings are based on a percentage of these units being replaced with a baseline standard efficiency unit (note that units actually replaced by a new ENERGY STAR qualifying unit record the savings increment between the baseline and ENERGY STAR).

Definition of Efficient Equipment

There is no efficient condition; this measure relates to retiring an existing inefficient unit.

Definition of Baseline Equipment

The baseline condition is the existing inefficient room air conditioning unit.

Deemed Lifetime of Equipment

The assumed remaining useful life of the early replacement existing room air conditioning unit being retired is 3 years.

Deemed Measure Cost

The actual implementation cost for recycling the existing unit plus the cost for replacing some of the units is $129.00.[55]

Deemed O&M Cost Adjustments

The net present value of the deferred replacement cost (the cost associated with replacing units with a standard unit that would have occurred within three years had the existing unit not been replaced) is $89.36.[56]

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{EFLH_{COOL} * Btuh}{1{,}000} * \left(\frac{1}{EER_{EXIST}} - \frac{\%\ \text{replaced}}{EER_{NEWBASE}}\right)$$

Where:

$EFLH_{COOL}$ = Equivalent full load hours of room air conditioning unit (= dependent on location; see table below)*

Equivalent Full Load Hours by City

City	$EFLH_{COOL}$
Indianapolis	332
South Bend	288
Evansville	445
Ft. Wayne	257
Terre Haute	391

Based on CDD adjusted values from: RLW Analytics. *Final Report Coincidence Factor Study Residential Room Air Conditioners.* June 23, 2008. Available online: http://www.puc.nh.gov/Electric/Monitoring%20and %20Evaluation%20Reports/National%20Grid/117_RLW_CF%20Res%20RAC.pdf

---

55 This is calculated by multiplying the percentage assumed to be replaced (76% based on: Nexus Market Research Inc. and RLW Analytics. *Impact, Process, and Market Study of the Connecticut Appliance Retirement Program: Overall Report*. December 2005.) by the assumed cost of a standard efficiency unit ($170.00 from: ENERGY STAR calculator. http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerRoomAC.xls). .

56 Determined by calculating the net present value (with a 5% discount rate) of the annuity payments from years 4 to 12 for a deferred replacement of a standard efficiency unit costing $170.00 multiplied by the 76%, the percentage of units being replaced (0.76 * $170 = $129.20). Baseline cost from ENERGY STAR calculator: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerRoomAC.xls

Btuh = Average capacity of rebated unit (= 11,357)[57]

EER_{EXIST} = Efficiency of existing unit (= 7.7)[58]

% replaced = Percentage of units dropped off that are replaced (= 76%)[59]

$EER_{NEWBASE}$ = Efficiency of baseline unit that replaces exiting unit (= 10.9)[60]

For example, the energy savings from removing a room air conditioning unit in Indianapolis would be:

$$\Delta kWh = \frac{332 * 11{,}357}{1{,}000} * \left(\frac{1}{7.7} - \frac{0.76}{10.9}\right) = 227$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{Btuh * CF}{1{,}000} * \left(\frac{1}{EER_{EXIST}} - \frac{\%\ \text{replaced}}{EER_{NEWBASE}}\right)$$

Where:

CF = Summer peak coincidence factor (= 0.3)[61]

For example, the demand reduction from removing a room air conditioner in Indianapolis would be:

$$\Delta kWh = \frac{11{,}357 * 0.3}{1{,}000} * \left(\frac{1}{7.7} - \frac{0.76}{10.9}\right) = 0.205$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

57 ENERGY STAR. "ENERGY STAR Certified Room Air Conditioners." http://www.energystar.gov/productfinder/product/certified-room-air-conditioners/

58 Nexus Market Research Inc. and RLW Analytics. *Impact, Process, and Market Study of the Connecticut Appliance Retirement Program: Overall Report*. December 2005.

59 Ibid. Report states that 63% of units were replaced with ENERGY STAR units and 13% with non-ENERGY STAR. However, this formula assumes that all units are non-ENERGY STAR since the increment of savings between baseline units and ENERGY STAR unit would be recorded for the Efficient Products Program when the new unit is purchased.

60 This is the minimum federal standard for capacity range. Department of Energy. *2015 Federal Energy Conservation Standard for Room ACs*. e-CFR Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32. June 2015

61 RLW Analytics. *Final Report Coincidence Factor Study Residential Room Air Conditioners*. June 23, 2008. Available online: http://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/117_RLW_CF%20Res%20RAC.pdf

Smart Strip Power Strip (Time of Sale)

	Measure Details
Official Measure Code	Res-Appl-Strip-1
Measure Unit	Per power strip
Measure Category	Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	23
Peak Demand Reduction (kW)	0.002
Annual Fossil Fuel Savings (MMBtu)	-0.041
Lifetime Energy Savings (kWh)	92
Lifetime Fossil Fuel Savings (MMBtu)	-0.164
Water Savings (gal/yr)	0
Effective Useful Life (years)	4
Incremental Cost	\$16.00 for a 5-plug \$26.00 for a 7-plug
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is controlled power strips (also known as smart strips), which are multi-plug power strips with the ability to automatically disconnect specific connected loads depending on the power draw of a control load, also plugged into the strip. Power is disconnected from the switched (controlled) outlets when the control load power draw is reduced below a certain adjustable threshold, thus turning off the appliances plugged into the switched outlets. By disconnecting, the overall standby load of a centralized group of equipment (i.e. entertainment centers and home office) can be reduced. Uncontrolled outlets are also provided that are not affected by the control device and are always providing power to any device plugged in. This measure provides savings from controllable peripheral devices associated with home computers and television sets.

Definition of Efficient Equipment

The efficient condition is the use of a smart strip.

Definition of Baseline Equipment

The baseline condition is a standard power strip that does not control connected loads.

Deemed Lifetime of Efficient Equipment

The assumed lifetime of the smart strip is 4 years.[62]

Deemed Measure Cost

The incremental cost over a standard power strip with surge protection is $16.00 for a 5-plug smart strip and $26.00 for a 7-plug smart strip.[63]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\sum^{Peripherals} W_{STANDBY} * F_{HOMES} * F_{CONTROL} * H * \frac{1 + WHF_E}{1{,}000}$$

Where:

$W_{STANDBY}$	=	Power use in standby mode
F_{HOMES}	=	Percentage of homes with peripherals (= see tables below)
F_{CONTOL}	=	Percentage of peripherals controlled (= see tables below)
H	=	Number of hours per year peripherals are controlled (= 7,474 for computer peripherals; = 6,784 for television peripherals) [64]
WHF_E	=	Waste heat factor for energy to account for HVAC interactions with efficient lighting (= - 0.059 as weighted average across all HVAC systems and cities; see Appendix B)

[62] David Rogers, Power Smart Engineering. *Smart Strip Electrical Savings and Usability.* October 2008. p. 22.

[63] New York State Energy Research and Development Authority. *Measure Characterization for Advanced Power Strips*. August 2011. p. 4.

[64] Ibid.

Assumptions for Home Computer Peripherals

Peripheral	$W_{STANDBY}$	$F_{CONTROL}$	F_{HOMES}
Flat Panel Monitor	1.29	100.0%	69.3%
CRT Monitor	0.72	100.0%	25.1%
Printer	2.32	80.0%	43.1%
Multifunction Printer (without fax)	7.81	66.7%	4.0%
Multifunction Printer (with fax)	7.57	57.3%	8.3%
Speakers	4.76	100.0%	0.6%
Scanner	1.42	95.5%	7.4%
Copier	0.32	58.1%	4.8%
Modem	6.46	90.4%	8.1%
Router	5.07	93.3%	9.9%
External Hard Drive	1.13	100.0%	0.3%

Assumptions for Television Peripherals

Peripheral	$W_{STANDBY}$	$F_{CONTROL}$	F_{HOMES}
DVD Player	2.12	93.3%	53.3%
VCR	5.92	97.9%	21.3%
Stereo	4.07	50.7%	30.9%
Speakers	11.07	86.2%	2.1%
Video Game Console	0.57	98.0%	5.3%
Computer Used for Video	17.77	66.7%	0.3%

For example, the energy savings would be calculated as:

$$\Delta kWh_{COMPUTER} = ((1.29 * 1.0 * 0.693) + (0.72 * 1.0 * 0.251) + (2.32 * 0.80 * 0.431) + (7.81 * 0.667 * 0.04) + (7.57 * 0.573 * 0.083) + (4.76 * 1.0 * 0.006) + (1.42 * 0.955 * 0.074) + (0.32 * 0.581 * 0.048) + (6.46 * 0.904 * 0.081) + (5.07 * 0.933 * 0.099) + (1.13 * 1.0 * 0.003)) * 7{,}474 * \frac{(1 - 0.059)}{1{,}000} = 24.8 \text{ kWh}$$

$$\Delta kWh_{TELEVISION} = ((2.12 * 0.933 * 0.533) + (5.92 * 0.979 * 0.213) + (4.07 * 0.507 * 0.309) + (11.07 * 0.862 * 0.021) + (0.57 * 0.98 * 0.053) + (17.77 * 0.667 * 0.003)) * 6{,}784 * \frac{1 - 0.059}{1{,}000} = 20.4$$

$$\Delta kWh = \frac{\Delta kWh_{COMPUTER} + \Delta kWh_{TELEVISION}}{2} = \frac{24.8+20.4}{2} = 23$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \sum_{1}^{Peripherals} W_{STANDBY} * F_{HOMES} * F_{CONTROL} * CF * \frac{1+WHF_D}{1{,}000}$$

CADMUS Opinion Dynamics INTEGRAL ANALYTICS BuildingMetrics INCORPORATED

Where:

WHF_D = Waste heat factor for demand to account for HVAC interactions with efficient lighting (= 0.057 as weighted average value across all HVAC systems and cities; see Appendix B)

CF = Summer peak coincidence factor (= 0.50)

Using default data from above, the demand reduction would be calculated as:

$$\Delta kW_{COMPUTER} = ((1.29 * 1.0 * 0.693) + (0.72 * 1.0 * 0.251) + (2.32 * 0.80 * 0.431) + (7.81 * 0.667 * 0.04) + (7.57 * 0.573 * 0.083) + (4.76 * 1.0 * 0.006) + (1.42 * 0.955 * 0.074) + (0.32 * 0.581 * 0.048) + (6.46 * 0.904 * 0.081) + (5.07 * 0.933 * 0.099) + (1.13 * 1.0 * 0.003)) * 0.5 * \frac{(1 + 0.057)}{1,000} = 0.002$$

$$\Delta kW_{TELEVISION} ((2.12 * 0.933 * 0.533) + (5.92 * 0.979 * 0.213) + (4.07 * 0.507 * 0.309) + 11.07 * 0.862 * 0.021) + (0.57 * 0.98 * 0.053) + (17.77 * 0.667 * 0.003)) * 0.5 * \frac{1 + 0.057}{1,000} = 0.002$$

$$\Delta kW = \frac{\Delta kW_{COMPUTER} + \Delta kW_{TELEVISION}}{2} = \frac{0.002+0.002}{2} = 0.002$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu_{WH} = \Delta kWh * WHF_G = 23 * (-0.0018) = -0.041$$

Where:

$\Delta MMBtu_{WH}$ = Gross customer annual heating MMBtu fuel increased usage from the reduction in lighting heat

WHF_G = Waste heat factor for fossil fuels to account for HVAC interactions with efficient lighting (=-0.0018 as weighted average value across all HVAC systems and cities; see Appendix B)

Building Shell

Envelope Insulation (Retrofit)

	Measure Details
Official Measure Codes	Res-Shell-RoofInsul-1, Res-Shell-WallIns-1
Measure Unit	Per square foot
Measure Category	Building shell
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	25
Incremental Cost	TBD
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing additional insulation in the attic, roof, ceiling, or wall of a residential building. The energy savings are based on an auditor, contractor, or utility staff member being on location to measure and record the existing and new insulation depth and type (to calculate R-values), and the surface area of insulation added.

Definition of Efficient Equipment

The new insulation should meet any qualification criteria required for participation in the program. The new insulation R-value should include the effective R-value of any existing insulation left in situ, as well as installation conditions, such as insulation compression and void fraction.

Definition of Baseline Equipment

The existing insulation R-value should include appropriate adjustment factors for insulation compression and void fraction. The R-value should include the insulation layer only; air gaps and other building materials are accounted for in the simulation models.

Deemed Lifetime of Efficient Equipment

The measure life is 25 years.[65]

Deemed Measure Cost

The actual insulation installation measure cost should be used.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = kSF * \frac{\Delta kWh}{kSF}$$

Where:

kSF	=	Area of installed insulation in 1,000 square feet
$\frac{\Delta \text{kWh}}{\text{kSF}}$	=	Unit energy savings (= dependent on city; see tables in Reference Tables section)

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW}_S = kSF * \frac{\Delta kW}{kSF} * CF$$

Where:

$\frac{\Delta \text{kW}}{\text{kSF}}$	=	Unit demand reduction (= dependent on city; see tables in Reference Tables section)
CF	=	Summer peak coincidence factor (= 0.88)[66]

Fossil Fuel Impact Descriptions and Calculation

Space Heating Savings Calculation

$$\Delta MMBtu = kSF * \frac{\Delta MMBtu}{kSF}$$

---

[65] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

[66] Duke Energy. Load shape data for residential air conditioner loads from DSMore cost-effectiveness tool. Available online: www.integralanalytics.com

Where:

$\frac{\Delta MMBtu}{kSF}$ = Unit fossil fuel energy savings (=dependent on city; see tables in Reference Tables section)

General Calculation Methodology

Unit energy savings values are provided in the Reference Tables sections for a set of baseline and measure R-values, for certain HVAC system types. These values are for homes with and without cooling, and for homes with natural gas, heat pump, or electric resistance heating systems. The R-values are for the insulation layer only; R-values of building materials are included in the simulation model. Interpolation within the tables is permissible for R-values not explicitly listed. The baseline and measure R-values should consider installation conditions, such as insulation compression and coverage. Insulation compression adjustment factors (F_{COMP}) are shown in the table below.

Insulation Compression Adjustment Factor Lookup

Compression Percentage	F_{COMP}
0%	1.00
5%	0.97
10%	0.93
15%	0.89
20%	0.85

An additional adjustment should be taken for the insulation coverage. This factor (F_{VOID}) is determined by the installation grade or void fraction, and the ratio of the insulation R-value (R_{MFG}) to the full assembly R-value (R_{TOTAL}). The insulation coverage adjustment is shown in the table below.

Insulation Void Factor Lookup

$\frac{R_{MFG} * F_{COMP}}{R_{TOTAL}}$	F_{VOID}	
	2% Void (Grade II)	5% Void (Grade III)
0.50	0.96	0.90
0.55	0.96	0.90
0.60	0.95	0.88
0.65	0.94	0.87
0.70	0.94	0.85
0.75	0.92	0.83
0.80	0.91	0.79
0.85	0.88	0.74
0.90	0.83	0.66
0.95	0.71	0.49
0.99	0.33	0.16

The adjusted R-value is the nominal R-value multiplied by the adjustment factors:

$$R_{ADJ} = R_{NOMINAL} * F_{COMP} * F_{VOID}$$

Calculations are given below for the following example project: 2,000 square feet of attic floor insulation is installed in an average Indianapolis home. The home started with uncompressed R-11 insulation with a 5% void fraction. The final R-value (including the original insulation) is R-38, with a 2% void fraction. The building materials and attic air space represent an additional R-5.

Initial Adjusted R-Value Calculation

$$\frac{R_{MFG} \ * \ F_{COMP}}{R_{TOTAL}} = \frac{11 \ * \ 1}{11 + 5} = 0.69$$

$F_{VOID} = 0.85$

The adjusted initial R-value is:

$$R_{ADJ} = R_{NOMINAL} * F_{COMP} * \ F_{VOID} = 11 * \ 1 \ * \ 0.85 = 9.4$$

Final Adjusted R-Value Calculation

$$\frac{R_{MFG} \ * \ F_{COMP}}{R_{TOTAL}} = \frac{38 \ * \ 1}{38 + 5} = 0.88$$

$F_{VOID} = 0.85$ (interpolated)

The adjusted final R-value is:

$$R_{ADJ} = R_{NOMINAL} * F_{COMP} * \ F_{VOID} = 38 * 1 * .85 = 32.3$$

Overall Savings Calculations

The following savings are calculated for the example project using values from tables in the Reference Tables section:

$$\Delta kWh = kSF * \frac{\Delta kWh}{kSF} = 2 * 774.6 = 1{,}550 \ kWh$$

$$\Delta kW \ = kS * \frac{\Delta kW}{kSF} * CF \ = 2 * 0.1179 * 0.88 = 0.118 \ kW$$

$$\Delta \text{MMBtu} = kS * \frac{\Delta MMBtu}{kSF} = 2 * 8.05 = 16.100 \ MMBtu$$

Reference Tables

Building: Single Family
City: Indianapolis
HVAC: Weighted Average
Measure: Roof/Attic/Ceiling Installation

Base R_{ADJ}	0			11			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	2,253.3	0.2109	23.00	N/A	N/A	N/A	N/A	N/A	N/A
19	2,519.1	0.2669	25.77	265.8	0.0557	2.81	N/A	N/A	N/A
30	2,673.3	0.2924	27.43	420.1	0.0813	4.42	154.3	0.0255	1.67
38	2,730.7	0.3093	28.05	477.6	0.0984	5.03	211.7	0.0424	2.28
49	2,783.0	0.3136	28.58	529.9	0.1027	5.64	264.2	0.0468	2.83
60	2,817.8	0.3136	28.96	564.7	0.1027	5.95	298.8	0.0468	3.19

Base R_{ADJ}	30			38		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	N/A	N/A	N/A
38	57.5	0.0169	0.62	N/A	N/A	N/A
49	109.8	0.0212	1.22	52.3	0.0043	0.53
60	144.6	0.0212	1.53	87.1	0.0043	0.91

Building: Single Family
City: South Bend
HVAC: Weighted Average
Measure: Roof/Attic/Ceiling Installation

Base R_{ADJ}	0			11			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	2,222.2	0.1062	23.16	N/A	N/A	N/A	N/A	N/A	N/A
19	2,486.0	0.1399	25.98	263.7	0.0337	2.83	N/A	N/A	N/A
30	2,636.0	0.1603	27.59	413.8	0.0541	4.50	150.1	0.0204	1.67
38	2,693.5	0.1611	28.26	471.3	0.0549	5.11	207.5	0.0212	2.29
49	2,745.3	0.1647	28.81	522.9	0.0585	5.65	259.3	0.0248	2.83
60	2,779.0	0.1647	29.19	556.7	0.0585	6.02	292.9	0.0248	3.21

Base R_{ADJ}	30			38		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	N/A	N/A	N/A
38	57.6	0.008	0.62	N/A	N/A	N/A
49	109.2	0.0043	1.22	51.8	0.0036	0.61
60	142.8	0.0043	1.60	85.3	0.0036	0.91

Building: Single Family
City: Evansville
HVAC: Weighted Average
Measure: Roof/Attic/Ceiling Installation

Base R_{ADJ}	0			11			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	1,870.3	0.4391	18.44						
19	2,096.1	0.5081	20.80	226	0.0682	2.29			
30	2,225.6	0.5544	22.11	355.5	0.1144	3.66	129.7	0.0462	1.37
38	2,275.4	0.5713	22.64	405.3	0.132	4.19	179.3	0.0631	1.90
49	2,318.4	0.5846	23.09	448.3	0.1453	4.65	222.5	0.0764	2.36
60	2,346.5	0.6007	23.40	476.4	0.1616	4.95	250.4	0.0923	2.66

Base R_{ADJ}	30			38		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	N/A	N/A	N/A
38	49.7	0.0169	0.53	N/A	N/A	N/A
49	92.8	0.0301	0.99	43	0.0133	0.46
60	120.9	0.0462	1.29	71.1	0.0294	0.76

Building: Single Family
City: Ft Wayne
HVAC: Weighted Average
Measure: Roof/Attic/Ceiling Installation

Base R_{ADJ}	0			11			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	2,279.7	0.1639	24.32	N/A	N/A	N/A	N/A	N/A	N/A
19	2,546.1	0.1976	27.27	266.3	0.0337	2.96	N/A	N/A	N/A
30	2,699.8	0.2305	28.96	420	0.0666	4.71	153.7	0.0329	1.75
38	2,761.2	0.2305	29.64	481.5	0.0666	5.40	215.1	0.0329	2.43
49	2,814.6	0.2465	30.25	534.9	0.0827	6.00	268.5	0.049	3.04
60	2,848.5	0.2473	30.63	568.7	0.0835	6.38	302.4	0.0498	3.42

Base R_{ADJ}	30			38		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	N/A	N/A	N/A
38	61.4	0.000	0.68	N/A	N/A	N/A
49	115	0.0161	1.29	53.5	0.0161	0.61
60	148.8	0.0169	1.67	87.3	0.0169	0.99

Building: Single Family
City: Terre Haute
HVAC: Weighted Average
Measure: Roof/Attic/Ceiling Installation

Base R_{ADJ}	0			11			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	2,289.2	0.1863	24.24	N/A	N/A	N/A	N/A	N/A	N/A
19	2,559.1	0.2032	27.21	269.9	0.0169	2.96	N/A	N/A	N/A
30	2,715.2	0.22	28.96	425.9	0.0337	4.71	156	0.0169	1.75
38	2,778.0	0.2359	29.64	488.9	0.0506	5.40	218.8	0.0337	2.43
49	2,828.3	0.2359	30.25	539.1	0.0506	6.00	269.2	0.0337	3.04
60	2,863.8	0.2376	30.63	574.7	0.0513	6.38	304.8	0.0345	3.42

Base R_{ADJ}	30			38		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	N/A	N/A	N/A
38	62.8	0.0169	0.68	N/A	N/A	N/A
49	113.2	0.0169	1.29	50.4	0.000	0.61
60	148.8	0.0176	1.67	85.9	0.008	0.99

Building: Single Family
City: Indianapolis
HVAC: Weighted Average
Measure: Wall Installation

Base R_{ADJ}	0			11			13		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	563.6	0.0871	6.16						
13	643.7	0.0918	7.07	80.1	0.0047	0.91			
17	769.2	0.1144	8.45	205.6	0.0273	2.28	125.5	0.0225	1.37
19	815.0	0.1152	8.98	251.4	0.0282	2.81	171.3	0.0233	1.90
21	852.4	0.1322	9.42	288.8	0.0451	3.27	208.8	0.0406	2.36
25	913.4	0.1330	10.05	349.8	0.0461	3.89	269.7	0.0414	2.98
27	937.2	0.1377	10.35	373.6	0.0506	4.18	293.5	0.0461	3.27

Base R_{ADJ}	17			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A	N/A
19	45.8	0.008	0.53	N/A	N/A	N/A
21	83.4	0.0178	0.91	37.4	0.0170	0.46
25	144.2	0.0187	1.60	98.4	0.0178	1.08
27	168.0	0.0233	1.90	122.3	0.0225	1.37

Building: Single Family
City: South Bend
HVAC: Weighted Average
Measure: Wall Installation

Base R_{ADJ}	0			11			13		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	558.4	0.0583	6.23	N/A	N/A	N/A	N/A	N/A	N/A
13	644.5	0.0591	7.22	86.3	0.008	0.99	N/A	N/A	N/A
17	770.7	0.0770	8.60	212.4	0.0187	2.37	126.2	0.0178	1.38
19	815.1	0.0770	9.13	256.9	0.0187	2.89	170.6	0.0178	1.90
21	851.4	0.0770	9.51	293.1	0.0187	3.34	206.8	0.0178	2.36
25	912.2	0.0808	10.20	353.9	0.0225	4.03	267.7	0.0216	2.98
27	936.6	0.0816	10.50	378.2	0.0233	4.27	292.1	0.0225	3.27

Base R_{ADJ}	17			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A	N/A
19	44.4	0.000	0.53	N/A	N/A	N/A
21	80.7	0.000	0.91	36.1	0.000	0.46
25	141.5	0.0037	1.60	97.1	0.0037	1.08
27	165.9	0.0047	1.90	121.4	0.0047	1.37

Building: Single Family
City: Evansville
HVAC: Weighted Average
Measure: Wall Installation

Base R_{ADJ}	0			11			13		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	456.6	0.1089	5.00	N/A	N/A	N/A	N/A	N/A	N/A
13	531.1	0.1267	5.78	74.4	0.0178	0.84	N/A	N/A	N/A
17	639.6	0.1594	6.92	182.9	0.0505	1.98	108.5	0.0319	1.14
19	676.6	0.1642	7.37	220.0	0.0554	2.36	145.6	0.0366	1.60
21	707.9	0.1775	7.68	251.4	0.0686	2.74	177.0	0.0505	1.90
25	756.9	0.1820	8.27	300.2	0.0732	3.27	225.8	0.0554	2.43
27	777.3	0.1953	8.44	320.6	0.0864	3.50	246.2	0.0686	2.66

Base R_{ADJ}	17			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A	N/A
19	37.0	0.0047	0.38	N/A	N/A	N/A
21	68.3	0.0178	0.76	31.5	0.0132	0.38
25	117.3	0.0225	1.29	80.3	0.0178	0.91
27	137.7	0.0357	1.52	100.7	0.0310	1.14

Building: Single Family
City: Ft Wayne
HVAC: Weighted Average
Measure: Wall Installation

Base R_{ADJ}	0			11			13		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	361.1	0.0322	4.03	N/A	N/A	N/A	N/A	N/A	N/A
13	417.3	0.0416	4.64	56.2	0.0104	0.61	N/A	N/A	N/A
17	496.2	0.0526	5.55	135.1	0.0213	1.52	78.9	0.0110	0.91
19	525.1	0.0526	5.93	163.9	0.0213	1.82	107.7	0.0110	1.22
21	548.9	0.0526	6.16	187.8	0.0213	2.13	131.6	0.0110	1.52
25	587.9	0.0526	6.61	226.8	0.0213	2.58	170.7	0.0110	1.90
27	602.5	0.0530	6.76	241.5	0.0218	2.74	185.3	0.0114	2.13

Base R_{ADJ}	17			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A	N/A
19	28.9	0.000	0.30	N/A	N/A	N/A
21	52.8	0.000	0.61	23.8	0.000	0.30
25	91.6	0.000	1.06	62.8	0.000	0.68
27	106.4	0.005	1.22	77.5	0.005	0.85

Building: Single Family
City: Terre Haute
HVAC: Weighted Average
Measure: Wall Installation

Base R_{ADJ}	0			11			13		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	349.1	0.0328	3.88	N/A	N/A	N/A	N/A	N/A	N/A
13	404.7	0.0328	4.56	55.6	0.00	0.61	N/A	N/A	N/A
17	487.0	0.0427	5.40	137.9	0.011	1.52	82.3	0.0110	0.91
19	513.8	0.0427	5.71	164.7	0.011	1.82	109.1	0.0110	1.22
21	538.5	0.0427	6.00	189.5	0.011	2.13	133.8	0.0110	1.46
25	575.7	0.0535	6.46	226.7	0.0218	2.51	171.0	0.0218	1.90
27	592.1	0.0535	6.61	243.0	0.0218	2.66	187.4	0.0218	2.05

Base R_{ADJ}	17			19		
New R_{ADJ}	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A	N/A
19	26.8	0.000	0.30	N/A	N/A	N/A
21	51.7	0.000	0.61	24.8	0.00	0.30
25	88.7	0.0110	0.99	61.9	0.011	0.68
27	105.0	0.0110	1.20	78.2	0.011	0.84

Air Sealing - Reduce Infiltration (Retrofit)

	Measure Details
Official Measure Code	Res-Shell-AirSeal-1
Measure Unit	Per Installation
Measure Category	Building shell
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by heating and cooling system
Peak Demand Reduction (kW)	Varies by heating and cooling system
Annual Fossil Fuel Savings (MMBtu)	Varies by heating and cooling system
Lifetime Energy Savings (kWh)	Varies by heating and cooling system
Lifetime Fossil Fuel Savings (MMBtu)	Varies by heating and cooling system
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	Varies by heating and cooling system
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is improving a building's air barrier, which together with insulation defines the thermal boundary of the conditioned space. Air leakage in buildings represents between 5% and 40% of the space conditioning costs,[67] but is also very difficult to control. The measure savings are based on a trained auditor, contractor, or utility staff member being on location to measure and record the existing air leakage rate[68] and post-air sealing leakage using a blower door.

Definition of Efficient Equipment

Air sealing materials and diagnostic testing should meet all eligibility program qualification criteria. The initial and final leakage rates should be tested in such a manner such that the identified reductions can be properly discerned, particularly in situations wherein multiple building envelope measures may be implemented simultaneously.

---

67 Krigger, J. and C. Dorsi. *Residential Energy*. 2004. p. 73.

68 In accordance with industry best practices per: Building Performance Institute. *Building Analyst and Envelope Professional Standards*. Available online: http://www.bpi.org/standards_approved.aspx

Definition of Baseline Equipment

The existing air leakage should be determined through approved and appropriate test methods. The baseline condition of a building upon first inspection significantly impacts the opportunity for cost-effective energy savings through air sealing.

Deemed Lifetime of Efficient Equipment

The measure life is 15 years.[69]

Deemed Measure Cost

The actual air sealing measure cost should be used.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\mathrm{kWh} = \frac{\mathrm{CFM50_{EXIST}} - \mathrm{CFM50_{NEW}}}{\mathrm{N-factor}} * \frac{\mathrm{kWh}}{\mathrm{CFM}}$$

Where:

$CFM50_{EXIST}$ = Existing cubic feet per minute at 50 Pascal pressure differential as measured by the blower door before air sealing (= actual)

$CFM50_{NEW}$ = New cubic feet per minute at 50 Pascal pressure differential as measured by the blower door after air sealing (= actual)

N-factor = Conversion factor from 50 Pascal airflows to natural airflow (= dependent on exposure level, see table below;[70] if exposure is unknown, assume “Normal;” if number of stories is unknown, use average value for stories 1-2; if both unknown, use 16.3)

N-Factor by Exposure Level and Number of Stories

Exposure	1 Story	1.5 Stories	2 Stories	3 Stories
Well Shielded	22.2	20.0	17.8	15.5
Normal	18.5	16.7	14.8	13.0
Exposed	16.7	15.0	13.3	11.7

69 GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

70 Krigger, J and C. Dorsi. “Residential Energy” 2004 p. 286.

ΔkWh/CFM = kWh impacts per CFM of infiltration rate reduction (= dependent on home cooling and heating types; see tables in Reference Tables section)

For example, the energy savings from reducing air leakage in a well-shielded, 1-story Ft Wayne home with central air conditioning and natural gas heat, from 5,000 CFM_{50} to 3,500 CFM_{50}, would be:

$$\Delta kWh = \frac{5{,}000-3{,}500}{22.2} * 2.1 = 142\ kWh$$

Summer Peak Coincident Demand Reduction

$$kW = \frac{CFM50_{EXIST} - CFM50_{NEW}}{N - factor} * \frac{\Delta\, kW}{CFM} * CF$$

Where:

ΔkW/CFM = kW impacts per CFM of infiltration rate reduction

CF = Summer peak coincidence factor (= 0.88)

For example, the demand reduction from reducing air leakage in a well-shielded, 2-story Indianapolis home with central air conditioning and natural gas heat, from 5,000 CFM_{50} to 3,500 CFM_{50}, would be:

$$\Delta kW = \frac{5{,}000-3{,}500}{17.8} * .001 * 0.88 = 0.074$$

Fossil Fuels Impact Descriptions and Calculation

$$\Delta MMBtu = \frac{CFM50Exist - CFM50New}{N - factor} * \frac{\Delta \mathrm{MMBtu}}{\mathrm{CFM}}$$

Where:

ΔMMBtu/CFM = Fossil fuel impacts per CFM of infiltration rate reduction

For example, the fossil fuel savings from reducing air leakage in a well-shielded, 2-story Indianapolis home with central air conditioning and natural gas heat, from 5,000 CFM_{50} to 3,500 CFM_{50}, would be:

$$\Delta MMBtu = \frac{5{,}000-3{,}500}{17.8} * 0.21 = 17.697\ MMBtu$$

Reference Tables

Electricity and Fossil Fuel Impacts of Air Leakage Sealing*

City	AC Natural Gas Heat			Heat Pump		AC Electric Heat	
	kWh/cfm	kW/cfm	MMBtu/cfm	kWh/cfm	kW/cfm	kWh/cfm	kW/cfm
Indianapolis	2.4	0.001	0.21	30.9	0.003	50.1	0.006
South Bend	1.7	0.001	0.20	30.0	0.003	47.6	0.003
Evansville	3.0	0.005	0.16	20.5	0.007	40.3	0.009
Ft Wayne	2.1	0.001	0.24	36.0	0.002	54.1	0.001
Terre Haute	3.0	0.00	0.19	24.8	0.003	43.5	0.00

* Infiltration unit savings derived from residential simulation models. See Appendix A.

City	Natural Gas Heat Only			Electric Heat Only	
	kWh/cfm	kW/cfm	MMBtu/cfm	kWh/cfm	kW/cfm
Indianapolis	1.1	0.00	0.22	48.2	0.00
South Bend	1.0	0.00	0.21	46.5	0.00
Evansville	0.8	0.00	0.17	36.9	0.00
Ft Wayne	1.2	0.00	0.24	53.1	0.00
Terre Haute	0.9	0.00	0.19	41.4	0.00

* Infiltration unit savings derived from residential simulation models. See Appendix A.

Weighted Average by City

City	kWh/cfm	kW/cfm	MMBtu/cfm
Indianapolis	12.87	0.0018	0.1609
South Bend	11.90	0.0013	0.1533
Evansville	10.81	0.0051	0.1229
Ft Wayne	13.72	0.009	0.1824
Terre Haute	11.66	0.001	0.1444

Duct Sealing and Insulation (Retrofit)

	Measure Details
Official Measure Code	Res-HVAC-DTS-1
Measure Unit	Per installation
Measure Category	Building shell
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	20
Incremental Cost	$71.45
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is performing duct sealing and insulation upgrades. Duct sealing is done using mastic sealant or metal tape to the distribution system of homes with either central air conditioning or a ducted heating system. The methodology requires either measuring the amount of duct leakage and observing the duct insulation R-value, or evaluating three duct characteristics (listed) below using the Building Performance Institute *Distribution Efficiency Look-Up Table*:[71]

1. Percentage of duct work within the conditioned space
2. Duct leakage evaluation
3. Duct insulation evaluation

Definition of Efficient Equipment

The efficient condition is sealed and/or insulated duct work throughout the home's unconditioned space.

Definition of Baseline Equipment

The baseline condition is leaky and/or uninsulated duct work within the home's unconditioned space.

[71] This look-up table is available online: http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf

Deemed Lifetime of Efficient Equipment

The lifetime of this measure is 20 years.[72]

Deemed Measure Cost

The incremental cost for the duct sealing measure is $71.45 per dwelling.[73]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh_{COOLING} = \frac{DE_{AFTER} - DE_{BEFORE}}{DE_{AFTER}} * \frac{EFLH_{COOL} * Btuh_{COOL}}{SEER * 1{,}000}$$

Where:

DE_{AFTER} = Distribution efficiency after duct sealing (= actual; based on total leakage and R-value; see tables in Reference Tables section or determine by evaluating duct system before and after duct sealing and insulation using BPI *Distribution Efficiency Look-Up Table*)

DE_{BEFORE} = Distribution efficiency before duct sealing (= actual; based on total leakage and R-value; see tables in Reference Tables section or determine by evaluating duct system before and after duct sealing and insulation using BPI *Distribution Efficiency Look-Up Table*)

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

---

72 GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

73 Itron, Inc. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Submitted to the California Public Utilities Commission. May 27, 2014.

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

$Btuh_{COOL}$ = Cooling capacity of equipment in Btuh (= actual; otherwise assume 28,994 Btuh; note: 1 ton = 12,000 Btuh)[74]

SEER = Seasonal average efficiency of air conditioning equipment in SEER (= actual; otherwise assume 11.15)[75]

For example, the energy savings from adding duct sealing to a house in Indianapolis with a 3-ton, SEER 11 central air conditioning and the following duct evaluation results would be:

$$DE_{AFTER} = 0.92$$

$$DE_{BEFORE} = 0.85$$

$$\Delta kWh = \frac{0.92-0.85}{0.92} * 487 * \frac{36,000}{11*1,000} = 121 \text{ kWh}$$

The heating savings for homes with electric heat (heat pump or resistance) would be:

$$kWh_{HEATING} = \frac{DE_{AFTER} - DE_{BEFORE}}{DE_{AFTER}} * \frac{EFLH_{HEAT} * Btuh_{HEAT}}{3,412 * \eta_{HEAT}}$$

Where:

$EFLH_{HEAT}$ = Equivalent full load heating hours (= actual; dependent on location, see table below)

74 TecMarket Works, et al. *Residential Baseline Report Final*. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs. November 2, 2012.

75 Ibid.

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix A.

$Btuh_{HEAT}$ = Heating capacity (output) of equipment in Btuh (= actual)

η_{HEAT} = Efficiency in COP of heating equipment (= actual; otherwise based on table below)

COP Estimates by System Type

System Type	Age of Equipment	HSPF Estimate	COP Estimate
Heat Pump	Before 2006	6.8	2.00
	After 2006	7.7	2.26
Resistance	N/A	N/A	1.00

3,412 = Conversion from Btuh to kW

For example, the energy savings from adding duct sealing to a house in Indianapolis with a 100,000 Btu/hr, 6.8 HSPF heat pump and the following duct evaluation results would be:

$$DE_{AFTER} = 0.92$$

$$DE_{BEFORE} = 0.85$$

$$\Delta kWh = \frac{0.92 - 0.85}{0.92} * 1{,}341 * \frac{100{,}000}{2 * 3{,}412} = 1{,}495 \text{ kWh}$$

Summer Coincident Peak kW savings

$$\Delta kW = \frac{DE_{PK,AFTER} - DE_{PK,BEFORE}}{DE_{PK,AFTER}} * \frac{Btuh_{COOL}}{EER * 1{,}000} * CF$$

Where:

$DE_{PK,AFTER}$ = Distribution efficiency under peak summer conditions after duct sealing

$DE_{PK,BEFORE}$ = Distribution efficiency under peak summer conditions before duct sealing

CF = Summer peak coincidence factor (= 0.88)[76]

EER = Peak efficiency in EER of Air Conditioning equipment (= actual; otherwise calculate as SEER * 0.9)

Fossil Fuel Impact Descriptions and Calculation

The fossil fuel savings for homes with fossil fuel heating would be:

$$\Delta \text{MMBtu} = \frac{DE_{AFTER} - DE_{BEFORE}}{DE_{AFTER}} * \frac{EFLH_{HEAT} * Btuh_{FF}}{1{,}000{,}000}$$

Where:

$Btuh_{FF}$ = Heating capacity of equipment in Btuh input (= actual; otherwise assume 77,386 Btuh)[77]

1,000,000 = Conversion from Btu to MMBtu

For example, the fossil fuel savings from adding duct sealing in a house in Indianapolis with a 100,000 Btu/hr, 84 AFUE natural gas furnace with the following duct evaluation results would be:

$$DE_{AFTER} = 0.92$$

$$DE_{BEFORE} = 0.85$$

$$\Delta \text{MMBtu} = \frac{0.92 - 0.85}{0.92} * 1{,}341 * \frac{100{,}000}{1{,}000{,}000} = 10.203 \text{ MMBtu}$$

Reference Tables

Distribution efficiencies, as based on observed R-values and measured leakage rates, are shown in the tables below.[78]

Single Family Distribution System Efficiency, Ducts Located in Unconditioned Basement

Total Duct Leakage	Duct System R-Value (supply and return)	Cooling		Heating
		DE_{COOL}	DE_{PK}	DE_{HEAT}
8%	Uninsulated	0.88	0.86	0.74
10%	Uninsulated	0.87	0.84	0.73
15%	Uninsulated	0.84	0.82	0.71
20%	Uninsulated	0.82	0.79	0.68

76 Duke Energy. Data for residential air conditioning loads.

77 TecMarket Works, et al. *Residential Baseline Report Final*. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs. November 2, 2012.

78 Distribution efficiencies were calculated using Indianapolis climate data and according to: ASHRAE Standard 152-2004. "Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems."

Total Duct Leakage	Duct System R-Value (supply and return)	Cooling		Heating
		DE_{COOL}	DE_{PK}	DE_{HEAT}
25%	Uninsulated	0.80	0.76	0.66
30%	Uninsulated	0.77	0.73	0.64
8%	R-4.2	0.91	0.90	0.88
10%	R-4.2	0.90	0.89	0.87
15%	R-4.2	0.88	0.86	0.84
20%	R-4.2	0.86	0.83	0.82
25%	R-4.2	0.83	0.80	0.79
30%	R-4.2	0.81	0.78	0.77
8%	R-8	0.92	0.91	0.90
10%	R-8	0.91	0.89	0.89
15%	R-8	0.88	0.86	0.86
20%	R-8	0.86	0.84	0.83
25%	R-8	0.84	0.81	0.81
30%	R-8	0.81	0.78	0.78

Single Family Distribution System Efficiency, Ducts Located in Unconditioned Attic

Total Duct Leakage	Duct System R-Value (supply and return)	Cooling		Heating
		DE_{COOL}	DE_{PK}	DE_{HEAT}
8%	Uninsulated	0.68	0.54	0.69
10%	Uninsulated	0.66	0.52	0.68
15%	Uninsulated	0.62	0.47	0.65
20%	Uninsulated	0.58	0.42	0.63
25%	Uninsulated	0.55	0.37	0.60
30%	Uninsulated	0.51	0.32	0.58
8%	R-4.2	0.84	0.79	0.86
10%	R-4.2	0.83	0.77	0.85
15%	R-4.2	0.78	0.71	0.82
20%	R-4.2	0.74	0.65	0.79
25%	R-4.2	0.70	0.59	0.76
30%	R-4.2	0.66	0.54	0.73
8%	R-8	0.86	0.82	0.88
10%	R-8	0.84	0.79	0.87
15%	R-8	0.80	0.73	0.84
20%	R-8	0.76	0.67	0.81
25%	R-8	0.71	0.62	0.78
30%	R-8	0.67	0.56	0.75

ENERGY STAR Windows (Time of Sale)

	Measure Details
Official Measure Code	Res-Shell-ESWind-1
Measure Unit	Per square foot
Measure Category	Building shell
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	25
Incremental Cost	$150.00 per 100 square feet of windows
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is purchasing and installing ENERGY STAR windows meeting the minimum requirement for the North Central region (Evansville) or Northern region (Indianapolis, South Bend, Ft. Wayne, and Terre Haute) at the natural time of replacement or during new construction. This does not relate to a window retrofit program.

Definition of Efficient Equipment

To qualify for this measure, the new window must meet ENERGY STAR criteria for the North Central region (u factor ≤ 0.32; SHGC ≤ 0.40) or Northern region (u factor ≤ 0.30). There is no minimum SHGC criterion for windows in the North region, so a medium gain window with SHGC of 0.40 is assumed.

Definition of Baseline Equipment

The baseline condition is a code-compliant window in IECC Climate Zone 4 (u factor = 0.35, SHGC = 0.40) or IECC Climate Zone 3 (u factor = 0.32). SHGC is not specified in climate zone 3, so a medium gain window with SHGC of 0.40 is assumed.

Deemed Lifetime of Efficient Equipment

The measure life is 25 years.[79]

---

[79] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

Deemed Measure Cost

The incremental cost for this measure is $150.00 per 100 square feet of windows.[80]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta\text{kWh} = \frac{SF}{100} * \frac{\Delta kWh}{100SF}$$

Where:

SF = Area of installed windows

$\frac{\Delta kWh}{100SF}$ = Unit energy savings (= dependent on type of HVAC system and city; see table in Reference Tables section)

For example, the energy savings from installing 200 square feet of ENERGY STAR windows in a home in Indianapolis with central air conditioning and natural gas heat would be:

$$\Delta kWh = \frac{200}{100} * 44 = 88 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta\text{kW} = \frac{SF}{100} * \frac{\Delta kW}{100SF} * CF_S$$

Where:

$\frac{\Delta kW}{100SF}$ = Unit demand reduction (= dependent on type of HVAC system and city; see table in Reference Tables section)

CF_S = Summer peak coincidence factor (= 0.88)[81]

For example, the demand reduction from installing 200 square feet of ENERGY STAR windows in a home in Indianapolis with central air conditioning and natural gas heat would be:

$$\Delta\text{kW} = \frac{200}{100} * 0.1 * 0.88 = 0.176 \text{ kW}$$

80 Alliance to Save Energy Efficiency Windows Collaborative Report, December 2007

81 Duke Energy. Load shape data for residential air conditioning loads from DSMore cost-effectiveness tool. Available online: www.integralanalytics.com

Fossil Fuels Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \frac{SF}{100} * \frac{\Delta MMBtu}{100SF}$$

Where:

$\frac{\Delta MMBtu}{100SF}$ = Unit fossil fuel energy savings (= dependent on type of HVAC system and city; see table in Reference Tables section)

For example, the fossil fuel savings from installing 200 square feet of ENERGY STAR windows in a home in Indianapolis with central air conditioning and natural gas heat would be:

$$\Delta \text{MMBtu} = \frac{200}{100} * \ 1.07 \ = \ 2.140$$

Reference Tables

Electricity and Fossil Fuel Impacts of Window Upgrades*HVAC System	kWh/100 Square Feet	kW/100 Square Feet	MMBtu/100 Square Feet
Indianapolis			
AC Natural Gas Heat	44	0.1	1.07
Heat Pump	1,378	0.2	0
AC Electric Heat	2,399	0.1	0
Electric Heat Only	2,380	0	0
Natural Gas Heat Only	55	0	1.09
South Bend			
AC Natural Gas Heat	70	0.1	1.01
Heat Pump	1,265	0.1	0
AC Electric Heat	2,252	0.1	0
Electric Heat Only	2,246	0	0
Natural Gas Heat Only	50	0	1.01
Evansville			
AC Natural Gas Heat	45	0	0.84
Heat Pump	838	0.1	0
AC Electric Heat	1,812	0.1	0
Electric Heat Only	1,787	0	0
Natural Gas Heat Only	40	0	0.85
Ft Wayne			
AC Natural Gas Heat	44	0	1.1
Heat Pump	1,428	0.1	0
AC Electric Heat	2,431	0	0
Electric Heat Only	2,443	0	0
Natural Gas Heat Only	53	0	1.1

Electricity and Fossil Fuel Impacts of Window Upgrades*HVAC System	kWh/100 Square Feet	kW/100 Square Feet	MMBtu/100 Square Feet
Terre Haute			
AC Natural Gas Heat	62	0.1	0.9
Heat Pump	1,036	0.1	0
AC Electric Heat	1,967	0.1	0
Electric Heat Only	1,949	0	0
Natural Gas Heat Only	43	0	0.9

HVAC System Weighted Average*

City	kWh/100 Square Feet	kW/100 Square Feet	MMBtu/100 Square Feet
Indianapolis	569.4	0.0890	0.8158
South Bend	551.5	0.0850	0.7676
Evansville	429.0	0.0220	0.6397
Ft Wayne	578.2	0.0040	0.8360
Terre Haute	479.1	0.0850	0.6840

* Infiltration unit savings derived from residential simulation models. See Appendix A.

Domestic Hot Water

Heat Pump Water Heaters (Time of Sale)

	Measure Details
Official Measure Code	Res-DHW-HPWH-1
Measure Unit	Per heat pump
Measure Category	Domestic hot water
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by heating system
Peak Demand Reduction (kW)	Varies by heating system
Annual Fossil Fuel Savings (MMBtu)	-7.380
Lifetime Energy Savings (kWh)	Varies by heating system
Lifetime Fossil Fuel Savings (MMBtu)	-73.80
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$700.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a heat pump DHW heater in place of a standard electric hot water heater. This is a time of sale measure. Savings are presented dependent on the heating system installed in the home.

Definition of Efficient Equipment

To qualify for this measure, the installed equipment must be a heat pump DHW heater.

Definition of Baseline Equipment

The baseline condition is a standard electric hot water heater.

Deemed Lifetime of Efficient Equipment

The measure life is 10 years.[82]

Deemed Measure Cost

The incremental cost for this measure is $700.00[83]

---

82 ENERGY STAR. *Residential Water Heaters, Final Criteria Analysis.* Available online: http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterDraftCriteriaAn alysis.pdf

83 Duke Energy. *Measure Cost Data*. 2012.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = kWh_{BASE} * \frac{COP_{NEW} - COP_{BASE}}{COP_{NEW}} + kWh_{COOLING} - kWh_{HEATING}$$

Where:

kWh_{BASE}	=	Average electric DHW consumption (= 3,460)[84]
COP_{NEW}	=	Coefficient of performance (efficiency) of heat pump water heater (= 2.0)[85]
COP_{BASE}	=	Coefficient of performance (efficiency) of standard electric water heater (= 0.904)[86]
$kWh_{COOLING}$	=	Cooling savings from conversion of heat in home to water heat (= 180)[87]
$kWh_{heating}$	=	Heating cost from conversion of heat in home to water heat (= dependent on heating system as follows)[88]

---

84 U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. *Residential Water Heaters Technical Support Document for the January 17, 2001, Final Rule.* DOE/EE-0317. Table 9.3.9, p. 9-34. May 2007. Available online: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/09.pdf

85 ENERGY STAR. *Residential Water Heaters, Final Criteria Analysis.* Available online: http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterDraftCriteriaAn alysis.pdf

86 Ibid.

87 Determined by: (1) calculating the MMBtu removed from the air, (2) applying the REM Rate-determined percentage of lighting savings that result in reduced cooling loads (35%; lighting is used as a proxy for DHW heating since load shapes suggest their seasonal usage patterns are similar), (3) assuming a SEER 11 central air conditioning unit, (4) multiplying by 64% to adjust for the percentage of Indiana homes with cooling (Energy Information Administration. *2005 Residential Energy Consumption Survey*. East North Central census division. Available online: http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/hc6airconditioningchar/pdf/tablehc12.6.pdf), and (5) applying a discretionary usage adjustment of 0.75 (Energy Center of Wisconsin. *Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research*. p. 31. May 2008).

88 Determined by applying the REM Rate-determined percentage of lighting savings that result in increased heating loads (45%) to the calculated MMBtu removed from the air, then converting to kilowatt-hours and dividing by the heating system efficiency (1.0 for electric resistance, 2.0 for heat pump).

Heading System	$kWh_{heating}$
Electric resistance	1,577
Heat pump COP 2.0	779
Fossil fuel	0

$$\Delta kWh \text{ electric resistance heat} = 3460 * \frac{2.0-0.904}{2.0} + 180 - 1577 = 499 \text{ kWh}$$

$$\Delta kWh \text{ heat pump heat} = 3460 * \frac{2.0-0.904}{2.0} + 180 - 779 = 1{,}297 \text{ kWh}$$

$$\Delta kWh \text{ fossil fuel heat} = 3460 * \frac{2.0-0.904}{2.0} + 180 - 0 = 2{,}076 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{Hours} * CF$$

Where:

Hours = Equivalent full load hours of hot water heater (= 2,533)[89]

CF = Summer peak coincidence factor (= 0.346)[90]

$$\Delta kW \text{ electric resistance heat} = \frac{499}{2{,}533} * 0.346 = 0.068 \text{ kW}$$

$$\Delta kW \text{ heat pump heat} = \frac{1{,}297}{2{,}533} * 0.346 = 0.177 \text{ kW}$$

$$\Delta kW \text{ fossil fuel heat} = \frac{2{,}076}{2{,}533} * 0.346 = 0.284 \text{ kW}$$

89 Efficiency Vermont. Load shape calculated from Itron eShapes.

90 Calculated from Itron eShapes, which is 8,760 hourly data by end use for Upstate New York, adjusted for Ohio peak definitions. The resulting peak coincident kilowatts are consistent with result shown in: U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. *Field Testing of Pre-Production Prototype Residential Heat Pump Water Heaters*. DOE/EE-0317. May 2007. Available online: http://www1.eere.energy.gov/femp/pdfs/tir_heatpump.pdf

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu = -7.380\ MMBtu$$[91]

[91] This is the additional energy consumption (therefore a negative value) required to replace the heat removed from the home during the heating season by the heat pump water heater. Determined by: (1) calculating the MMBtu removed from the air, (2) applying the REM Rate-determined percentage of lighting savings that result in increased heating loads (45%; lighting is used as a proxy for DHW heating since load shapes suggest their seasonal usage patterns are similar), and (3) dividing by the efficiency of the heating system (estimated assuming that natural gas central furnace heating is typical for Indiana residences; 65% of East North Central homes have a natural gas furnace (Energy Information Administration. *2005 Residential Energy Consumption Survey*. Available online: http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/hc4spaceheating/pdf/tablehc12.4.pdf).
In 2000, 40% of furnaces purchased in Indiana were condensing (based on data from GAMA, provided to U.S. Department of Energy during the federal standard setting process). Assuming typical efficiencies for condensing and non-condensing furnace and duct losses, the average heating system efficiency is estimated as: (0.4 * 0.92) + (0.6 * 0.8) * (1 - 0.15) = 0.72.

Low-Flow Faucet Aerator (Time of Sale or Early Replacement)

	Measure Details
Official Measure Code	Res-DHW-Aerator-1
Measure Unit	Per aerator
Measure Category	Domestic hot water
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by space, building type, and location
Peak Demand Reduction (kW)	Varies by space, building type, and location
Annual Fossil Fuel Savings (MMBtu)	Varies by space, building type, and location
Lifetime Energy Savings (kWh)	Varies by space, building type, and location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by space, building type, and location
Water Savings (gal/yr)	Varies by space, building type, and location
Effective Useful Life (years)	10
Incremental Cost	$2.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a low-flow (1.0 - 1.5 GPM) kitchen or bathroom faucet aerator in a home. This could be a retrofit direct install measure or a new installation. Both electric and fossil fuel savings are provided, although only savings corresponding to the hot water heating fuel should be claimed.

Definition of Efficient Equipment

The efficient equipment is a low-flow faucet aerator.

Definition of Baseline Equipment

The baseline equipment is a standard faucet aerator using > 2 GPM.

Deemed Lifetime of Efficient Equipment

The measure life is 10 years.[92]

Deemed Measure Cost

As a retrofit measure, the cost will be the actual cost for the aerator and installation.

92 California Public Utilities Commission. *Database for Energy Efficient Resources.* Assumption for faucet aerators. Available online: www.deeresources.com

As a measure distributed to and installed by participants, the cost is the price of the aerator and distribution, determined to be \$2.00.[93]

Deemed O&M Cost Adjustments

When a retrofit measure, there would be a very small O&M benefit associated with the deferral of the next replacement, but this has conservatively not been characterized.

Savings Algorithm

Energy Savings

The energy savings from homes with an electric DHW heater would be:

$$\Delta kWh = ISR * (GPM_{BASE} - GPM_{LOW}) * MPD * \frac{PH}{FH} * DR * 8.3 * (T_{MIX} - T_{IN}) * \frac{365}{RE * 3{,}412}$$

Where:

ISR = In-service rate, or fraction of units that get installed (= 1.0 for retrofit/direct install; = 0.48 for customer self-install)[94]

GPM_{BASE} = Gallons per minute of baseline faucet aerator (= 1.90 for bathrooms, = 2.44 for kitchens)[95]

GPM_{LOW} = Gallons per minute of low-flow faucet aerator (= 1.01 for bathrooms, = 1.49 for kitchens)[96]

MPD = Average minutes of faucet use per person per day (= 1.6 for bathrooms, = 4.5 for kitchens)[97]

PH = Average number of people per household (= 2.64 for single family, = 1.83 for multifamily, = 2.47 for unknown housing type)[98]

---

93 Navigant Consulting and Ontario Energy Board. *Measures and Assumptions for Demand Side Management (DSM) Planning.* April 2009.

94 EGD_2009_DSM_Annual Report from table 27 survey of Install rates: Overall averages of 62% and 34% for kitchen and bath aerators respectively are averaged to get 48%. There is significant variation in rates by building type, aerator type, and distribution so surveying participants is encouraged

95 Cadmus. *2011 IPL Residential Core Plus Evaluation, Multifamily Direct Install Program.* 2012.

96 Ibid.

97 Cadmus and Opinion Dynamics. *Showerhead and Faucet Aerator Meter Study.* Memorandum prepared for Michigan Evaluation Working Group. 2013.

98 Census data from Ferret Software for Indiana uses ACS three-year public-use microdata (2008-2010). Weighted values by housing type of 79% for single family and 21% for multifamily) determined from: U.S. Energy Information Administration. *Residential Energy Consumption Surveys.* 2009.

FH = Average faucets per household (= dependent on sink and housing type; see table below)[99]

Quantity of Faucets by Sink and Housing Type

Housing Type	Bathroom	Kitchen
Single-Family	2.04	1.00
Multifamily	1.43	1.00
Unknown	1.91	1.00

365 = Days of faucet use per year

DR = Percentage of water flowing down drain (= 50% for kitchens, = 70% for bathrooms;[100] if water is collected in a sink, a faucet aerator will not result in any saved water)

8.3 = Specific weight of water in pounds per gallon, which is then multiplied by the specific water temperature ($1.0 \frac{Btu}{lb*°F}$)

T_{MIX} = Mixed water temperature exiting faucet (= 86.0°F for bathrooms, = 93.0°F for kitchens)[101]

T_{IN} = Cold water temperature entering the DWH system (= dependent on climate, see table below)

---

99 Cadmus and Opinion Dynamics. *Showerhead and Faucet Aerator Meter Study.* Memorandum prepared for Michigan Evaluation Working Group. 2013. “Unknown” housing type percentages of 79% for single family and 21% for multifamily are weighted averages from: U.S. Energy Information Administration. *Residential Energy Consumption Surveys*. 2009.

100 Navigant Consulting and Ontario Energy Board. *Measures and Assumptions for Demand Side Management (DSM) Planning.* April 2009.

101 Cadmus and Opinion Dynamics. *Showerhead and Faucet Aerator Meter Study.* Memorandum prepared for Michigan Evaluation Working Group. 2013.

Cold Water Entering Temperature by City*

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Ft Wayne	55.6

* Burch, J. and C. Christensen, National Renewable Energy Lab. White paper: "Towards Development of an Algorithm for Mains Water Temperature." Prepared for American Solar Energy Society. 2007.

RE = Recovery efficiency of electric hot water heater (= 0.98)[102]

3,412 = Constant to convert Btu to kWh

For example, the energy savings from a 1.5 GPM direct-installation bathroom aerator in a single family Indianapolis home with an electric water heater would be:

$$\Delta kWh = 1.0 * (1.90 - 1.01) * 1.6 * \frac{2.64}{2.04} * 0.70 * 8.3 * (86 - 58.1) * \frac{365}{0.98 * 3{,}412} = 33 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = ISR * (GPM_{BASE} - GPM_{LOW}) * 60 * DR * 8.3 * \frac{T_{MIX} - T_{IN}}{RE * 3{,}412} * CF$$

Where:

60 = Minutes per Hour

CF = Summer peak coincidence factor (= 0.0012 for bathrooms, = 0.0033 for kitchens)[103]

For example, the demand reduction from a 1.5 GPM direct-installation bathroom aerator in a multifamily home in South Bend with an electric water heater would be:

$$\Delta kW = 1.0 * (1.90 - 1.01) * 60 * 0.70 * 8.3 * \frac{(86 - 57.4)}{0.98 * 3{,}412} * 0.0012 = 0.003 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

Homes with a fossil fuel DHW heater have the following MMBtu savings:

$$\Delta MMBtu = ISR * (GPM_{BASE} - GPM_{LOW}) * MPD * \frac{PH}{FH} * DR * 8.3 * (T_{MIX} - T_{IN}) * \frac{365}{RG * 1{,}000{,}000}$$

---

[102] NREL, Building America Research benchmark definition, 2009, p. 12. http://www.nrel.gov/docs/fy10osti/47246.pdf.

[103] Cadmus. *Wisconsin Technical Reference Manual.* Prepared for Wisconsin Focus on Energy. January 2015.

Where:

RG = Recovery efficiency of natural gas hot water heater (= 0.76)[104]

1,000,000 = Constant to convert Btu to MMBtu

For example, the fossil fuel savings from a 1.5 GPM direct-installation kitchen aerator in a single family home in Evansville with a natural gas water heater would be:

$$\Delta MMBtu = 1.0 * (2.44 - 1.49) * 4.5 * \frac{2.64}{1.00} * 0.50 * 8.3 * (93.0 - 62.8) * \frac{365}{0.76 * 1{,}000{,}000} = 0.679$$

Water Impact Descriptions and Calculation

$$\text{Water Savings} = ISR * (GPM_{BASE} - GPM_{LOW}) * MPD * \frac{PH}{FH} * DR * 365$$

For example, the water savings from a 1.5 GPM direct-installation bathroom aerator in an unknown home type would be:

$$\text{Water Savings} = 1.0 * (1.90 - 1.01) * 1.6 * \frac{2.47}{1.91} * 0.70 * 365 = 470.5 \text{ gallons}$$

[104] NREL, Building America Research benchmark definition, 2009, p. 12.

http://www.nrel.gov/docs/fy10osti/47246.pdf.

Low-Flow Showerhead (Time of Sale or Early Replacement)

	Measure Details
Official Measure Code	Res-DHW-SH-1
Measure Unit	Per showerhead
Measure Category	Domestic hot water
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by building type and location
Peak Demand Reduction (kW)	Varies by building type and location
Annual Fossil Fuel Savings (MMBtu)	Varies by building type and location
Lifetime Energy Savings (kWh)	Varies by building type and location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by building type and location
Water Savings (gal/yr)	Varies by building type and location
Effective Useful Life (years)	10
Incremental Cost	$18.50
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a low-flow showerhead in a home. This is a retrofit direct install measure or for a new installation. Both electric and fossil fuel savings are provided, although only savings corresponding to the hot water heating fuel should be claimed.

Definition of Efficient Equipment

The efficient condition is a low-flow showerhead of 1.74 GPM or less.

Definition of Baseline Equipment

The baseline is a standard showerhead with a flow of 2.63 GPM (the baseline in Indiana).

Deemed Lifetime of Efficient Equipment

The measure life is 10 years.

Deemed Measure Cost

As a retrofit measure, the incremental cost will be the cost of the showerhead including its installation.

As a measure distributed to and installed by participants, the cost is the price of the showerhead and for distribution, or $18.50[105].

[105] Itron, Inc. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. May 27, 2014. Submitted to the California Public Utilities Commission.

Deemed O&M Cost Adjustments

When a retrofit measure, there would be a very small O&M benefit associated with the deferral of the next replacement, but this has conservatively not been characterized.

Savings Algorithm

Energy Savings

The energy savings from homes with an electric domestic hot water heater would be:

$$\Delta kWh = ISR * (GPM_{BASE} - GPM_{LOW}) * MS * SPD * \frac{PH}{SH} * 8.3 * (T_{MIX} - T_{IN}) * \frac{365}{RE * 3{,}412}$$

Where:

ISR = In-service rate, or fraction of units that get installed (= 1.0 for retrofit/direct install; = 0.81 for customer self-install)

GPM_{BASE} = Gallons per minute of baseline showerhead (= 2.63)[106]

GPM_{LOW} = Gallons per minute of low-flow showerhead (= actual; otherwise = 1.74)[107]

MS = Average minutes per shower event (= 7.8)[108]

SPD = Average number of shower events per person per day (= 0.6)[109]

PH = Average number of people per household (= 2.64 for single family, = 1.83 for multifamily, = 2.47 for unknown housing type)[110]

SH = Average number of showerheads per household (= 1.6 for single family,[111] = 1.2 for multifamily)[112]

365 = Days of shower use per year

---

106 Cadmus. *2011 IPL Residential Core Plus Evaluation, Multifamily Direct Install Program*. 2012.

107 Ibid.

108 Cadmus and Opinion Dynamics. *Showerhead and Faucet Aerator Meter Study.* Memorandum prepared for Michigan Evaluation Working Group. 2013.

109 Ibid.

110 Census data from Ferret Software for Indiana Uses ACS three-year public use microdata (2008-2010). Weighted values by housing type of 79% for single family and 21% for multifamily determined from: U.S. Energy Information Administration. *Residential Energy Consumption Surveys.* 2009.

111 TecMarket Works, et al. *Residential Baseline Report Final*. November 2, 2012. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs

112 Cadmus. *2011 IPL Residential Core Plus Evaluation, Multifamily Direct Install Program*. 2012.

8.3 = Specific weight of water in pounds per gallon, which is multiplied by the specific heat of water (1.0 $\frac{Btu}{lb*°F}$)

T_{MIX} = Average mixed temperature of water used for shower (= 101°F) [113]

T_{IN} = Cold water temperature entering the DWH system (= depending on climate, see table below)

Cold Water Temperature by City

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Ft Wayne	55.6

* Burch, J. and C. Christensen, National Renewable Energy Lab. White paper: "Towards Development of an Algorithm for Mains Water Temperature." Prepared for American Solar Energy Society. 2007.

RE = Recovery efficiency of electric hot water heater (= 0.98)[114]

3412 = Constant to convert Btu to kWh

For example, the energy savings from a 2.0 GPM direct installation in an Indianapolis single family home would be:

$$\Delta kWh = 1.0 * (2.63 - 2.0) * 7.8 * 0.6 * \frac{2.64}{1.6} * 8.3 * (101 - 58.1) * \frac{365}{0.98*3{,}412} = 189$$

Summer Peak Coincident Demand Reduction

The demand reduction from homes with an electric DHW heater would be:

$$\Delta kW = ISR * (GPM_{BASE} - GPM_{LOW}) * 60 * 8.3 * \frac{(T_{MIX} - T_{IN})}{RE * 3{,}412} * CF$$

Where:

60 = Minutes per hour

CF = Summer peak coincidence factor (= 0.0023)[115]

113 Cadmus and Opinion Dynamics Evaluation Team, *Showerhead and Faucet Aerator Meter Study* [Memorandum]. Michigan Evaluation Working Group, 2013

114 NREL, Building America Research benchmark definition, 2009, p. 12. http://www.nrel.gov/docs/fy10osti/47246.pdf.

115 Cadmus. *Wisconsin Technical Reference Manual.* Prepared for Wisconsin Focus on Energy. January 2015.

For example, the demand reduction from a 2.0 GPM direct-installation in an Indianapolis multifamily home would be:

$$\Delta kW = 1.0 * (2.63 - 2.0) * 60 * 8.3 * \frac{(101-58.1)}{0.98 * 3{,}412} * 0.0023 = 0.009$$

Fossil Fuel Impact Descriptions and Calculation

The fossil fuel savings for homes with a fossil fuel DHW heater would be:

$$\Delta MMBtu = ISR * (GPM_{BASE} - GPM_{LOW}) * MS * SPD * \frac{PH}{SH} * 8.3 * (T_{MIX} - T_{IN}) * \frac{365}{RG * 1{,}000{,}000}$$

Where:

RG = Recovery efficiency of natural gas hot water heater (= 0.76)[116]

1,000,000 = Conversion from Btu to MMBtu

For example, the fossil fuel savings from a 2.0 GPM direct-installation in an Indianapolis multifamily home would be:

$$\Delta MMBtu = 1.0 * (2.63 - 2.0) * 7.8 * 0.6 * \frac{1.83}{1.2} * 8.3 * (101 - 58.1) * \frac{365}{0.76 * 1{,}000{,}000} = 0.318$$

Water Impact Descriptions and Calculation

$$\text{Water Savings} = ISR * (GPM_{BASE} - GPM_{LOW}) * MS * SPD * \frac{PH}{SH} * 365$$

For example, the water savings from a 2.0 GPM direct installation in an Indianapolis multifamily home would be:

$$\text{Water Savings} = 1.0 * (2.63 - 2.0) * 7.8 * 0.6 * \frac{1.83}{1.2} * 365 = 1{,}641 \text{ gallons}$$

---

116 NREL, Building America Research benchmark definition, 2009, p. 12. http://www.nrel.gov/docs/fy10osti/47246.pdf.

Domestic Hot Water Pipe Insulation (Retrofit)

	Measure Details
Official Measure Code	Res-DHW-PipeIns-1
Measure Unit	Per installation
Measure Category	Domestic hot water
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by pipe length
Peak Demand Reduction (kW)	Varies by pipe length
Annual Fossil Fuel Savings (MMBtu)	Varies by pipe length
Lifetime Energy Savings (kWh)	Varies by pipe length
Lifetime Fossil Fuel Savings (MMBtu)	Varies by pipe length
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost (per linear foot)	$8.98
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is adding insulation to uninsulated DHW pipes. The measure savings are based on the pipe wrap being installed to the first length of both the hot and cold pipe up to the first elbow.

Definition of Efficient Equipment

The efficient condition is installing pipe wrap insulation to a length of hot water carrying copper pipe.

Definition of Baseline Equipment

The baseline is an uninsulated hot water carrying copper pipe.

Deemed Lifetime of Efficient Equipment

The measure life is 15 years.[117]

Deemed Measure Cost

The measure cost including material and installation is $8.98 per linear foot. [118].

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

---

[117] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

[118] Itron, Inc. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. May 27, 2014. Submitted to the California Public Utilities Commission.

Savings Algorithm

Energy Savings

The energy savings for homes with an electric DHW system would be:

$$\Delta \text{kWh} = \left(\frac{1}{R_{EXIST}} - \frac{1}{R_{NEW}}\right) * \frac{L * C * \Delta T * 8{,}760}{\eta_{DHW} * 3{,}412}$$

Where:

R_{EXIST} = Pipe heat loss coefficient (R-value) of uninsulated pipe existing (= 1.0 $\frac{°F * hr * ft^2}{Btu}$)[119]

R_{NEW} = Pipe heat loss coefficient (R-value) of insulated pipe (= actual; otherwise = 3)[120]

L = Feet of pipe from water heating source covered by pipe wrap (= actual)

C = Circumference of pipe in feet (= actual; = π * diameter)

ΔT = Average temperature difference between supplied water and ambient air temperature (= 65°F)[121]

8,760 = Hours per year

η_{DHW} = Recovery efficiency of electric hot water heater (= 0.98)[122]

3,412 = Conversion from Btu to kWh

For example, the energy savings from insulating 5 feet of 0.75-inch pipe with R-4 wrap would be:

$$\Delta kWh = \left(\frac{1}{1} - \frac{1}{5}\right) * \frac{5 * \left(\pi * \frac{0.75}{12}\right) * 65 * 8{,}760}{0.98 \ * \ 3{,}412} = 134\ kWh$$

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{\Delta kWh}{8{,}760}$$

119 Navigant Consulting and Ontario Energy Board. *Measures and Assumptions for Demand Side Management (DSM) Planning.* "Appendix C Substantiation Sheets." P. 77. April 2009.

120 Assumes standard 0.5-inch insulation with 4 $\frac{°F * hr * ft^2}{Btu * in}$ in addition to R-value of uninsulated pipe, based on: ASHRAE Fundamentals Chapter 23-Table 2.

121 Assumes 130°F average water temperature leaving the hot water tank and average basement temperature of 65°F.

122 Electric water heater have recovery efficiency of 98%: http://www.ahrinet.org/ARI/util/showdoc.aspx?doc=576

Where:

ΔkWh = kWh savings from pipe wrap installation

8,760 = Number of hours in a year

For example, the demand savings from insulating 5 feet of 0.75-inch pipe with R-4 wrap would be:

$$\Delta kW = \frac{133}{8{,}760} = 0.015 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

The fossil fuel savings for homes with a fossil fuel DHW system would be:

$$\Delta MMBtu = \left(\frac{1}{R_{EXIST}} - \frac{1}{R_{NEW}}\right) * \frac{L * C * \Delta T * 8{,}760}{\eta_{DHW} * 1{,}000{,}000}$$

Where:

η_{DHW} = Recovery efficiency of natural gas hot water heater (= 0.75)[123]

1,000,000 = Conversion from Btu to MMBtu

For example, the fossil fuel savings from insulating 5 feet of 0.75-inch pipe with R-4 wrap would be:

$$\Delta MMBtu = \left(\frac{1}{1} - \frac{1}{5}\right) * \frac{5 * 0.196 * 65 * 8{,}760}{0.75 * 1{,}000{,}000} = 0.596 \text{ MMBtu}$$

[123] Per AHRI directory, the range of recovery efficiency ratings for new natural gas DHW units is 70% to 87%, so the average of existing units is estimated as 75%.

Natural Gas Water Heaters (Time of Sale)

	Measure Details
Official Measure Code	Res-DHW-StorWH-1
Measure Unit	Per water heater
Measure Category	Domestic hot water
Sector(s)	Residential
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	13
Incremental Cost	Varies by technology
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is purchasing and installing an efficient natural gas water heater meeting or exceeding ENERGY STAR criteria[124] for the water heater category.

Definition of Efficient Equipment

The efficient condition is a natural gas water heater meeting the minimum efficiency ENERGY STAR qualification criteria, listed by category in the table below[125].

ENERGY STAR Criteria by Water Heater Type

Water Heater Type	Energy Factor
Natural Gas Storage ≤ 55 gallons	0.67
Natural Gas Storage > 55 gallons	0.77
Natural Gas Tankless (whole house)	0.90

[124] ENERGY STAR. "Residential Water Heaters Key Product Criteria." 2015http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters

[125] Ibid.

Definition of Baseline Equipment

The baseline condition is a 50-gallon conventional natural gas storage water heater with the federal minimum rating of 0.58 EF.

Deemed Lifetime of Efficient Equipment

The measure life is 13 years.[126]

Deemed Measure Cost

The deemed measure cost by water heater type is given in the table below.

Incremental cost by Water Heater Type

Water Heater Type	Incremental Cost*
Natural Gas Storage (0.67 EF)	$400
Natural Gas Storage Condensing (0.80 EF)	$685
Natural Gas Tankless (whole house; 0.82 EF)	$605

* U.S. Environmental Protection Agency. *ENERGY STAR Water Heater Criteria Final Analysis*. Used the low end of the cited range for the tankless category due to age of report.

Deemed O&M Cost Adjustments

There is no justification at this time for O&M cost adjustments.

Savings Algorithm

Energy Savings

$$\Delta\text{MMBtu} = GPD * 365 * 8.3 * \frac{\Delta T}{1{,}000{,}000} * \left(\frac{1}{EF_{BASE}} - \frac{1}{EF_{EFF}}\right)$$

Where:

GPD = Average daily hot water consumption (= see table)

8.3 = Constant (Btu/gal-°F)

Hot water use varies by family size. Estimates of hot water use per person as a function of number of people in the home are shown in the table below.

[126] The life expectancy of each water heater depends on local variables, such as water chemistry and homeowner maintenance. While there is currently insufficient data to determine tankless water heaters lifetimes, preliminary data show lifetimes up to 20 years. This value of 13 years is the weighted average lifetime for this measure category in aggregate and is supported by the findings in: http://www.aceee.org/consumerguide/WH_LCC_1107.pdf

Hot Water Use by Family Size

Number of People	Gallons per Person per Day	Gallons per Day per Household
1	29.4	29
2	22.8	46
3	20.6	62
4	19.5	78
5	18.9	94
6	18.5	111

ΔT = Water temperature difference between water heater setpoint and entering cold water

The water heater setpoint for residential buildings is usually between 120°F and 140°F. The average cold water entering temperature varies by climate, as shown in the table below.

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Ft Wayne	55.6

* Burch, J. and C. Christensen, National Renewable Energy Lab. White Paper: "Towards Development of an Algorithm for Mains Water Temperature." 2007.

EF_{BASE} = Energy factor for baseline equipment (= 0.594)

EF_{EFF} = Energy factor for efficient equipment (= actual)

For example, the energy savings from installing a new tankless unit with an EF of 0.82 in a four person home in Indianapolis would be:

$$\Delta\text{MMBtu} = GPD * 365 * 8.3 * \frac{\Delta T}{1{,}000{,}000} * \left(\frac{1}{EF_{BASE}} - \frac{1}{EF_{EFF}}\right)$$

$$= 78 * 365 * 8.3 * \frac{140-58.1}{1{,}000{,}000} * \left(\frac{1}{0.594} - \frac{1}{0.82}\right) = 8.98 \text{ MMBtu}$$

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

Water Heater Wrap (Direct Install)

	Measure Details
Official Measure Code	Res-DHW-TankWrap-1
Measure Unit	Per wrap
Measure Category	Domestic hot water
Sector(s)	Residential
Annual Energy Savings (kWh)	79
Peak Demand Reduction (kW)	0.009
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	393
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	TBD
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is wrapping tank wrap or an insulation blanket around the outside of a hot water tank to reduce standby losses. This measure savings only apply to homes with an electric water heater that is not already well insulated. Generally this can be determined based on the appearance of the tank and whether it is insulated by foam (which is newer, rigid, and more effective) or fiberglass (which is older and gives to gently pressure).

Definition of Efficient Equipment

The efficient condition is properly installed insulating tank wrap that reduces standby energy losses from the tank to the surrounding ambient area.

Definition of Baseline Equipment

The baseline condition is a standard electric DHW tank without additional tank wrap. Natural gas storage water heaters are excluded due to the limitations of retrofit wrapping and the associated impacts on reduced savings and safety.

Deemed Lifetime of Efficient Equipment

The measure life is 5 years.[127]

---

[127] This estimate is based on tank wrap being installed on an existing unit with 5 years of remaining life. On average when retrofitting an existing tank, the tank would be roughly halfway through its 13 to 15 year life, but qualifying baseline tanks with fiberglass (rather than foam insulation) are older on average by a few years.

Deemed Measure Cost

The incremental cost is the actual material cost of procuring and labor cost of installing the tank wrap.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

This calculation is based on the finding that a poorly insulated electric resistance water heater with a pre-wrap EF of 0.86 has a new and more effective EF of 0.88 after being properly wrapped with supplemental insulation. The impacts of waste heat on heating and cooling savings are not included.

Energy Savings

$$\Delta \text{kWh} = kWh_{BASE} * \frac{EF_{NEW} - EF_{BASE}}{EF_{NEW}}$$

Where:

kWh_{BASE} = Average kilowatt-hour consumption of electric DHW tank (= 3,460)[128]

EF_{NEW} = Assumed efficiency of electric tank with tank wrap installed (= 0.88)[129]

EF_{BASE} = Assumed efficiency of electric tank without tank wrap installed (= 0.86)

$$\Delta \text{kWh} = 3{,}460 * \frac{0.88 - 0.86}{0.88} = 79 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{\Delta kWh}{8{,}760}$$

Where:

ΔkWh = Kilowatt-hour savings from tank wrap installation

8,760 = Number of hours in a year

$$\Delta \text{kW} = \frac{79}{8{,}760} = 0.009 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

128 U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. *Residential Water Heaters Technical Support Document for the January 17, 2001, Final Rule.* DOE/EE-0317. Table 9.3.9, p. 9-34. May 2007. Available online: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/09.pdf

129 Oak Ridge National Laboratory. *Meeting the Challenge: The Prospect of Achieving 30 percent Energy Savings Through the Weatherization Assistance Program*. May 2002. Available online: http://www.cee1.org/eval/db_pdf/309.pdf. Study predicted that wrapping a 40-gallon water heater would increase the electric DHW tank energy factor by 0.02 (from 0.86 to 0.88).

Solar Water Heater with Electric Backup (Retrofit)

	Measure Details
Official Measure Code	Res-DHW-SWH-1
Measure Unit	Per system
Measure Category	Domestic hot water
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	20
Incremental Cost	$9,506.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a new solar water heater system with electric backup meeting the SRCC OG-300 performance standards presented below. This measure relates to installing a new system in an existing home.

Definition of Efficient Equipment

The efficient equipment is an SRCC OG-300 certified solar water heater with a solar energy factor meeting the ENERGY STAR specification.

Definition of Baseline Equipment

The baseline equipment is a standard electric water heater meeting or exceeding the minimum energy factor set in the 2004 federal conservation standard for water heaters.

Deemed Lifetime of Efficient Equipment

The expected measure life is 20 years.[130]

---

130 ENERGY STAR. *Residential Water Heaters, Final Criteria Analysis.* Available online: http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterDraftCriteriaAn alysis.pdf

Deemed Measure Cost

The cost for this measure is $9,506.00.[131]

Deemed O&M Cost Adjustments

The deemed O&M cost adjustment for this measure is $344.00.[132]

Savings Algorithm

Energy Savings

$$\Delta kWh = \left(\frac{1}{EF} - \frac{1}{SEF}\right) * Q_{DEL}$$

Where:

EF = Minimum energy factor for residential electric water heater (= 0.96 - (0.003 * Rated Storage Volume in gallons) = 0.945 for 50-gallon residential tank)[133]

SEF = Minimum system performance for solar water heaters (= actual)[134]

Q_{DEL} = Annual energy delivered to hot water load ($= 23{,}470 * (135 - T_{IN}) * \frac{8.3}{3{,}412}$)

Where:

23,470 = Average gallons of water drawn per year, assuming 365 days per year operation[135]

135 = Average hot water supply temperature [136]

---

131 Green Energy Ohio. “GEO Solar Thermal Rebate Program.” http://www.greenenergyohio.org/page.cfm?pageID=2712. The average cost of a fully installed solar thermal system is $9,506, ranging from $6,825 to $11,850.

132 Vermont Energy Investment Corporation. *Appendix 2 APS-Incentives for Photovoltaic Distributed Generation*. 2010. This value reflects the net present value of future costs including glycol, pump, and tank replacement. Because this retrofit measure replaces an existing water tank with some years remaining, this net present value conservatively overstates the O&M costs to the degree that the existing tank would have required replacement a few years earlier.

133 2015 Federal Energy Conservation Standard for water heaters (e-CFR Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32).

134 Based on SRCC annual system performance rating for solar water heaters (OG-300 7/28/2010). ENERGY STAR specifications require a solar fraction greater than 0.5, which equates to a minimum solar energy factor of 1.8.

135 Based on U.S. DOE and SRCC test procedure assumptions.

136 Based on U.S. DOE and SRCC test procedure assumptions.

T_{IN} = Average cold water entering home (= depending on location; see table below)

Average Cold Water Temperature Entering Home by City*

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Ft Wayne	55.6

* Burch, J. and C. Christensen, National Renewable Energy Lab. White paper: "Towards Development of an Algorithm for Mains Water Temperature." Prepared for American Solar Energy Society. 2007.

8.3 = Specific weight of water in pounds per gallon, multiplied by the specific heat of water (1.0 $\frac{Btu}{lb*°F}$)

3,412 = Conversion constant (1 kWh = 3,412 Btu)

For example, the energy savings from installing a solar water heater system with solar EF rating of 1.8 in Indianapolis would be:

$$\Delta kWh = \left(\frac{1}{0.945} - \frac{1}{1.8}\right) * 23{,}470 * (135 - 58.1) * \frac{8.3}{3{,}412} = 2{,}207\ kWh$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{1}{EF} * \frac{Q_{DEL}}{Hours} * CF$$

Where:

Hours = Equivalent full load hours of water heater (= 2,533)[137]

CF = Summer peak coincidence factor for measure (= 0.203)[138]

For example, the demand reduction from installing a solar water heater system with solar EF rating of 1.8 in Indianapolis would be:

---

[137] Efficiency Vermont. Load shape calculated from Itron eShapes.

[138] Calculated from Itron eShapes, which has 8,760 hourly data by end use for Upstate New York.

$$\Delta kW = \frac{1}{0.945} * \frac{23{,}470 * (135 - 58.1) * \frac{8.3}{3{,}412}}{2{,}533} * 0.203 = 0.372\ kW$$ [139]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

[139] The resultant demand reduction from the Itron eShapes is consistent with the results of the ADM whitepaper for FirstEnergy's solar water heater program in Pennsylvania, in which the demand reduction is based on the system being designed to meet 100% of a home's hot water need during the summer months and is the product of two factors: (1) the annual baseline energy usage of an electric water heater and (2) the fraction of energy usage during the coincident peak times of 3:00 p.m. to 6:00 p.m. during the months of June thru August. The fractional usage was calculated from: PJM. *Deemed Savings Estimates for Legacy Air Conditioning and Water Heating Direct Load Control Programs in PJM Region*. Available online: http://www.pjm.com/~/media/committees-groups/working-groups/lrwg/20070301/20070301-pjm-deemed-savings- report.ashx

HVAC

Residential HVAC Maintenance/Tune-Up (Retrofit)

	Measure Details
Official Measure Code	Res-HVAC-AC/Furn Tuneup-1
Measure Unit	Per tune-up
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	$64.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is (1) measuring refrigerant charge levels and airflow over the central air conditioning or heat pump unit coil, (2) correcting any problems found, and (3) re-measuring the levels and airflow post-treatment. Measurements must be performed with standard industry tools and the results tracked by the efficiency program.

Savings from this measure are based on a reputable Wisconsin study. It is recommended that future evaluation be conducted in Indiana to generate a more locally appropriate characterization.

Definition of Efficient Equipment

The efficient condition is measuring, correcting, and verifying the refrigerant charge levels and airflow over the central air conditioning or heat pump unit coil.

Definition of Baseline Equipment

The measure savings are based on the existing unit being regularly maintained being either a residential central air conditioning unit or an air-source heat pump.

Deemed Lifetime of Efficient Equipment

The measure life is 5 years.[140]

Deemed Measure Cost

If the implementation mechanism involves delivering and paying for the tune-up service, the actual cost should be used. If the customer receives a rebate and the private contractors perform the work, the measure cost is $64.00.[141]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \mathrm{kWh}_{CAC} = EFLH_{COOL} * Btuh_{COOL} * \frac{1}{SEER_{CAC} * 1{,}000} * MF_E$$

$$\Delta \mathrm{kWh}_{ASHP} = \left(EFLH_{COOL} * Btuh_{COOL} * \frac{1}{SEER_{ASHP}} + EFLH_{HEAT} * Btuh_{HEAT} * \frac{1}{HSPF_{ASHP}} \right) * \frac{MF_E}{1{,}000}$$

Where:

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

[140] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures* June 2007.

[141] A survey of Dayton-area HVAC contractors revealed inspection and tune-up cost of $160.00. Given that inspection costs are $96.00, the tune-up cost is $64.00.

$Btuh_{COOL}$ = Cooling capacity of equipment in Btuh (= actual; otherwise = 28,994 Btuh;[142] Note: 1 ton = 12,000 Btuh)

$SEER_{CAC}$ = SEER efficiency of existing central air conditioning unit receiving maintenance (= actual; otherwise use 11.15)[143]

1,000 = Conversion from Wh to kWh

MF_E = Maintenance energy savings factor (= 0.05)[144]

$SEER_{ASHP}$ = SEER efficiency of existing air-source heat pump unit receiving maintenance (= actual; otherwise use 11.15)[145]

$EFLH_{HEAT}$ = Equivalent full load heating hours (= actual; dependent on location, see table below)

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Extracted from simulations. See Appendix B.

$Btuh_{HEAT}$ = Heating capacity of equipment in Btuh (= actual)

$HSPF_{BASE}$ = Heating season performance factor of existing air-source heat pump unit receiving maintenance (= actual; otherwise use 6.8)[146]

For example, the energy savings from conducting maintenance on a 3-ton, SEER 10 air conditioning unit in Indianapolis would be:

$$\Delta kWh_{CAC} = 487 * 36{,}000 * \frac{1}{10*1{,}000} * 0.05 = 88 \text{ kWh}$$

142 TecMarket Works, et al. *Residential Baseline Report Final*. November 2, 2012. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs

143 Ibid.

144 Energy Center of Wisconsin. *Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research*. May 2008. Note: the MF_E for heat pumps is set to the MF_E for air conditioners, pending EM&V review.

145 TecMarket Works, et al. *Residential Baseline Report Final*. November 2, 2012. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs

146 This was the minimum federal standard between 1992 and 2006.

For example, the energy savings from conducting maintenance on a 3-ton (cooling and heating) , SEER 10, HSPF 6.8 air-source heat pump unit in Indianapolis would be:

$$\Delta kWh_{ASHP} = \frac{487 * 36{,}000 * \frac{1}{10}}{1{,}000} * 0.05 + 1{,}341 * 36{,}000 * \frac{1}{6.8 * 1{,}000} * 0.05 = 443 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = Btuh_{COOL} * \frac{1}{EER * 1{,}000} * MF_D * CF$$

Where:

EER	=	EER efficiency of existing unit receiving maintenance (= actual; otherwise calculate using SEER * 0.9)
MF_D	=	Maintenance demand reduction factor (= 0.05)[147]
CF	=	Summer peak coincidence factor (= 0.88)[148]

For example, the demand reduction from conducting maintenance on 3-ton, SEER 10 (equals EER 9.0) unit would be:

$$\Delta kW = 36{,}000 * \frac{1}{9.0 * 1{,}000} * 0.05 * 0.88 = 0.176 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

[147] Data are sparse for this parameter. Set equal to MF_E, subject to EM&V review.

[148] Duke Energy. Data for residential AC loads.

Residential Boiler Tune-Up

	Measure Details
Official Measure Code	Res-HVAC-Boiler Tuneup-1
Measure Unit	Per tune-up
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	$140.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the tune-up of an existing residential boiler to improve the seasonal heating efficiency.

Definition of Efficient Equipment

The efficient condition is the boiler after a tune up is performed.

Definition of Baseline Equipment

The baseline condition is the existing boiler before a tune up.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 5 years.

Deemed Measure Cost

The incremental cost for this measure is $140.00 per boiler.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

There are no expected energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\text{Annual MMBtu Savings } = EFLH_{HEAT} * Btuh * ESF * 10^{-6}$$

Where:

Btuh = Size of equipment in Btuh input capacity (= actual; otherwise = 77,386)[149]

$EFLH_{HEAT}$ = Equivalent full load heating hours (= dependent on location; see table below)

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix B.

ESF = Energy savings factor (= 0.05)[150]

For example, the fossil fuel savings from tuning up a 100 kBtu/hr boiler installed in Indianapolis would be:

$$\text{Annual MMBtu Savings} = EFLH_{HEAT} * BtuH * ESF * 10^{-6} = 1{,}341 * 100{,}000 * 0.05 * 10^{-6}$$
$$= 6.7 \text{ MMBtu per year}$$

149 TecMarket Works, et al. *Residential Baseline Report Final*. November 2, 2012. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs

150 *Michigan Efficiency Measures Database*. Report uses energy savings of 5% for residential boiler tune ups.

Central Air Conditioning (Early Replacement)

	Measure Details
Official Measure Code	Res-HVAC-AC-ER-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	18
Incremental Cost	Varies by location
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the early removal of an existing inefficient central air conditioning unit from service, prior to its natural end of life, and replacing with a new ENERGY STAR-qualifying unit. Savings are calculated between the existing unit and efficient unit consumption during the remaining life of the existing unit, and between the new baseline unit and efficient unit consumption for the remainder of the measure life.

Definition of Efficient Equipment

The efficient equipment is a ducted, split central air conditioning unit meeting the minimum ENERGY STAR efficiency level standards of 14.5 SEER and 12 EER.

Definition of Baseline Equipment

The baseline condition is the existing inefficient central air conditioning unit for the remaining assumed useful life of the unit, then for the remainder of the measure life the baseline becomes a new replacement unit meeting the minimum federal efficiency standard of 13 SEER and 11 EER.

Deemed Lifetime of Efficient Equipment

The expected measure life is 18 years.[151]

[151] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

The assumed remaining useful life of the existing central air conditioning unit being replaced is 5 years.[152]

Deemed Measure Cost

The actual measure cost for removing the existing unit and installing the new should be used.

Deemed O&M Cost Adjustments

The net present value of the deferred replacement cost (the cost associated with replacing the existing unit with a standard unit that would have had to have occurred after 5 years, had the existing unit not been replaced) should be calculated as: Actual Cost of ENERGY STAR unit - incremental cost of ENERGY STAR unit over baseline unit (depending on SEER; see table below)[153] * 63%.[154]

Deemed O&M Cost Adjustments per Ton by SEER

Efficiency Level	Cost per Ton
SEER 14	$119
SEER 15	$238
SEER 16	$357
SEER 17	$476
SEER 18	$596
SEER 19	$715
SEER 20	$834
SEER 21	$908

Savings Algorithm

Energy Savings

$$\Delta kWh \text{ for remaining life of existing unit (first 5 years)} = EFLH_{COOL} * Btuh * \frac{\frac{1}{SEER_{EXIST}} - \frac{1}{SEER_{EE}}}{1{,}000}$$

152 This value is a parameter estimate.

153 California Public Utilities Commission. *Database for Energy Efficient Resources.* 2008. Available online: www.deeresources.com.

154 This 63% is the ratio of the net present value (with a 5% discount rate) of the annuity payments from years 6 to 18 of a deferred replacement of a standard efficiency unit costing $2,857.00, divided by the standard efficiency unit cost ($2,857.00). This way of calculating savings allows for using the known ENERGY STAR replacement cost to calculate an appropriate baseline replacement cost. The standard unit cost based on: ENERGY STAR. "Central Air Conditioning Calculator." http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls

$$\Delta\text{kWh for remaining measure life (next 13 years)} = EFLH_{COOL} * Btuh * \frac{\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}}{1{,}000}$$

Where:

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

Btuh = Size of equipment in Btuh (= actual; otherwise assume 28,994;[155] note: 1 ton = 12,000 Btuh)

$SEER_{EXIST}$ = Seasonal average efficiency of existing unit (= actual; otherwise assume 11.15)[156]

$SEER_{EE}$ = SEER efficiency of ENERGY STAR unit (= actual)

$SEER_{BASE}$ = SEER efficiency of baseline unit (= 13)[157]

For example, the energy savings from replacing a 3-ton, SEER 10 unit with a new SEER 14.5 unit in Indianapolis would be:

$$\Delta\text{kWh for remaining life of existing unit (first 5 years)} = 487 * 36{,}000 * \frac{\frac{1}{10} - \frac{1}{14.5}}{1{,}000} = 544\text{ kWh}$$

$$\Delta\text{kWh for remaining measure life (next 13 years)} = 487 * 36{,}000 * \frac{\frac{1}{13} - \frac{1}{14.5}}{1{,}000} = 139.5\text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta\text{kW for remaining life of existing unit (first 5 years)} = Btuh * \frac{\frac{1}{EER_{EXIST}} - \frac{1}{EER_{EE}}}{1{,}000} * CF$$

155 TecMarket Works, et al. *Residential Baseline Report Final*. November 2, 2012. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs

156 Ibid.

157 This value reflects the minimum federal standard.

$$\Delta \text{kW for remaining measure life (next 13 years)} = Btuh * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}}{1{,}000} * CF$$

Where:

EER_{EXIST} = EER efficiency of existing unit (= actual; otherwise calculate as SEER * 0.9)

EER_{BASE} = EER efficiency of baseline unit (= 11)[158]

EER_{EE} = EER efficiency of ENERGY STAR unit (= actual)

CF = Summer peak coincidence factor (= 0.88)[159]

For example, the demand reduction from replacing a 3-ton, SEER 10 unit (EER 9) with a new SEER 14.5, EER 12 unit in Indianapolis would be:

$$\Delta \text{kW for remaining life of existing unit (first 5 years)} = 36{,}000 * \frac{\frac{1}{9} - \frac{1}{12}}{1{,}000} * 0.88 = 0.88 \text{ kW}$$

$$\Delta \text{kW for remaining measure life (next 13 years)} = 36{,}000 * \frac{\frac{1}{11} - \frac{1}{12}}{1{,}000} * 0.88 = 0.24 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

158 Ibid.

159 Duke Energy load shape data for residential AC loads from: Integral Analytics, Inc. DSMore cost-effectiveness tool. Available online: www.integralanalytics.com

Central Air Conditioning (Time of Sale)

	Measure Details
Official Measure Code	Res-HVAC-AC-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	18
Incremental Cost	Varies by location
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is replacing a central air conditioning unit with a new ENERGY STAR-qualifying unit. Savings are calculated between a new baseline unit and an efficient unit.

Definition of Efficient Equipment

The efficient equipment is a ducted, split central air conditioning unit meeting the minimum ENERGY STAR efficiency level standards of 14.5 SEER and 12 EER.

Definition of Baseline Equipment

The baseline condition is a new replacement unit meeting the minimum federal efficiency standard of 13 SEER and 11 EER.

Deemed Lifetime of Efficient Equipment

The expected measure life is 18 years.[160]

Deemed Measure Cost

The incremental measure cost between a new baseline unit and the efficient unit should be used; see table below.

---

160 GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

Deemed Incremental Measure Cost per Ton by SEER

Efficiency Level	Incremental Cost per Ton
SEER 14	$119
SEER 15	$238
SEER 16	$357
SEER 17	$476
SEER 18	$596
SEER 19	$715
SEER 20	$834
SEER 21	$908

Savings Algorithm

Energy Savings

$$\Delta kWh = EFLH_{COOL} * Btuh * \frac{\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}}{1{,}000}$$

Where:

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

Btuh = Size of equipment in Btuh (= actual; otherwise assume 28,994;[161] note: 1 ton = 12,000 Btuh)

$SEER_{EE}$ = SEER efficiency of ENERGY STAR unit (= actual)

$SEER_{BASE}$ = SEER efficiency of baseline unit (= 13)[162]

161 TecMarket Works, et al. *Residential Baseline Report Final*. November 2, 2012. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs

162 This value reflects the minimum federal standard.

For example, the energy savings from installing a new 3-ton, SEER 14.5 unit in Indianapolis would be:

$$\Delta\text{kWh} = 487 * 36{,}000 * \frac{\frac{1}{13} - \frac{1}{14.5}}{1{,}000} = 140\text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta\text{kW} = BtuH * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}}{1{,}000} * CF$$

Where:

EER_{BASE}	=	EER efficiency of baseline unit (= 11)[163]
EER_{EE}	=	EER efficiency of ENERGY STAR unit (= actual)
CF	=	Summer peak coincidence factor (= 0.88)[164]

For example, the demand reduction from installing a new 3-ton, SEER 14.5, EER 12 unit in Indianapolis would be:

$$\Delta\text{kW} = 36{,}000 * \frac{\frac{1}{11} - \frac{1}{12}}{1{,}000} * 0.88 = 0.220\text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

163 Ibid.

164 Duke Energy load shape data for residential AC loads from: Integral Analytics, Inc. DSMore cost-effectiveness tool. Available online: www.integralanalytics.com

Central Air Source Heat Pump (Early Replacement)

	Measure Details
Official Measure Code	Res-HVAC-ASHP-ER-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	18
Incremental Cost	Varies by location
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the early removal of an existing inefficient central heat pump unit from service, prior to its natural end of life, and replacing with a new ENERGY STAR-qualifying unit. Savings are calculated between the existing unit and efficient unit consumption during the remaining life of the existing unit, and between the new baseline unit and efficient unit consumption for the remainder of the measure life.

Definition of Efficient Equipment

The efficient equipment is a ducted, split central heat pump unit meeting the minimum ENERGY STAR efficiency level standards of 14.5 SEER, 12 EER, and 8.2 HSPF.

Definition of Baseline Equipment

The baseline condition is the existing inefficient central heat pump unit for the remaining assumed useful life of the unit, then for the remainder of the measure life the baseline becomes a new replacement unit meeting the minimum federal efficiency standard of 13 SEER, 11 EER, and 7.7 HSPF).

Deemed Lifetime of Efficient Equipment

The expected measure life is 18 years.[165]

---

[165] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

The assumed remaining useful life of the existing central heat pump unit being replaced is 5 years.[166]

Deemed Measure Cost

The actual measure cost for removing the existing unit and installing the new should be used.

Deemed O&M Cost Adjustments

The net present value of the deferred replacement cost (the cost associated with replacing the existing unit with a standard unit that would have occurred after 5 years, had the existing unit not been replaced) should be calculated as: Actual Cost of ENERGY STAR unit - incremental cost of ENERGY STAR unit over baseline unit (based on efficiency level; see table below)[167] * 63%.[168]

Deemed O&M Cost Adjustment per Ton by SEER Level

Efficiency Level	Cost per Ton
SEER 14	$137
SEER 15	$274
SEER 16	$411
SEER 17	$548
SEER 18	$685

Savings Algorithm

Energy Savings

ΔkWh for remaining life of existing unit (first 5 years) = $EFLH_{COOL} * Btuh_{COOL} * \frac{\frac{1}{SEER_{EXIST}} - \frac{1}{SEER_{EE}}}{1{,}000} +$

$$EFLH_{HEAT} * Btuh_{HEAT} * \frac{\frac{1}{HSPF_{EXIST}} - \frac{1}{HSPF_{EE}}}{1000}$$

ΔkWh for remaining measure life (next 13 years) = $FLH_{COOL} * Btuh_{COOL} * \frac{\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}}{1{,}000} +$

$$EFLH_{HEAT} * Btuh_{HEAT} * \frac{\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}}{1{,}000}$$

---

166 Ohio Technical Reference Manual.

167 California Public Utilities Commission. *Database for Energy Efficient Resources.* 2008. Available online: www.deeresources.com.

168 This 63% is the ratio of the net present value (with a 5% discount rate) of the annuity payments from years 6 to 18 of a deferred replacement of a standard efficiency unit costing $2,857.00, divided by the standard efficiency unit cost ($2,857.00). This way of calculating savings allows for using the known ENERGY STAR replacement cost to calculate an appropriate baseline replacement cost. The standard unit cost based on: ENERGY STAR. “Central Air Conditioning Calculator."

Where:

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

$EFLH_{HEAT}$ = Equivalent full load heating hours (= dependent on location; see table below)

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix A.

$Btuh_{COOL}$ = Cooling capacity of equipment in Btu/hr (= actual; note: 1 ton = 12,000 Btuh)

$Btuh_{HEAT}$ = Heating capacity of equipment in Btu/hr (= actual)

$SEER_{EXIST}$ = Seasonal average efficiency of existing unit in SEER (= actual; otherwise assume 11.15)[169]

$SEER_{EE}$ = SEER efficiency of ENERGY STAR unit (= actual)

$SEER_{BASE}$ = SEER efficiency of baseline unit (= 13)[170]

$HSPF_{EXIST}$ = Heating seasonal performance factor of existing air-source heat pump (= actual)

169 TecMarket Works, et al. *Residential Baseline Report Final*. November 2, 2012. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs

170 This value reflects the minimum federal standard.

$HSPF_{EE}$ = Heating seasonal performance factor of efficient air-source heat pump (= actual installed)

$HSPF_{BASE}$ = Heating seasonal performance factor of baseline air-source heat pump (= 7.7)[171]

1,000 = Conversion from Wh to kWh

For example, the energy savings from replacing a 3-ton SEER 10, HSPF 7.2 unit with a new SEER 14.5, HSPF 8.7 unit in Indianapolis would be:

$$\Delta kWh \text{ for remaining life of existing unit (first 5 years)} = 487 * 36{,}000 * \frac{\frac{1}{10} - \frac{1}{14.5}}{1{,}000} + 1{,}341 * \frac{36{,}000}{1{,}000} * \left(\frac{1}{7.2} - \frac{1}{8.7}\right) = 1{,}700 \text{ kWh}$$

$$\Delta kWh \text{ for remaining measure life (next 13 years)} = 487 * 36{,}000 * \frac{\frac{1}{13} - \frac{1}{14.5}}{1{,}000} + 1{,}341 * \frac{36{,}000}{1{,}000} * \left(\frac{1}{7.7} - \frac{1}{8.7}\right) = 860 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW \text{ for remaining life of existing unit (first 5 years)} = Btuh_{COOL} * \frac{\frac{1}{EER_{EXIST}} - \frac{1}{EER_{EE}}}{1{,}000} * CF$$

$$\Delta kW \text{ for remaining measure life (next 13 years)} = Btuh_{COOL} * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}}{1{,}000} * CF$$

Where:

EER_{EXIST} = EER efficiency of existing unit (= actual; = SEER * 0.9)[172]

EER_{BASE} = EER efficiency of baseline unit (= 11)[173]

EER_{EE} = EER efficiency of ENERGY STAR unit (= actual)

CF = Summer peak coincidence factor (= 0.88)[174]

---

171 Ibid.

172 If SEER is unknown, use the default EER of (10 * 0.9) = 9.0. This calculation is based on a prior assessment of industry equipment efficiency ratings.

173 This value reflects the minimum federal standard.

174 Duke Energy load shape data for residential AC loads from: Integral Analytics, Inc. DSMore cost-effectiveness tool. Available online: www.integralanalytics.com

For example, the demand reduction from replacing a 3-ton, SEER 10 (EER 9) unit with a new SEER 14.5 (EER 12) unit in Indianapolis would be:

$$\Delta kW \text{ for remaining life of existing unit (first 5 years)} = 36{,}000 * \frac{\frac{1}{9}-\frac{1}{12}}{1{,}000} * 0.88 = 0.88 \text{ kW}$$

$$\Delta kW \text{ for remaining measure life (next 13 years)} = 36{,}000 * \frac{\frac{1}{11}-\frac{1}{12}}{1{,}000} * 0.88 = 0.24 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

Central Air Source Heat Pump (Time of Sale)

	Measure Details
Official Measure Code	Res-HVAC-ASHP-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	18
Incremental Cost	Varies by location
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation a new ENERGY STAR-qualifying unit. Savings are calculated between a new baseline unit and the efficient unit.

Definition of Efficient Equipment

The efficient equipment is a ducted, split central heat pump unit meeting the minimum ENERGY STAR efficiency level standards of 14.5 SEER, 12 EER, and 8.2 HSPF.

Definition of Baseline Equipment

The baseline condition is a new replacement unit meeting the minimum federal efficiency standard of 13 SEER, 11 EER, and 7.7 HSPF.

Deemed Lifetime of Efficient Equipment

The expected measure life is 18 years.[175]

Deemed Measure Cost

The incremental measure cost of installing the new unit over the baseline unit should be used; see table below.

---

175 GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

Deemed Incremental Measure Cost by SEER

Efficiency Level	Incremental Cost per Ton
SEER 14	$137
SEER 15	$274
SEER 16	$411
SEER 17	$548
SEER 18	$685

Savings Algorithm

Energy Savings

$$\Delta kWh = \left(\frac{EFLH_{COOL} * Btuh_{COOL}}{1{,}000}\right) * \left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right) + \left(\frac{EFLH_{HEAT} * Btuh_{HEAT}}{1{,}000}\right) * \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}\right)$$

Where:

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

$EFLH_{HEAT}$ = Equivalent full load heating hours (= actual; dependent on location, see table below)

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix A.

$Btuh_{COOL}$ = Cooling capacity of equipment in Btuh (= actual; note: 1 ton = 12,000 Btuh)

$Btuh_{HEAT}$ = Heating capacity of equipment in Btuh (= actual)

$SEER_{EE}$ = SEER efficiency of ENERGY STAR unit (= actual)

$SEER_{BASE}$ = SEER efficiency of baseline unit (= 13)[176]

$HSPF_{EE}$ = Heating seasonal performance factor of efficient air-source heat pump (= actual)

$HSPF_{BASE}$ = Heating sseasonal performance factor of baseline air-source heat pump (= 7.7)[177]

For example, the energy savings from installing a new SEER 14.5, HSPF 8.7, 3-ton unit in Indianapolis would be:

$$\Delta kWh = 487 * 36{,}000 * \frac{\frac{1}{13} - \frac{1}{14.5}}{1{,}000} + 1{,}341 * \frac{36{,}000}{1{,}000} * \left(\frac{1}{7.7} - \frac{1}{8.7}\right) = 860 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = Btuh_{COOL} * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}}{1{,}000} * CF$$

Where:

EER_{BASE} = EER efficiency of baseline unit (= 11)[178]

EER_{EE} = EER efficiency of ENERGY STAR unit (= actual)

CF = Summer peak coincidence factor (= 0.88)[179]

For example, the demand reduction from installing a new SEER 14.5, EER 12 unit in Indianapolis would be:

$$\Delta kW = 36{,}000 * \frac{\frac{1}{11} - \frac{1}{12}}{1{,}000} * 0.88 = 0.24 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

176 This value reflect the minimum federal standard.

177 Ibid.

178 Ibid.

179 Roberts and Salcido, Architectural Energy Corporation. *Peak Electric Demand Calculations in the REM/Rate Home Energy Rating Software and REM/Design Home Energy Analysis Software*. February 2008. "This formulaic relationship was derived from 1,861 unique combinations of data, from nearly 200,000 ARI-rated residential central air conditioners.

Ground Source Heat Pumps (Time of Sale)

	Measure Details
Official Measure Code	Res-HVAC-GSHP-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	18
Incremental Cost	$3,609.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure in installing a new GSHP system meeting the ENERGY STAR efficiency standards presented in the table below. This measure relates to installing a new system in an existing home (i.e., time of sale).

ENERGY STAR Efficiency Standards for Ground-Source Heat Pumps

Product Type	EER	COP
Water-to-Air		
Closed Loop	17.1	3.6
Open Loop	21.1	4.1
Water-to-Water		
Closed Loop	16.1	3.1
Open Loop	20.1	3.5
DGX	16	3.6

Definition of Efficient Equipment

The efficient equipment is a GSHP meeting the minimum ENERGY STAR efficiency level standards effective at the time of installation, as detailed in the table above.

Definition of Baseline Equipment

The baseline equipment is an ASHP meeting the federal standard efficiency level of 13 SEER and 11 EER.

Deemed Lifetime of Efficient Equipment

The expected measure life is 18 years.[180]

Deemed Measure Cost

The actual installed cost of the GSHP should be used, minus the assumed installation cost of a 3-ton, standard baseline ASHP of $3,609.00.[181]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \left(EFLH_{COOL} * Btuh_{COOL} * \frac{\frac{1}{SEER_{BASE}} - \frac{1}{EER_{EE} * 1.02}}{1{,}000} \right) + \left(EFLH_{HEAT} * Btuh_{HEAT} * \frac{\frac{1}{HSPF_{BASE}} - \frac{1}{COP_{EE} * 3.412}}{1{,}000} \right)$$

Where:

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

[180] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

[181] California Public Utilities Commission. *Database for Energy Efficient Resources.* 2008. Available online: www.deeresources.com. The material cost of a 13 SEER air conditioner is $796.00 per ton, with a labor cost of $407.00 per ton. The cost for a 3-ton unit would be: (796 + 407) * 3 = $3,609.00.

$Btuh_{COOL}$ = Cooling capacity of equipment in Btuh (= actual; note: 1 ton = 12,000 Btuh)

$Btuh_{HEAT}$ = Heating capacity of equipment in Btuh (= actual)

$SEER_{BASE}$ = SEER efficiency of baseline unit (= 13)[182]

EER_{EE} = EER efficiency of efficient unit (= actual)

1.02 = Constant used to estimate the SEER based on the efficient unit EER[183]

$EFLH_{HEAT}$ = Equivalent full load heating hours (= actual; dependent on location, see table below)

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix A.

$HSPF_{BASE}$ = Heating season performance factor for baseline unit (= 7.7)[184]

COP_{ee} = Coefficient of Performance of efficient unit (= actual)

3.412 = Constant to convert the COP of the unit to the heating season performance factor

For example, the energy savings from installing a 3-ton heating and cooling unit with EER rating of 16 and COP of 3.5 in Indianapolis would be:

$$\Delta kWh = \left(487 * 36{,}000 * \frac{\frac{1}{13} - \frac{1}{16 \, * \, 1.02}}{1{,}000}\right) + \left(1{,}341 * 36{,}000 * \frac{\frac{1}{7.7} - \frac{1}{3.5 \, * \, 3.412}}{1{,}000}\right) = 2{,}501$$

182 This is the minimum federal standard from: Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations. p. 7,170-7,200.

183 Note that the EERs of GSHPs are measured differently than EERs of ASHP, as they are focused on entering water temperatures rather than ambient air temperatures. The equivalent SEER of a GSHP can be estimated by multiplying the EER by 1.02 (based on extrapolating manufacturer data).

184 This is the minimum federal standard from: Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations. p. 7,170-7,200.

Summer Peak Coincident Demand Reduction

$$\Delta kW = Btuh_{COOL} * \frac{\left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE} * 1.02 * 0.37 + 6.43}\right)}{1{,}000} * CF$$

Where:

EER_{BASE} = EER efficiency of baseline unit (= 11)[185]

EER_{EE} = EER efficiency of ENERGY STAR unit (= actual)

1.02 = Constant used to estimate the unit's equivalent air conditioning SEER based on GSHP unit's EER.[186] This is then converted to the unit's equivalent air conditioning EER to enable comparisons to the baseline unit using the following algorithm: $EER_{AC} = (SEER * 0.37) + 6.43$[187]

CF = Summer peak coincidence factor (= 0.88)[188]

For example, a 3 ton unit with EER rating of 16:

$$\Delta kW = 36{,}000 * \frac{\frac{1}{11} - \frac{1}{16 * 1.02 * 0.37 + 6.43}}{1000} * 0.88 = 0.34 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

185 Ibid.

186 Note that the EERs of GSHPs are measured differently than EERs of ASHP, as they are focused on entering water temperatures rather than ambient air temperatures. The equivalent SEER of a GSHP can be estimated by multiplying the EER by 1.02 (based on extrapolating manufacturer data).

187 Roberts and Salcido, Architectural Energy Corporation. *Peak Electric Demand Calculations in the REM/Rate Home Energy Rating Software and REM/Design Home Energy Analysis Software*. February 2008. "This formulaic relationship was derived from 1,861 unique combinations of data, from nearly 200,000 ARI-rated residential central air conditioners.

188 Duke Energy load shape data for residential AC loads from: Integral Analytics, Inc. DSMore cost-effectiveness tool. Available online: www.integralanalytics.com

Residential Electronically Commutated Motors

	Measure Details
Official Measure Code	Res-HVAC-ECMotor-1
Measure Unit	Per motor
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	415
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	
Lifetime Fossil Fuel Savings (MMBtu)	
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$250.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing an electronically commutated motors on a natural gas furnace or heat pump supply fans. Energy savings and demand reduction are realized through reductions in fan power due to improved motor efficiency and variable flow operation.

Definition of Efficient Equipment

The efficient condition is installing an electronically commutated motor on a furnace or heat pump air handler fan.

Definition of Baseline Equipment

The baseline condition is a standard furnace or heat pump supply fan motor.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 10 years.

Deemed Measure Cost

The incremental cost for this measure is $250.00.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = 415 \text{ per furnace or air handler}$$

The deemed energy savings per electronically commutated motor furnace or air handler were originally based on a 2009 impact evaluation of these furnaces in Wisconsin.[189] The study findings were based on field measurements of furnaces with and without electronically commutated motors as well as on surveys with homeowners and contractors to determine homeowner behavior with respect to fan control strategies for electronically commutated motor furnaces. The study included details of cycling versus continuous fan operation in furnaces before and after installing a furnace with an electronically commutated motor. The 2015 publication of the Wisconsin Focus on Energy Technical Reference Manual[190] revised the deemed savings from this study to 415 kWh per year.

Summer Peak Coincident Demand Reduction

There is no summer peak coincident demand reduction from this measure.

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.[191]

---

189 PA Consulting Group. *ECM Furnace Impact Assessment Report.* January 12, 2009. https://focusonenergy.com/sites/default/files/emcfurnaceimpactassessment_evaluationreport.pdf

190 The Cadmus Group, Inc. *Wisconsin Focus on Energy Technical Reference Manual.* January 2015. p. 338.

191 Fossil fuel interactions are expected for this technology, but were not evaluated.

Programmable Thermostats (Time of Sale, Direct Install)

	Measure Details
Official Measure Code	Res-HVAC-Tstat-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$35.00
Important Comments	Assumes standard manual thermostat as baseline
Effective Date	January 10, 2013
End Date	TBD

Description

Programmable thermostats can save energy through the advanced scheduling of time-of-day and/or day-of-week setbacks to control heating and cooling setpoints. Typical usage reduces the heating setpoint during times of the day when occupants are usually not at home (work hours), keeping the home at a cooler temperature in the winter; or increases the cooling setpoint during times of the day when occupants are usually not at home (work hours), keeping the home at a warmer temperature in the summer.

Definition of Efficient Equipment

The efficient condition is a standard programmable thermostat.

Definition of Baseline Equipment

The baseline condition is a standard, non-programmable thermostat for the central cooling and/or heating system (baseboard electric is excluded).

Deemed Lifetime of Efficient Equipment

The lifetime of this measure is 15 years.

Deemed Measure Cost

The incremental cost for purchasing a programmable thermostat has significant variation, but is typically around $35.00 (based on current retail market prices). Measures directly installed through retrofit programs should use the actual material and labor costs.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Savings from programmable thermostats can be difficult to estimate from analytical methods due to the significant behavioral interactions in both the initial programming and the year-over year operation. Studies that evaluate the savings impacts of programmable thermostats vary, but there is considerable and credible regard for the findings of a 2007 study[192] that incorporated large sample sizes of survey response and billing analyses.

Energy Savings

The cooling energy savings for homes with a central air conditioner would be:

$$\Delta \text{kWh} = \frac{1}{SEER} * EFLH_{COOL} * \frac{Btuh_{COOL}}{1{,}000} * ESF_{COOL}$$

Where:

SEER = Seasonal average energy efficiency ratio (Btu/watt-hour; = actual, otherwise based on year from table below)

SEER by Equipment Age

Age of Equipment	SEER Estimate
Before 2006	10
After 2006	11.15[193]

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

192 2007, RLW Analytics, "Validating the Impact of Programmable Thermostats"

193 TecMarket Works, et al. *Residential Baseline Report Final*. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs. November 2, 2012.

$Btuh_{COOL}$= Cooling system capacity in Btu/hr (= actual; otherwise assume 28,994 Btuh)[194]

1,000 = Conversion from Wh to kWh

ESF_{COOL} = Cooling energy savings fraction (= 0.09)[195]

For example, the cooling savings in a home in Indianapolis with a 3-ton, 10 SEER heat pump would be:

$$\Delta kWh = \frac{1}{10} * 487 * \frac{36{,}000}{1{,}000} * 0.09 = 158 \text{ kWh}$$

The heating savings from that same home (which has a heat pump or electric furnace) would be:

$$\Delta kWh = EFLH_{HEAT} * \frac{Btuh_{HEAT}}{\eta_{HEAT} * 3{,}412} * ESF_{HEAT}$$

Where:

$EFLH_{HEAT}$ = Equivalent full load heating hours (= actual; dependent on location, see table below)

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix B.

$Btuh_{HEAT}$ = Heating capacity (output) of equipment in Btuh (= actual)[196]

η_{HEAT} = Efficiency in COP of heating equipment (= actual; otherwise depending on equipment age, see table below)

COP Estimates by System Type

System Type	Age of Equipment	HSPF Estimate	COP Estimate
Heat Pump	Before 2006	6.8	2.00
	After 2006	7.7	2.26
Resistance	N/A	N/A	1.00

194 Ibid.

195 2007, RLW Analytics, "Validating the Impact of Programmable Thermostats"

196 TecMarket Works, et al. *Residential Baseline Report Final*. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs. November 2, 2012.

3,412 = Conversion from Btuh to kW

ESF_{HEAT} = Heating energy savings fraction (= 0.068)[197]

For example, the energy heating savings in a home in Indianapolis with 6.8 HSPF heat pump with 100,000 Btu/hr of heating capacity would be:

$$\Delta kWh = 1{,}341 * \frac{100{,}000}{2.0 * 3{,}412} * 0.068 = 1{,}336 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu = FLH_{HEAT} * \frac{Btuh_{FF}}{1{,}000{,}000} * ESF_{HEAT}$$

Where:

$Btuh_{FF}$ = Heating capacity of fossil fuel equipment in Btuh (= actual; otherwise assume 77,386 Btuh)[198]

1,000,000 = Conversion from Btu to MMBtu

For example, the fossil fuel savings from a home in Indianapolis with a 100,000 Btu/hr, 84 AFUE natural gas furnace would be:

$$\Delta MMBtu = 1{,}341 * \frac{100{,}000}{1{,}000{,}000} * 0.068 = 9.119 \text{ MMBtu}$$

---

197 RLW Analytics. *Validating the Impact of Programmable Thermostats.* 2007.

198 TecMarket Works, et al. *Residential Baseline Report Final*. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs. November 2, 2012.

Wi-Fi Connected Smart Thermostats (Time of Sale, Direct Install)

	Measure Details
Official Measure Code	Res-HVAC-Tstat-2
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$250.00
Important Comments	Assumes standard non-programmable thermostat as baseline
Effective Date	July 15, 2015
End Date	TBD

Description

Programmable thermostats can save energy through the advanced scheduling of time-of-day and/or day-of-week setbacks to control heating and cooling setpoints. In addition to these capabilities, Wi-Fi connected smart thermostats provide remote control and monitoring via a smartphone application or web portal. Smart thermostats also have the capacity to detect when the house is unoccupied, and can be set to automatically lower energy use without requiring active programming from the user. When the house in unoccupied, the smart thermostat will reduce the heating setpoint in the winter, and increase the cooling setpoint in the summer. As a result, smart thermostats optimize energy without the need for interaction from the user.

Definition of Efficient Equipment

The efficient condition is a Wi-Fi connected smart thermostat.

Definition of Baseline Equipment

The baseline condition is a standard, non-programmable thermostat for the central cooling and/or heating system (baseboard electric is excluded).

Deemed Lifetime of Efficient Equipment

The lifetime of this measure is 15 years.

Deemed Measure Cost

The incremental cost for purchasing a programmable thermostat has significant variation, but is typically around $250.00 (based on current retail market prices). Measures directly installed through retrofit programs should use the actual material and labor costs.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

The measure savings are based on a 2015 evaluation study[199] in Indiana that revealed the heating and cooling energy saving impacts of Wi-Fi connected smart thermostats on users with a manual thermostat as baseline, using large sample sizes and billing analyses.

Energy Savings

The cooling energy savings for homes with a central air conditioner would be:

$$\Delta \text{kWh} = \frac{1}{SEER} * EFLH_{COOL} * \frac{Btuh_{COOL}}{1{,}000} * ESF_{COOL}$$

Where:

SEER = Seasonal average energy efficiency ratio (Btu/watt-hour; = actual, otherwise based on year from table below)

SEER by Equipment Age

Age of Equipment	SEER Estimate
Before 2006	10
After 2006	11.15[200]

$EFLH_{COOL}$ = Equivalent full load cooling hours (= dependent on location; see table below)

Equivalent Full Load Cooling Hours by City

Location	$EFLH_{COOL}$*
Indianapolis	487
South Bend	431
Evansville	600
Ft. Wayne	373
Terre Haute	569

* Based on prototypical building simulations. See Appendix A.

199 Cadmus (Aarish, C., M. Perussi, A. Rietz, and D. Korn). *Evaluation of the 2013–2014 Programmable and Smart Thermostat Program.* Prepared for Northern Indiana Public Service Company and Vectren Corporation. 2015.

200 TecMarket Works, et al. *Residential Baseline Report Final*. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs. November 2, 2012.

$Btuh_{COOL}$ = Cooling system capacity in Btu/hr (= actual; otherwise assume 28,994 Btuh)[201]

1,000 = Conversion from Wh to kWh

ESF_{COOL} = Cooling energy savings fraction (= 0.139)[202]

For example, the cooling savings in a home in Indianapolis with a 3-ton, 10 SEER heat pump would be:

$$\Delta kWh = \frac{1}{10} * 487 * \frac{36{,}000}{1{,}000} * 0.139 = 244 \text{ kWh}$$

The heating savings from that same home (which has a heat pump or electric furnace) would be:

$$\Delta kWh = EFLH_{HEAT} * \frac{Btuh_{HEAT}}{\eta_{HEAT} * 3{,}412} * ESF_{HEAT}$$

Where:

$EFLH_{HEAT}$ = Equivalent full load heating hours (= actual; dependent on location, see table below)

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix B.

$Btuh_{HEAT}$ = Heating capacity (output) of equipment in Btuh (= actual)[203]

η_{HEAT} = Efficiency in COP of heating equipment (= actual; otherwise depending on equipment age, see table below)

COP Estimates by System Type

System Type	Age of Equipment	HSPF Estimate	COP Estimate
Heat Pump	Before 2006	6.8	2.00
	After 2006	7.7	2.26

201 Ibid.

202 Cadmus (Aarish, C., M. Perussi, A. Rietz, and D. Korn). *Evaluation of the 2013–2014 Programmable and Smart Thermostat Program.* Prepared for Northern Indiana Public Service Company and Vectren Corporation. 2015.

203 TecMarket Works, et al. *Residential Baseline Report Final*. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs. November 2, 2012.

Resistance	N/A	N/A	1.00

3,412 = Conversion from Btuh to kW

ESF_{HEAT} = Heating energy savings fraction (= 0.125)[204]

For example, the energy heating savings in a home in Indianapolis with 6.8 HSPF heat pump with 100,000 Btu/hr of heating capacity would be:

$$\Delta kWh = 1{,}341 * \frac{100{,}000}{2.0 * 3{,}412} * 0.125 = 2{,}456 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu = FLH_{HEAT} * \frac{Btuh_{FF}}{1{,}000{,}000} * ESF_{HEAT}$$

Where:

$Btuh_{FF}$ = Heating capacity of fossil fuel equipment in Btuh (= actual; otherwise assume 77,386 Btuh)[205]

1,000,000 = Conversion from Btu to MMBtu

For example, the fossil fuel savings from a home in Indianapolis with a 100,000 Btu/hr, 84 AFUE natural gas furnace would be:

$$\Delta MMBtu = 1{,}341 * \frac{100{,}000}{1{,}000{,}000} * 0.125 = 16.763 \text{ MMBtu}$$

204 Cadmus (Aarish, C., M. Perussi, A. Rietz, and D. Korn). *Evaluation of the 2013–2014 Programmable and Smart Thermostat Program.* Prepared for Northern Indiana Public Service Company and Vectren Corporation. 2015.

205 TecMarket Works, et al. *Residential Baseline Report Final*. Prepared for the Indiana Demand Side Management Coordination Committee Core Programs. November 2, 2012.

Condensing Furnaces-Residential (Time of Sale)

	Measure Details
Official Measure Code	Res-HVAC-Furn-1
Measure Unit	Per furnace
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is a new, ENERGY STAR-qualified, high-efficiency natural gas-fired condensing furnace for residential space heating. High-efficiency features may include improved heat exchangers and modulating multi-stage burners.

Definition of Efficient Equipment

The efficient condition is a furnace with an AFUE rating ≥ 90% and with < 225,000 Btuh input energy.

Definition of Baseline Equipment

The baseline condition is a non-condensing furnace with the federal AFUE baseline of 78%.[206] A review of GAMA shipment data indicates that a more suitable market baseline is 80% AFUE.

Deemed Lifetime of Efficient Equipment

The lifetime of this measure is 15 years.[207]

206 Starting on November 19, 2015, savings should be based on using an 80% AFUE for residential furnaces (as indicated in the Electronic Code of Federal Regulations, Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32).

207 http://www.cee1.org/resrc/facts/gs-ht-fx.pdf

Deemed Measure Cost

The incremental measure cost is based on the material cost alone, because the labor of the efficient measure is comparable to the labor cost of the baseline measure, and is dependent on the unit AFUE as outlined in the table below.[208]

Incremental Cost for Measure by AFUE

AFUE	Incremental Cost
90%	$325.68
92%	$379.96
94%	$856.59
96%	$910.87

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Savings are calculated using the difference in the amount of natural gas required based on the efficiency of the furnace and the average annual heating load. There is no change in the distribution system efficiency when the inclusion of a fan motor is assumed.

Energy Savings

There are no energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = EFLH_{HEAT} * Btuh * \left(\frac{AFUE_{EFF}}{AFUE_{BASE}} - 1\right) * 10^{-6}$$

Where:

$EFLH_{HEAT}$ = Equivalent full load heating hours (= actual; dependent on location, see table below)

[208] Itron, Inc. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Submitted to the California Public Utilities Commission. May 27, 2014.

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix B.

Btuh = Size of equipment in Btuh input capacity (= actual)

$AFUE_{BASE}$ = Annual fuel utilization efficiency percentage of baseline equipment (= 0.80)

$AFUE_{EFF}$ = Annual fuel utilization efficiency percentage of efficient equipment (= actual)

10^{-6} = Conversion from Btu to MMBtu

For example, the fossil fuel savings from installing a 100,000 Btuh (input) furnace rated at 96 AFUE in Indianapolis would be:

$$\Delta MMBtu = 1{,}341 * 100{,}000 * \left(\frac{0.96}{0.80} - 1\right) * 10^{-6} = 26.820 \text{ MMBtu}$$

Boilers (Time of Sale)

	Measure Details
Official Measure Code	Res-HVAC-Boiler-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Residential
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	18
Incremental Cost	Varies by location
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is a new, ENERGY STAR-qualified, high-efficiency natural gas-fired boiler installed for residential space heating.

Definition of Efficient Equipment

The efficient condition is a boiler with an AFUE rating ≥ 85% and with <300,000 Btuh energy input.

Definition of Baseline Equipment

The baseline condition is the federal standard AFUE for boilers of 80%.

Deemed Lifetime of Efficient Equipment

The lifetime of this measure is 18 years.[209]

Deemed Measure Cost

The incremental measure cost, based on materials and installation costs, are a function of the unit AFUE as outlined in the table below.[210]

---

[209] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. "Appliance and Equipment Standards Program." http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/fb_fr_tsd/appendix_e.pdf

[210] Ibid.

Incremental Cost for Measure by AFUE

AFUE	Incremental Cost
85-90	$216.00
≥91	$422.00

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Savings are calculated as the difference in required natural gas, based on the efficiency of the boiler and the average annual heating load. No changes in the distribution system efficiency (including circulator motor) are assumed.

Energy Savings

There are no energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = EFLH_{HEAT} * Btuh * \left(\frac{AFUE_{EFF}}{AFUE_{BASE}} - 1\right) * 10^{-6}$$

Where:

$EFLH_{HEAT}$ = Equivalent full load heating hours (= actual; dependent on location, see table below)

Equivalent Full Load Heating Hours by City

Location	$EFLH_{HEAT}$*
Indianapolis	1,341
South Bend	1,427
Evansville	982
Ft. Wayne	1,356
Terre Haute	804

* Heating EFLH extracted from simulations. See Appendix A.

Btuh = Size of new equipment in Btuh input capacity (= actual)

$AFUE_{BASE}$ = Annual fuel utilization efficiency percentage of baseline equipment (= 0.80)

$AFUE_{EFF}$ = Annual fuel utilization efficiency percentage of efficient equipment (= actual)

For example: the fossil fuel savings from installing a 100,000 Btuh boiler rated at AFUE 85% in Indianapolis would be:

$$\Delta MMBtu = 1{,}341 * 100{,}000 * \left(\frac{0.85}{0.80} - 1\right) * 10^{-6} = 8.381\ MMBtu$$

Lighting

Residential ENERGY STAR Lighting (CFL and LED)

	Measure Details
Official Measure Code	Res-Ltg-CFL-TOS-1
Measure Unit	Per lamp
Measure Category	Lighting
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by program
Peak Demand Reduction (kW)	Varies by program
Annual Fossil Fuel Savings (MMBtu)	Varies by program
Lifetime Energy Savings (kWh)	Varies by program
Lifetime Fossil Fuel Savings (MMBtu)	Varies by program
Water Savings (gal/yr)	0
Effective Useful Life (years)	Varies by program
Incremental Cost	Varies by program
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Compact Fluorescent Lamps Time-of-Sale

This measure is a low-wattage, ENERGY STAR-qualified CFL being purchased through a retail outlet in place of an incandescent screw-in bulb. The incremental cost of the CFL compared to the incandescent light bulb is offset via either a rebate or upstream markdowns. Assumptions are based on a time-of-sale purchase, not as retrofit or direct install.

The measure savings are based on the CFL being installed in a residential location. Where the implementation strategy does not allow for the installation location to be known, and absent verifiable evaluation data to support an appropriate residential versus commercial split, it is recommended to use this residential characterization for all purchases, leading to appropriately conservative savings assumptions.

Compact Fluorescent Lamps Direct Install (Early Replacement)

This measure is a low-wattage, ENERGY STAR-qualified CFL being installed by an auditor, contractor, or member of utility staff in a residential location in place of an existing incandescent screw-in bulb through a direct install program. The savings are based on protocols being implemented that guide the bulb installation to high-use locations. The CFL is provided at no cost to the end user.

Residential Light-Emitting Diode Lamps

This measure is a low-wattage, ENERGY STAR-qualified LED screw-in lamp being installed in place of an incandescent screw-in lamp. The incremental cost of the LED compared to the incandescent lamp is offset via either a rebate coupon or upstream markdowns.

Definition of Efficient Equipment

The high-efficiency equipment must be a standard ENERGY STAR-qualified CFL or LED.

Definition of Baseline Equipment

The baseline equipment is an incandescent light bulb, making adjustments to the baseline lamp wattage based on the Lifetime of the LED replacement lamp.

Deemed Lifetime of Efficient Equipment

The expected lifetime of CFLs is 5 years.[211] The expected lifetime of screw-in LED lamps is 15 years.

Deemed Measure Cost

Compact Fluorescent Lamps Time-of-Sale

The incremental cost for a time-of-sale CFL measure is $3.41.[212]

Compact Fluorescent Lamps Direct Install (Early Replacement)

The full cost for a direct-install (early replacement) CFL measure equals the actual cost for implementation and installation (i.e., the cost of the product and the labor for installation).

Residential Light-Emitting Diode Lamps

The incremental cost for a time-of-sale LED measure is $30.91.[213]

Deemed O&M Cost Adjustments

In order to account for the shift in baseline due to federal legislation, the levelized baseline replacement cost over the lifetime of the CFL is calculated using the key assumptions documented in the table below.

Replacement Cost and Component Life by Type of Bulb

	Standard Incandescent	Halogen
Replacement Cost	$0.50	$2.00
Component Life (years; based on lamp life / assumed annual run hours)	1	3

The calculated net present value of the baseline replacement costs based on CFL type is $4.52.

---

211 This value was calculated using the average rated CFL life of 10,000 hours, including a switching adjustment factor of 0.523 (10,000/1,040 * 0.523 = 5 years) from: California Public Utilities Commission. *Database for Energy Efficient Resources.* 2008. Available online: www.deeresources.com.

212 Itron, Inc. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Submitted to the California Public Utilities Commission. May 27, 2014.

213 Ibid.

Savings Algorithms for this Measure

Energy Savings

$$\Delta kWh = \left(\frac{\text{watts}_{BASE} - \text{watts}_{EFF}}{1{,}000}\right) * ISR * HOURS * (1 + WHF_E)$$

Where:

watts_{BASE} = Wattage of baseline lamp (= actual; if missing, see table below for CFL[214] and LED wattage)[215]

watts_{EFF} = Wattage of efficient lamp (= actual; if missing, see table below)

Efficient Technology	watts_{EFF}	watts_{BASE}
CFL	15W or less	3.05 * watts_{EFF}
	16W - 20W	3.00 * watts_{EFF}
	21W or more	3.06 * watts_{EFF}
LED	9W or less	3.38* watts_{EFF}
	10W – 17W	3.41 * watts_{EFF}
	18W or more	4.04 * watts_{EFF}

ISR = In-service rate, or percentage of rebated units that get installed (= use table below)

---

214 Duke Energy. *Ohio Residential Smart Saver CFL Program* June 2010. Average CFL is 15.47 watts, with average replacement incandescent bulb of 65.8 watts, for a ratio of 4.25 to 1. (note: the study only includes data from respondents who reported both the wattage removed and wattage replaced). Federal legislation stemming from EISA required that all general purpose light bulbs between 40 watts and 100 watts be approximately 30% more energy efficient than incandescent bulbs by 2014, in essence beginning the phase out of standard incandescent bulbs. Watts_{BASE} was calculated by finding the new baseline after the incandescent bulb wattage was reduced (from 100 watts to 72 watts, 75 watts to 53 watts, 60 watts to 43 watts, and 40 watts to 29 watts). For example, an average CFL size replacing a 60-watt incandescent is 60/ (4.25) = 14.1 watts; so when the 60-watt incandescent is replaced by a 43-watt halogen, the multiplier is 43/14.1 = 3.05.

215 U.S. Environmental Protection Agency. “ENERGY STAR-Certified Light Bulbs.” http://www.energystar.gov/productfinder/product/certified-light-bulbs/results. EISA baseline adjustments made to the watts multiplier (which is based on weighted averages) according to lumen range requirements set by ENERGY STAR (https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V1%201_Specification.pdf). For example, a 100-watt equivalent bulb needs to output between 1,600 lumens and 1,999 lumens. The average LED in this lumen range is 17.8 watts, so the watts multiplier is 72/17.8 = 4.04.

In-Service Rate by Bulb Type

Program Type	ISR
CFL*	0.89
LED**	1.00

* Based on Duke Energy ISR data for direct install programs. Note: the ISR does not account for stored lamps that may be installed later, and assumes that uninstalled direct install lamps have been permanently removed.

** There is currently no research regarding LED ISR; therefore an ISR of 1.0 is assigned.

HOURS = Average hours of use per year (= based on program type; see table below)

Annual Hours of Use by Program Type*

Program Type	Annual Hours
Time of Sale	902
Direct Install	902
School Kit	1,135
Specialty Lighting	1,190
Multifamily Common Areas	5,950

* TecMarket Works, et al. *Indiana Core Lighting Logger Hours of Use (HOU) Study*. July 29, 2013. Annual hours of use for specialty bulbs and multifamily common areas are from: Illinois Technical Reference Manual, Version 4.0. 2015.

WHF_E = Waste heat factor for energy to account for HVAC interactions with efficient lighting (= depending on location; see table below)

Weighted Average Waste Heat Factors by City*

City	WHF_E	WHF_D	WHF_G
Indianapolis	-0.061	0.055	-0.0018
South Bend	-0.070	0.038	-0.0019
Evansville	-0.034	0.092	-0.0017
Ft Wayne	-0.082	0.038	-0.0019
Terre Haute	-0.048	0.061	-0.0018
Statewide	**-0.059**	**0.057**	**-0.0018**

* See Appendix B for supporting calculations.

For example, the energy savings from direct install 20-watt CFL using the statewide average for HVAC interactive effects would be:

$$\Delta kWh = \left(\frac{(3.00 * 20) - 20}{1{,}000}\right) * 0.89 * 902 * (1 - .059) \ = 30\ kWh$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \left(\frac{\text{watts}_{BASE} - \text{watts}_{EFF}}{1{,}000}\right) * ISR * (1 + WHF_D) * CF$$

Where:

WHF_D = Waste heat factor for demand to account for HVAC interactions with efficient lighting (= depending on location; see table above)

CF = Summer peak coincidence factor (= 0.11)[216]

For example, the demand reduction from a direct install 10-watt LED in Indianapolis would be:

$$\Delta kW = \left(\frac{(3.41 * 10) - 10}{1{,}000}\right) * 1.0 * (1 + 0.055) * 0.11 = 0.003\, kW$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu_{WH} = \left(\frac{\text{watts}_{BASE} - \text{watts}_{EFF}}{1{,}000}\right) * ISR * HOURS * WHF_G$$

Where:

$\Delta MMBtu_{WH}$ = Gross customer annual heating MMBtu fuel increased usage from the reduction in lighting heat

WHF_G = Waste heat factor for fossil fuels to account for HVAC interactions with efficient lighting (= depending on location; see table above)

For example, the fossil fuel savings from a 20-watt, time-of-sale CFL in Terre Haute would be:

$$\Delta MMBtu_{WH} = \left(\frac{(3.00*20) - 20}{1{,}000}\right) * 0.89 * 902 * -0.0018 = -0.058\, MMBtu$$

216 Nexus Market Research, RLW Analytics, and GDS Associates. *New England Residential Lighting Markdown Impact Evaluation.* January 20, 2009.

LED Night Lights

	Measure Details
Official Measure Code	Res-Ltg-NiteLite-1
Measure Unit	Per night light
Measure Category	Lighting
Sector(s)	Residential
Annual Energy Savings (kWh)	14
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	224
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	16
Incremental Cost	$3.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is a night light with an LED light source replacing an incandescent night light.

Definition of Efficient Equipment

The efficient condition is an LED night light.

Definition of Baseline Equipment

The baseline condition is an incandescent night light.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 16 years.[217]

Deemed Measure Cost

The first cost for this measure is $3.00.[218]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

[217] Franklin Energy Systems. *FES-L6a LED and Specialty Lighting – Residential*. Duke Energy work papers. July 1, 2010.

[218] Ibid.

Savings Algorithm

Energy Savings

$$\Delta\text{kWh} = \frac{Watt_{BASE} - Watt_{LED}}{1{,}000} * ISR * Hours$$

Where:

$Watt_{BASE}$	=	Wattage of incandescent night light (= 5)
$Watt_{LED}$	=	Wattage of LED night light (= 0.33)
ISR	=	In-service rate, or percentage of rebated units that get installed (= 1.0)
HOURS	=	Average hours of use per year (= 2,920, or 8 hours per day)

LED night light savings are calculated as follows:

$$\Delta\text{kWh} = \frac{5 - 0.33}{1{,}000} * 1.0 * 2{,}920 = 14\text{ kWh}$$

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

ENERGY STAR Torchiere (Time of Sale)

	Measure Details
Official Measure Code	Res-Ltg-Torchiere-1
Measure Unit	Per unit
Measure Category	Lighting
Sector(s)	Residential
Annual Energy Savings (kWh)	113
Peak Demand Reduction (kW)	0.008
Annual Fossil Fuel Savings (MMBtu)	-0.137
Lifetime Energy Savings (kWh)	791
Lifetime Fossil Fuel Savings (MMBtu)	-0.959
Water Savings (gal/yr)	0
Effective Useful Life (years)	7
Incremental Cost	$5.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is a high-efficiency ENERGY STAR fluorescent torchiere being purchased in place of a baseline mix of halogen and incandescent torchieres, then installed in a residential setting. The savings assumptions are based on a time-of-sale purchase, not as a retrofit or direct install installation.

Definition of Efficient Equipment

The efficient condition is a fluorescent torchiere that meets the ENERGY STAR efficiency standards.

Definition of Baseline Equipment

The baseline condition is a mix of halogen and incandescent torchieres.

Deemed Lifetime of Efficient Equipment

The lifetime of the measure is 7 years.[219]

Deemed Measure Cost

The incremental cost for this measure is $5.00.[220]

---

219 U.S. Environmental Protection Agency. ENERGY STAR value for this measure. Available online: www.energystar.gov.

220 California Public Utilities Commission. *Database for Energy Efficient Resources.* 2008. Available online: www.deeresources.com; and Efficiency Vermont. *Technical Reference Manual*. August 9, 2013

Deemed O&M Cost Adjustments

The annual O&M cost adjustment savings is $2.52, based on the component costs and lifetimes shown in the table below.

Deemed Cost Adjustments*

	Efficient Measure		Baseline Measures	
Component	**Cost**	**Life (years)**	**Cost**	**Life (years)**
Lamp	$7.50	8.87**	$6.00	1.83***

* Efficiency Vermont. *Technical Reference Manual*. August 9, 2013.

** Calculated using the assumed 9,710 hour average rated life of ENERGY STAR CFL torchieres (9,710/1,095= 8.87 years; http://downloads.energystar.gov/bi/qplist/fixtures_prod_list.xls.

** Based on assumption of baseline bulb mix of incandescent and halogen having average rated life of 2,000 hours.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{\Delta Watts_{TORCH}}{1,000} * ISR * Hours * (1 + WHF_E)$$

Where:

$\Delta Watts_{TORCH}$ = Average delta watts per purchased ENERGY STAR torchiere (= 73)[221]

ISR = In-service rate, or percentage of units rebated that get installed (= 0.95)[222]

HOURS = Average hours of use per year (= 1,095, or 3 hours per day)[223]

WHF_E = Waste heat factor for energy to account for HVAC interactions with efficient lighting (= -0.059, the weighted average value across all HVAC systems and cities; see Appendix B)

---

221 Nexus Market Research. *Impact Evaluation of the Massachusetts, Rhode Island and Vermont 2003 Residential Lighting Programs*. Final Report. p. 43 (Table 4-9). October 1, 2004. Value adjusted to conform to EISA baseline reduction, and reduced delta watts multipliers to 63% in 2015.

222 Nexus Market Research and RLW Analytics. *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Table 6-3 on page 63 indicates that 86% of torchieres were installed, and 9% more would be installed. Table 6-7 on page 67 indicates that no torchieres are purchased as spares, so savings are based on all bulbs being installed in first year.

223 Nexus Market Research. *Impact Evaluation of the Massachusetts, Rhode Island and Vermont 2003 Residential Lighting Programs*. Final Report. p. 104 (Table 9-7). October 1, 2004.

For example, the energy savings from installing an ENERGY STAR torchiere using statewide average HVAC interactive effects would be:

$$\Delta kWh = \frac{73}{1{,}000} * 0.95 * 1{,}095 * (1 - 0.059) = 71\ kWh$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta Watts_{TORCH}}{1{,}000} * ISR * (1 + WHF_D) * CF$$

Where:

WHF_D = Waste heat factor for demand to account for HVAC interactions with efficient lighting (= 0.057 as weighted average value across all HVAC systems and cities; see Appendix B)

CF = Summer peak coincidence factor (= 0.11)[224]

For example, the demand reduction from installing an ENERGY STAR torchiere using statewide average HVAC interactive effects would be:

$$\Delta kW = \frac{73}{1{,}000} * 0.95 * (1 + 0.057) * 0.11 = 0.008\ kW$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu_{WH} = \frac{\Delta Watts_{TORCH}}{1{,}000} * ISR * Hours * WHF_G$$

Where:

$\Delta MMBtu_{WH}$ = Gross increase in customer annual heating MMBtu fuel usage from the reduction in lighting heat

WHF_G = Waste heat factor for fossil fuels to account for HVAC interactions with efficient lighting (= -0.0018 as weighted average value across all HVAC systems and cities; see Appendix B)

For example, the fossil fuel savings from installing an ENERGY STAR torchiere using statewide average HVAC interactive effects would be:

$$\Delta MMBtu_{WH} = \frac{73}{1{,}000} * 0.95 * 1{,}095 * -0.0018 = -0.137\ MMBtu$$

[224] Nexus Market Research, RLW Analytics, and GDS Associates. *New England Residential Lighting Markdown Impact Evaluation*. January 20, 2009.

Dedicated Pin Based Compact Fluorescent Lamp (CFL) Table Lamp (Time of Sale)

	Measure Details
Official Measure Code	Res-Ltg-CFLTable-1
Measure Unit	Per unit
Measure Category	Lighting
Sector(s)	Residential
Annual Energy Savings (kWh)	24
Peak Demand Reduction (kW)	0.003
Annual Fossil Fuel Savings (MMBtu)	-0.046
Lifetime Energy Savings (kWh)	192
Lifetime Fossil Fuel Savings (MMBtu)	-0.368
Water Savings (gal/yr)	0
Effective Useful Life (years)	8
Incremental Cost	$8.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is a dedicated, pin-based, low-wattage CFL table lamp being purchased through a retail outlet in place of an equivalent incandescent lamp. The incremental cost of the CFL lamp compared to an incandescent lamp is offset via either rebate coupons or upstream markdowns. Savings assumptions are based on a time-of-sale purchase, not as a retrofit or direct install installation, and based on the CFL being installed in a residential location.

Definition of Efficient Equipment

The high-efficiency equipment is a dedicated, pin-based, low-wattage CFL table lamp.

Definition of Baseline Equipment

The baseline equipment is an incandescent table lamp.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 8 years.[225]

Deemed Measure Cost

The incremental cost for this measure is $8.00.

---

[225] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

Deemed O&M Cost Adjustments

In order to account for the shift in baseline due to federal legislation, the levelized baseline replacement cost over the lifetime of the CFL is calculated using the key assumptions outlined in the table below.

Key Assumptions for Deemed Cost Adjustments

	Standard Incandescent	Halogen
Replacement Cost	\$0.50	\$2.00
Component Life (years, based on lamp life / assumed annual run hours)	1*	3

* Assumes a rated life for incandescent bulb of approximately 1,000 hours.

The calculated net present value of the baseline replacement costs based on CFLs is \$4.97.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{\Delta Watts}{1{,}000} * ISR * Hours * (1 + WHF_E)$$

Where:

ΔWatts = Difference in wattage between CFL and incandescent bulb (= 28.8)[226]

ISR = In-service rate, or percentage of units rebated that get installed (= 1.0)

HOURS = Average hours of use per year (= 901)[227]

WHF_E = Waste heat factor for energy to account for HVAC interactions with efficient lighting (=- 0.059 as weighted average value across all HVAC systems and cities; see Appendix B)

For example, the energy savings from installing a CFL table lamp using statewide average HVAC interactive effects would be:

$$\Delta kWh = \frac{28.8}{1{,}000} * 1.0 * 901 * (1 - 0.059) = 24 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta Watts}{1{,}000} * ISR * (1 + WHF_D) * CF$$

[226] RLW Analytics. *New England Residential Lighting Markdown Impact Evaluation*. January 20, 2009. Value adjusted to conform to the EISA baseline reduction. Delta watts multiplier reduced to 63% in 2015.

[227] Nexus Market Research, RLW Analytics, and GDS Associates. *New England Residential Lighting Markdown Impact Evaluation*. p. 50. January 20, 2009.

Where:

WHF_D = Waste heat factor for demand to account for HVAC interactions with efficient lighting (= 0.057 as weighted average value across all HVAC systems and cities; see Appendix B)

CF = Summer peak coincidence factor (= 0.11)[228]

For example, the demand reduction from installing a CFL table lamp using statewide average HVAC interactive effects would be:

$$\Delta kW = \frac{28.8}{1{,}000} * 1.0 * (1 + 0.057) * 0.11 = 0.003 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu_{WH} = \frac{\Delta Watts}{1{,}000} * ISR * Hours * WHF_G$$

Where:

$\Delta MMBtu_{WH}$ = Gross increase in customer annual heating MMBtu fuel usage from the reduction in lighting heat

WHF_G = Waste heat factor for fossil fuels to account for HVAC interactions with efficient lighting (= -0.0018 as weighted average value across all HVAC systems and cities; see Appendix B)

For example, the fossil fuel savings from installing a CFL table lamp using statewide average HVAC interactive effects would be:

$$\Delta MMBtu_{WH} = \frac{28.8}{1{,}000} * 1.0 * 901 * -0.0018 = -0.046 \text{ MMBtu}$$

228 Ibid.

Ceiling Fan with ENERGY STAR Light Fixture (Time of Sale)

	Measure Details
Official Measure Code	Res-Appl-CeilFan-1
Measure Unit	Per unit
Measure Category	Lighting/Appliances
Sector(s)	Residential
Annual Energy Savings (kWh)	108
Peak Demand Reduction (kW)	0.013
Annual Fossil Fuel Savings (MMBtu)	-0.194
Lifetime Energy Savings (kWh)	~1,080
Lifetime Fossil Fuel Savings (MMBtu)	~-1.94
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$86.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing an ENERGY STAR ceiling fan with a high-efficiency motor and CFLs in place of a standard fan with incandescent bulbs.

Definition of Efficient Equipment

The efficient equipment is an ENERGY STAR-certified ceiling fan with CFLs.

Definition of Baseline Equipment

The baseline equipment is a standard fan with incandescent bulbs.

Deemed Lifetime of Efficient Equipment

The measure life is 10 years.[229]

Deemed Measure Cost

The incremental cost for the ENERGY STAR ceiling fan is $86.00.[230]

229 U.S. Environmental Protection Agency. "ENERGY STAR Ceiling Fan Savings Calculator." http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Ceiling_Fan_Savings_Calculator_Consumer.xls

230 Ibid.

Deemed O&M Cost Adjustments

In order to account for the shift in baseline due to federal legislation, the levelized baseline replacement cost over the lifetime of the CFL is calculated using the key assumptions shown in the table below.

Key Assumptions for Calculating Levelized Baseline Replacement Costs

	Standard Incandescent	Efficient Incandescent
Replacement Cost	\$0.50	\$2.00
Component Life (years, based on lamp life / assumed annual run hours)	1*	3

* Based on a rated life for incandescent bulb of approximately 1,000 hours.

The calculated net present value of the baseline replacement costs minus the CFL replacement cost (i.e., three bulbs) is \$7.45.

Savings Algorithm

Energy Savings

$$\Delta kWh = (\%low * (LowkW_{BASE} - LowkW_{EE}) + \%med * (MedkW_{BASE} - MedkW_{EE}) + \%high * (HighkW_{BASE} - HighkW_{EE})) * Hours_{FAN}) + (InckW - CFLkW) * Hours_{LIGHT} * (1 + WHF_E)$$

Where:[231]

%low	=	Percentage of time on low speed (= 40%)
%med	=	Percentage of time on medium speed (= 40%)
%high	=	Percentage of time on high speed (= 20%)
$LowWatt_{BASE}$	=	Low speed baseline ceiling fan wattage (= 0.0152 kW)
$LowWatt_{EE}$	=	Low speed ENERGY STAR ceiling fan wattage (= 0.0117 kW)
$MedWatt_{BASE}$	=	Medium speed baseline ceiling fan wattage (= 0.0348 kW)
$MedWatt_{EE}$	=	Medium speed ENERGY STAR ceiling fan wattage (= 0.0314 kW)
$HighWatt_{BASE}$	=	High speed baseline ceiling fan wattage (= 0.0725 kW)
$HighWatt_{EE}$	=	High speed ENERGY STAR ceiling fan wattage (= 0.0715 kW)
$HOURS_{FAN}$	=	Typical fan operating hours (= 1,022 at 2.8 hours per day)
InckW	=	Incandescent bulb kilowatts (= 0.129, assumes three 43-watt bulbs)
CFLkW	=	CFL kilowatts (= 0.042, assumes three 14-watt bulbs)

[231] All data points (unless otherwise noted) came from: U.S. Environmental Protection Agency. "ENERGY STAR Ceiling Fan Savings Calculator." http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Ceiling_Fan_Savings_Calculator_Consumer.xls

$HOURS_{LIGHT}$ = Typical lighting operating hours (= 1,277.5 at 3.5 hours per day)

WHF_E = Waste heat factor for energy to account for HVAC interactions with efficient lighting (= -0.059 as weighted average value across all HVAC systems and cities; see Appendix B)

For example, the energy savings from installing an ENERGY STAR ceiling fan (using statewide average HVAC interactive effects) would be:

$$\Delta kWh = ((0.4 * (0.0152 - 0.0117) + 0.4 * (0.0348 - 0.0314) + 0.2 * (0.0725 - 0.0715)) * 1{,}022) + ((0.129 - 0.042) * 1{,}277.5 * (1 - 0.059)) = 108\ kWh$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \%low * (LowkW_{BASE} - LowkW_{EE}) + \%med * (MedkW_{BASE} - MedkW_{EE}) + \%high * (HighkW_{BASE} - HighkW_{EE}) + (InckW - CFLkW) * (1 + WHF_D) * CF$$

Where:

WHF_D = Waste heat factor for demand to account for HVAC interactions with efficient lighting (= 0.057 as weighted average across all HVAC systems and cities; see Appendix B)

CF = Summer peak coincidence factor (= 0.11)[232]

For example, the demand reduction from installing an ENERGY STAR ceiling fan (using statewide average HVAC interactive effects) would be:

$$\Delta kW = ((0.4 * (0.0152 - 0.0117) + 0.4 * (0.0348 - 0.0314) + 0.2 * (0.0725 - 0.0715)) + ((0.129 - 0.042) * (1 + 0.057)) * 0.11 = 0.013\ kW$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu_{WH} = \Delta kWh * WHF_G$$

Where:

$\Delta MMBtu_{WH}$ = Gross increase in customer annual heating MMBtu fuel usage from the reduction in lighting heat

WHF_G = Waste heat factor for fossil fuels to account for HVAC interactions with efficient lighting (= -0.0018 as weighted average across all HVAC systems and cities; see Appendix B)

232 Nexus Market Research, RLW Analytics, and GDS Associates. *New England Residential Lighting Markdown Impact Evaluation.* January 20, 2009.

Miscellaneous

Residential Two Speed / Variable Speed Pool Pumps (Time of Sale)

	Measure Details
Official Measure Code	Res-Pool-Pump-1
Measure Unit	Per unit
Measure Category	Miscellaneous
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by speed control type
Peak Demand Reduction (kW)	Varies by speed control type
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by speed control type
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	Varies by speed control type
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is purchasing and installing an efficient two speed or variable speed residential pool pump motor in place of a standard single speed motor of equivalent horsepower.

Definition of Efficient Equipment

The high efficiency equipment is a two speed or variable speed residential pool pump.

Definition of Baseline Equipment

The baseline equipment is a single speed residential pool pump.

Deemed Lifetime of Efficient Equipment

The estimated useful life for a variable speed pool pump is 10 years.

Deemed Measure Cost

The incremental cost is estimated as $175.00 for a two speed motor and $750.00 for a variable speed motor.[233]

233 Lockheed Martin. Pump retail price data. July 2009.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{hp*LF*0.746}{\eta_{PUMP}} * \frac{Hrs}{day} * \frac{Days}{yr} * ESF$$

Where:[234]

hp	=	Horsepower of pump motor (= 1.5)
LF	=	Load factor of pump motor (= 0.66)
0.746	=	Conversion of hp to kW
η_{PUMP}	=	Efficiency of pump motor (= 0.325)
Hrs/day	=	Assumed hours of pump operation per day (= 6)[235]
Days/yr	=	Assumed number of days pool in use (= 100)[236]
ESF	=	Energy savings factor (= depending on pump type)

$$ESF_{TWO\ SPEED} = 0.322$$

$$ESF_{VARIABLE\ SPEED} = 0.86$$

$$\Delta kWh_{TWO\ SPEED} = \frac{1.5*0.66*0.746}{0.325} * 6 * 100 * 0.32 = 436\ kWh$$

$$\Delta kWh_{VARIABLE\ SPEED} = \frac{1.5*0.66*0.746}{0.325} * 6 * 100 * 0.86 = 1{,}173\ kWh$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{HP*LF*0.746}{\eta Pump} * CF * DSF$$

---

234 Unless otherwise stated, all assumptions from: First Energy. *Residential Swimming Pool Pumps memo.*

235 Consortium for Energy Efficiency. *Pool Pump Exploration Memo*. June 2009.

236 Assumes pool operation from Memorial Day to Labor Day.

Where:

DSF = Demand savings factor (= dependent on pump type)

$$DSF_{TWO\ SPEED} = 0.59$$

$$DSF_{VARIABLE\ SPEED} = 0.91$$

CF = Summer peak coincidence factor (= 0.83)[237]

$$\Delta kW_{TWO\ SPEED} = \frac{1.5 * 0.66 * 0.746}{0.325} * 0.83 * 0.59 = 1.113 \text{ kW}$$

$$\Delta kW_{VARIABLE\ SPEED} = \frac{1.5 * 0.66 * 0.746}{0.325} * 0.83 * 0.91 = 1.716 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

[237] Efficiency Vermont. TRM August, 9, 2013. Coincidence factor based on market feedback about the typical run pattern for pool pumps, which revealed that most people run the pump during the day, and set a timer to turn the pump off during the night.

Residential Premium Efficiency Pool Pump Motor (Time of Sale)

	Measure Details
Official Measure Code	Res-Pool-Motor-1
Measure Unit	Per unit
Measure Category	Miscellaneous
Sector(s)	Residential
Annual Energy Savings (kWh)	404
Peak Demand Reduction (kW)	0.559
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	4,040
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$50.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is purchasing and installing a residential, 1.5 HP, premium efficiency, single speed pool pump motor in place of a standard single speed motor of equivalent horsepower.

Definition of Efficient Equipment

The high-efficiency equipment is a residential, 1.5 HP, premium efficiency, single speed pool pump motor.

Definition of Baseline Equipment

The baseline equipment is a residential, 1.5 HP, standard, single speed pool pump motor.

Deemed Lifetime of Efficient Equipment

The estimated useful life for a pump is 10 years.

Deemed Measure Cost

The incremental cost for this measure is $50.00.[238]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

[238] Franklin Energy Services. *M4 – HE Swimming Pool Pumps – Residential*.

Savings Algorithm

Energy Savings

$$\Delta kWh = hp * 0.746 * \frac{Hrs}{Day} * \frac{Days}{Yr} * \left(\frac{LF_{BASE}}{\eta_{BASE}} - \frac{LF_{EFF}}{\eta_{EFF}}\right)$$

Where:[239]

hp	=	Horsepower of motors (= 1.5)
0.746	=	Conversion from horsepower to kilowatts
LF_{BASE}	=	Load factor of baseline motor (= 0.66)
LF_{EFF}	=	Load factor of efficient motor (= 0.65)
$\eta Pump_{BASE}$	=	Efficiency of baseline motor (= 0.325)
$\eta Pump_{EFF}$	=	Efficiency of premium efficiency motor (= 0.455)
Hrs/Day	=	Assumed hours of pump operation per day (= 6)[240]
Days/Yr	=	Assumed number of days pool in use (= 100 days)[241]

$$\Delta kWh = 1.5 * 0.746 * 6 * 100 * \left(\frac{0.66}{0.325} - \frac{0.65}{0.455}\right) = 404\ kWh$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = hp * 0.746 * CF * \left(\frac{LF_{BASE}}{\eta_{BASE}} - \frac{LF_{EFF}}{\eta_{EFF}}\right)$$

Where:

CF	=	Summer peak coincidence factor (= 0.83)[242]

$$\Delta kWh = 1.5 * 0.746 * 0.83 * \left(\frac{0.66}{0.325} - \frac{0.65}{0.455}\right) = 0.559\ kW$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

239 Unless otherwise stated, all assumptions from: First Energy. *Residential Swimming Pool Pumps Memo.*

240 Consortium for Energy Efficiency. *Pool Pump Exploration Memo*. June 2009.

241 Assumes pool operation from Memorial Day to Labor Day.

242 Efficiency Vermont. TRM. August 9, 2013. Coincidence factor based on market feedback about the typical run pattern for pool pumps, which revealed that most people run the pump during the day, and set a timer to turn the pump off during the night.

Residential New Construction

	Measure Details
Official Measure Code	Res-WB-RNC-1
Measure Unit	Per project
Measure Category	Miscellaneous
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	Varies by project
Effective Useful Life (years)	Varies by project
Incremental Cost	
Important Comments	
Effective Date	
End Date	

Description

This measure is residential new construction for homes built in Indiana. The savings are based on using accredited HERS software that complies with the Mortgage Industry National Home Energy Rating Systems Accreditation Standards developed by RESNET.

Energy savings and demand reduction are estimated per home for heating, cooling, hot water, lighting, ceiling fans, and appliances, including refrigerators and dishwashers. To avoid double-counting savings, this measure savings should not also be included as savings under another program. However, savings for efficient products installed in the home other than those listed above and that are not claimed under the program may be captured through another program.

Definition of Efficient and Baseline Equipment

The following assumptions underlie the measure savings calculation methodology:

1. Program implementers are using REM/Rate™ or another RESNET-approved software to conduct HERS ratings on each efficient new home built. For recommendations on estimating savings using a rating tool other than REM/Rate™, see the Other Software section.
2. Program administrators will employ the User Defined Reference Home (UDRH) feature provided in REM/Rate™ to estimate savings. This allows for comparing the energy consumption of a rated home with a UDRH.

The UDRH is an exact replica of the rated home in size, structure, and climate zone, but the energy characteristics are defined by local code or building practices. Until a formal study characterizing baseline building practices is completed for Indiana, the UDRH shall be defined by the residential energy efficiency section of the prevailing Indiana building code.

Deemed Lifetime of Efficient Equipment

The estimated useful life varies by equipment installed.

Deemed Measure Cost

More program detail is needed to determine incremental costs.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

Energy savings, including fossil fuel savings, for heating, cooling, hot water, lighting, and appliances are based on the direct output of REM/Rate™ (or other RESNET-approved energy modeling software). Energy savings are determined on a per-home basis with the following calculation:

Energy savings = UDRH energy consumption – Rated home energy consumption

The UDRH shall be defined by the most recent code, with some supplemental clarifications (see the table in the User Defined Reference Home Specifications section below).

For residential new construction projects that participate through a RESNET-approved sampling protocol, energy savings shall be determined based on the savings from the model home, linearly adjusted based on the floor square footage compared to all other homes included in that sample set. Chapter 6 of the RESNET Mortgage Industry National Home Energy Rating Standards provides technical guidelines on the sampling protocol.

Summer Peak Coincident Demand Reduction

Demand reduction for heating, cooling, hot water, lighting, and appliances are based on the direct output of REM/Rate™ (or other RESNET-approved energy modeling software). System peak electric demand reduction is calculated on a per-home basis using the following calculation:

$$\text{Peak coincident demand reduction} = (UDRH\ electric\ demand - Rated\ home\ electric\ demand) * CF$$

The demand reduction from right-sizing mechanical equipment is calculating using the following equation:

$$\text{Peak coincident demand reduction} = (UDRH\ electric\ demand * OFUDRH - Rated\ home\ electric\ demand * OFr) * CF$$

Where:

CF	=	Coincidence factor; equates the installed HVAC system demand to its demand during system peak
OFUDRH	=	Over-sizing factor for the HVAC unit in the UDRH home
OF_R	=	Over-sizing factor for the HVAC unit in the rated home
Rated Home	=	Rated home electric demand output as determined from REM/Rate™
UDRH	=	User defined reference home electric demand output (= see table below)

Peak Demand Variable Definitions

Variable	Type	Value	Sources
OFUDRH	Fixed	1.60	Public Service Electric and Gas. *Residential New Construction Baseline Study*. 1997. Long Island Power Authority. *Residential New Construction Technical Baseline Study.* 2004. Reports use over-sizing values of 155% to 172%.
OF_R	Fixed	1.15	Program guideline for rated home.
CF	Fixed	0.50	Energy Center of Wisconsin. *Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research.* p. 32. May 2008.

Fossil Fuel Impact Descriptions and Calculation

The fossil fuel impacts from this measure are outlined as part of the Energy Savings section.

User Defined Reference Home (UDRH) Specifications

The following table provides inputs for a UDRH based on the 2009 IECC, with some supplemental clarifications.

2009 IECC UDRH Specifications

Data Point	Value		Unit	Source	Comment
	Zone 4	Zone 5			
Building Thermal Envelope					
Fenestration	0.40	0.35	U-factor	2009 IECC Table 402.1.3	
Skylight	0.60	0.60	U-factor	2009 IECC Table 402.1.3	
Glazed Fenestration SHGC	0.40	0.40	SHGC	2009 IECC Table 404.5.2(1)	No prescriptive requirement.
Ceiling	0.030	0.030	U-factor	2009 IECC Table 402.1.3	
Wood Frame Wall	0.082	0.057	U-factor	2009 IECC Table 402.1.3	
Rim and Band Joists	0.082	0.060	U-factor		Code requirement for wood frame wall.
Mass Wall	0.141	0.082	U-factor	2009 IECC Table 402.1.3	
Frame Floor	0.047	0.033	U-factor	2009 IECC Table 402.1.3	
Basement Wall	0.059	0.059	U-factor	2009 IECC Table 402.1.3	

Data Point	Value		Unit	Source	Comment
	Zone 4	Zone 5			
Slab, Unheated	10, 2	10, 2	R-value, feet	2009 IECC Table 402.1.1	Feet from top of slab edge below grade.
Slab, Heated	15, 2	15, 2	R-value, feet	2009 IECC Table 402.1.1	Feet from top of slab edge below grade.
Crawlspace Wall	0.065	0.065	U-factor	2009 IECC Table 402.1.3	
Air Infiltration Rate	0.0036	0.0036	SLA	2009 IECC Table 404.5.2(1)	Approximately 7 to 8 ACH50.
Mechanical Systems					
Furnace	80		AFUE	Federal Standard	Standard is 78 AFUE, 80 AFUE is adopted based on typical minimum availability and practice.
Boiler	80		AFUE	Federal Standard	
Heat Pump, Heating	7.7		HSPF	Federal Standard	All heat pumps shall be characterized as an ASHP.
Central Air Conditioning	13		SEER	Federal Standard	
Heat Pump, Cooling	13		SEER	Federal Standard	
Water Heating, Natural Gas	0.58		EF	Federal Standard	Federal requirements vary based on tank size. The UDRH feature does not allow adjustments to efficiency values based on tank size, therefore the UDRH reference efficiency shall be based on minimum federal efficiency requirements for a 50 gallon tank.
Water Heating, Oil	0.50		EF	Federal Standard	See Water Heating, Natural Gas.
Water Heating, Electric	0.90		EF	Federal Standard	See Water Heating, Natural Gas.
Integrated Space/Water Heating, Heating	80		AFUE	Federal Standard, Boiler	Combination space and water heating units shall reference the minimum federal standard boiler efficiency for the heating portion of unit.
Integrated Space/Water Heating, Water	0.58 (natural gas) 0.50 (oil) 0.90 (electric)		EF	Federal Standard, Water Heating	Combination space and water heating units shall reference the minimum federal standard water heating efficiency for the water heating portion of unit.
Thermostat, Type	Manual			2009 IECC Table 404.5.2(1)	

Data Point	Value		Unit	Source	Comment
	Zone 4	Zone 5			
Thermostat, Cooling Set Point	75		°F	2009 IECC Table 404.5.2(1)	
Thermostat, Heating Set Point	72		°F	2009 IECC Table 404.5.2(1)	
Duct Insulation	8		R-Value	2009 IECC 403.2.1	
Duct Insulation, Floor Truss	6		R-Value	2009 IECC 403.2.1	
Duct Leakage	0.88		DSE	2009 IECC Table 404.5.2(1)	
Mechanical Ventilation	N/A				Ventilation is not required by code. The UDRH shall not reference ventilation. The program home will see no energy savings or energy penalty from ventilation.
Lights and Appliances					
Efficient Lighting	50		%	IECC 2009 Section 404.1	
Refrigerator	585		kWh/yr	Vermont Energy Investment Corporation	Based on weighted average of NAECA baseline kWh/yr installed in Vermont of 5,000 hours/year.
Dishwasher	0.46		EF	RESNET Standard	
Ceiling Fan	None			RESNET Standard	

Definitions and Acronyms

HERS Provider - A firm or organization that develops, manages, and operates a home energy rating system and is currently accredited by RESNET.

Home Energy Rater or Rater – The person trained and certified by a HERS provider to inspect and analyze a home to evaluate the minimum rated features and prepare an energy efficiency rating.

IECC - International Energy Conservation Code

Rated Home - The specific home being evaluated using the rating procedures contained in the National Home Energy Rating Technical Guidelines.

Rating Tool - A procedure for calculating a home energy efficiency rating, annual energy consumption, and annual energy costs, and which is listed in the "National Registry of Accredited Rating Software Programs" as posted on the RESNET website.

Reference Home - A hypothetical home configured in accordance with the specifications set forth in the National Home Energy Rating Technical Guidelines for the purpose of calculating rating scores

REM/Rate™ - RESNET-approved residential energy analysis, code compliance, and rating software supported by the Architectural Energy Corporation.

RESNET - Residential Energy Services Network, the national standards-making body for the building energy efficiency rating system, www.resnet.us.

UDRH - User Defined Reference Home*,* a feature of REM/Rate™ that enables HERS providers to create other reference buildings based on local construction practice, local code, etc. to compare to the rated home.

Lighting and Appliances

REM/Rate™ offers two input modes for Lights and Appliances: simplified and detailed. The simplified input mode (Lights & Appliances – HERS) is the default and is used to calculate a HERS Index. The detailed input mode (Lights & Appliances – AUDIT) is used to capture additional lighting and appliance data. Since only the simplified input mode is used when calculating a HERS Index, the simplified mode shall be used when calculating energy savings and demand reduction for new construction programs.

Energy savings and demand reduction shall be estimated per home for heating, cooling, hot water, lighting, ceiling fans, and appliances, including refrigerators and dishwashers. To avoid double-counting of savings, measures included in new construction program savings should not also be included in savings for another program. However, savings for efficient products installed in the home other than those listed above and that are not claimed through the residential new construction program may be captured through another program.

User Defined Reference Home (UDRH) Feature

The UDRH feature in REM/Rate™ provides a home-by-home comparison of energy consumption against a user-defined reference home. REM/Rate™ allows for modifying the thermal and energy performance features of the rated home to the specifications provided by the UDRH, leaving the rated home's building size, structure, and climate zone. This allows for comparing the energy consumption of the rated home to the energy consumption of the same home built to different specifications.

The UDRH shall be defined by the residential energy efficiency section of the prevailing Indiana building code. As of April 2012, the Indiana building code is based on the 2009 International Energy Conservation Code (IECC). Therefore, energy savings and demand reduction in Indiana will be based on the difference in estimated energy consumption of the program home, compared to that same home built to 2009 (or any subsequently-updated) IECC specifications.

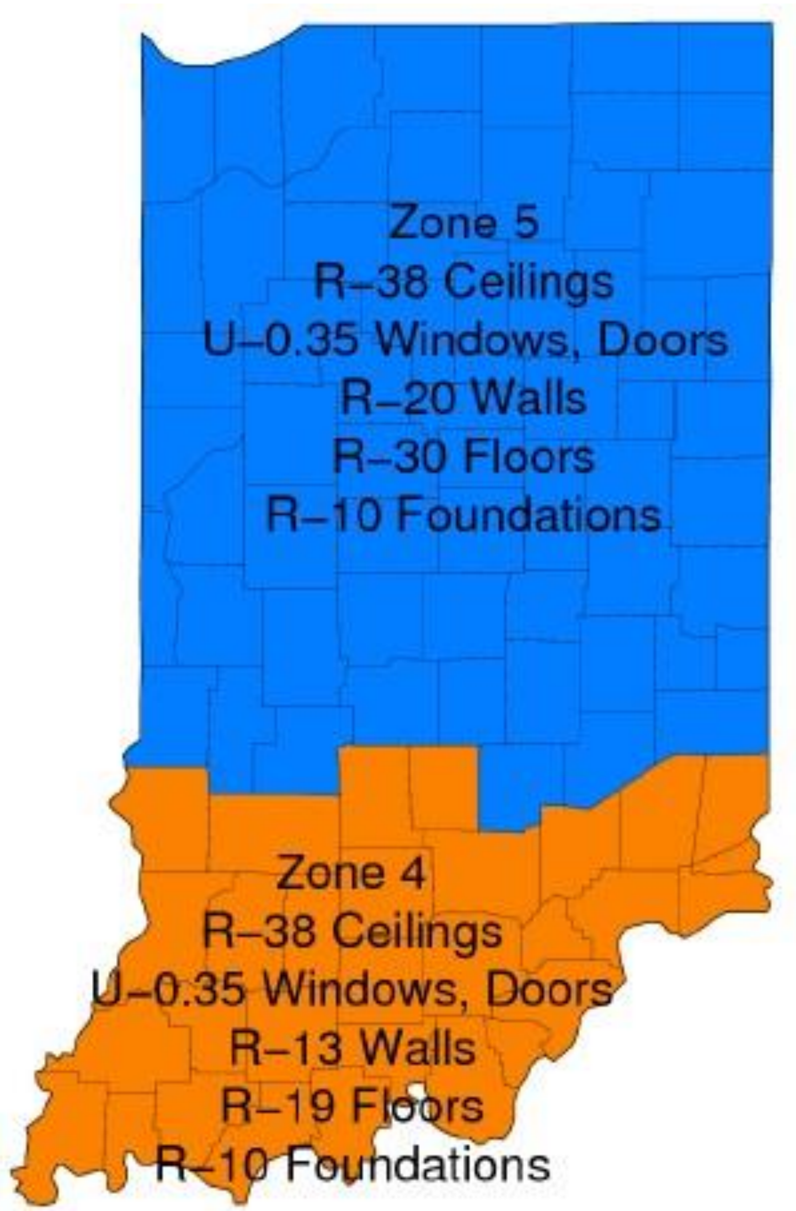
For REM/Rate™, the UDRH specifications are contained in an ASCII script file that follows a specific syntax. Details on creating a UDRH file are in the REM/Rate™ Help module. Inputs for a UDRH file based on 2009 IECC (with supplemental clarifications) are in Table 3 of the User Defined Reference Home (UDRH) Specifications section.

A UDRH report may be run singly for each home, or in batch mode for multiple homes. Data from the UDRH report may also be exported from REM/Rate™ to an Access database for additional data manipulation and to calculate savings. Additional information on using the UDRH batch export feature is in the REM/Rate™ Help module.

Indiana Climate Zones

Climate zones from the figure below shall be used to determine the applicable energy requirements for the UDRH.

Indiana Climate Zones Map



Active Solar & Photovoltaics

Solar systems installed for water and/or space heating and photovoltaic systems installed to meet electricity demand are not addressed in the 2006 IECC. However, they need to be addressed in the UDRH.

If savings for the residential new construction program can be claimed from the use of active solar or PV systems, these systems should be eliminated from the UDRH so that their savings can be quantified in comparison to the rated home. If savings for the residential new construction program *cannot* be claimed from the use of active solar or PV systems, these systems should not be included in the UDRH. When a system is not referenced in the UDRH, that system will be the same in both the rated and reference homes. This way, the energy consumption for the rated home and the UDRH will be estimated assuming both configurations have the solar or PV system installed, so no savings will be reported. The specific syntax for this is provided in the REM/Rate™ UDRH Syntax Report.

Whole-House Residential Retrofit

	Measure Details
Official Measure Code	Res-WB-WWRetro-1
Measure Unit	Varies by project
Measure Category	Miscellaneous
Sector(s)	Residential
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	Varies by project
Effective Useful Life (years)	20
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Whole-house retrofit programs, such as home performance with ENERGY STAR and low-income weatherization initiatives, may include a variety of treatments, including building shell and HVAC upgrades and the direct installation of energy-efficient products. This protocol describes how building energy modeling of each individual home treated through a program may be used to estimate savings for the building shell (e.g., air sealing, insulation) and HVAC (e.g., duct sealing, central heating and/or cooling system replacements) measures installed in those homes. Savings from other measures such as efficient lighting, appliances, or water heating should be estimated using deemed values or deemed calculations provided for such measures elsewhere in this TRM.

The alternative to using building energy modeling to develop energy savings for the shell and HVAC measures would be to use the deemed measure savings calculations found elsewhere in this TRM for each installed measures (air sealing, insulation, duct sealing, etc.). Deemed savings calculations are easier to administer and implement but may be less precise because they are based on some assumed average characteristics of homes (such as average heating system efficiencies) and do not capture interactive effects between some measures.

Definition of Efficient Equipment

The efficient condition is a house that was treated by installing building shell and HVAC measures. Savings from installed measures outside of these categories should follow the appropriate measure-specific characterizations.

Definition of Baseline Equipment

The baseline condition is a house before being retrofitted with installed measures. The only exception is that the assumed baseline efficiency of a heating system or central air conditioner that is being replaced should be consistent with the current minimum federal efficiency standards for such equipment, unless it is clear that the equipment would not have been replaced at that particular time were it not for program influence (i.e., to claim a baseline efficiency lower than the current federal minimum, there must be program documentation that the old equipment would otherwise not have been replaced).

Deemed Lifetime of Efficient Equipment

The average savings-weighted lifetime for this measure is 20 years, based on an anticipated mixture of building shell and HVAC measures ranging from 15 years to 25 years.[243]

Deemed Measure Cost

The actual costs for procuring and installing the equipment, materials, and/or services should be used as the deemed measure cost.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

The requirements for a model-based approach to savings claims are delineated in part through adherence with at least one of the following national standards for whole-house savings calculations:

- RESNET-approved rating software (http://resnet.us)
- Software energy simulation performance exceeding the requirements of National Renewable Energy Laboratory's Home Energy Rating System, BESTEST (http://www.nrel.gov/docs/legosti/fy96/7332b.pdf)
- U.S. Department of Energy Weatherization Assistance Program approval (http://www.waptec.org)

Proper savings estimates from modeling software also require that uninsulated wall or ceiling baseline conditions are modeled as no less than R-5. In addition, software tools must be calibrated against actual consumption data for each treated home or from a sample sized for a 90% confidence interval with ±10% margin of statistical precision error. These requirements address concerns that modeling software can overestimate savings, particularly cooling savings.

The software tools must provide outputs that separately account for heating and cooling energy and peak demand reduction so that demand and fuel-related economic savings may be properly addressed.

243 A review of measures installed could be used to assess whether to adjust the savings-weighted average in accordance with a measure distribution that favors longer (insulation) or shorter (air sealing) lifetimes.

Commercial & Industrial Market Sector

Building Shell

Cool Roof (Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-Shell-CoolRoof-1
Measure Unit	Per unit
Measure Category	Building Shell
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$8,454.67 per 1,000 square feet
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of cool roof roofing materials in commercial buildings. A cool roof is assumed to have a solar absorbance of 0.3[244] compared to a standard roof with a solar absorbance of 0.8.[245] Energy savings and demand reduction are realized through reductions in the building cooling loads. The approach uses DOE-2.2 simulations on a series of commercial prototypical building models. Energy and demand impacts are normalized per thousand square feet of roof space.

Definition of Efficient Equipment

The efficient condition is a roof with a solar absorbance of 0.30.

Definition of Baseline Equipment

The baseline condition is a roof with a solar absorbance of 0.80.

---

244 Maximum value to meet cool roof standards under California's Title 24.

245 Itron. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study.* December 2005.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 15 years.[246]

Deemed Measure Cost

The full installed cost for retrofit applications is $8,454.67 per 1,000 square feet (kSF).[247]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{SF}{1{,}000} * \Delta kWh_{kSF}$$

Where:

SF = Square footage of the roof (= actual; to be collected with the incentive form)

ΔkWh_{kSF} = Unit energy savings per 1,000 square feet of roof (= see table in Reference Tables section)

For example, the energy savings from an assembly building in Indianapolis with 1,000 square feet of roof would be:

$$\Delta kWh = \frac{1{,}000}{1{,}000} * 197 = 197 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{SF}{1{,}000} * \Delta kW_{kSF} * CF$$

Where:

ΔkW_{kSF} = Unit demand reduction per 1,000 square foot of roof area (= see table in Reference Tables section)

CF = Summer peak coincident factor (= 0.74)[248]

---

[246] California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. “Effective/Remaining Useful Life Values.” December 16, 2008.

[247] California Public Utilities Commission. *2005 Database for Energy-Efficiency Resources (DEER), Version 2005.2.01*. “Technology and Measure Cost Data.” October 26, 2005.

[248] Duke Energy supplied the coincidence factor for the commercial HVAC end uses (pending verification based on information from the utilities).

For example, the demand reduction from an assembly building in Indianapolis with 1,000 square feet of roof would be:

$$\Delta kW = \frac{1{,}000}{1{,}000} * 0.141 * 0.74 = 0.104\ kW$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu = \frac{SF}{1{,}000} * \Delta MMBtu_{kSF}$$

Where:

$\Delta MMBtu_{kSF}$ = Unit natural gas savings per 1,000 square feet of roof space (= see table in Reference Tables section)

For example, the fossil fuel impacts from an assembly building in Indianapolis with 1,000 square feet of roof would be:

$$\Delta MMBtu = \frac{1{,}000}{1{,}000} * -1.451 = -1.45\ MMBtu$$

Reference Tables

Energy Savings and Demand Reduction Factors for Small Commercial Applications

Building	City	ΔkWh_{kSF}	ΔkW_{kSF}	$\Delta MMBtu_{kSF}$
Assembly	Evansville	263	0.159	-1.44
	Ft. Wayne	154	0.091	-1.63
	Indianapolis	197	0.141	-1.45
	South Bend	157	0.003	-1.41
	Terre Haute	203	0.156	-1.44
Big Box Retail	Evansville	223	0.126	-0.90
	Ft. Wayne	152	0.080	-1.16
	Indianapolis	183	0.125	-1.09
	South Bend	155	0.078	-1.02
	Terre Haute	215	0.122	-1.02
Fast Food Restaurant	Evansville	253	0.050	-1.90
	Ft. Wayne	140	0.050	-2.10
	Indianapolis	189	0.050	-2.05
	South Bend	146	0.00	-2.05
	Terre Haute	170	0.003	-2.05
Full Service Restaurant	Evansville	233	0.150	-1.55
	Ft. Wayne	152	0.100	-1.80
	Indianapolis	187	0.150	-1.78
	South Bend	152	0.050	-1.83
	Terre Haute	184	0.100	-1.43
Light Industrial	Evansville	197	0.094	-1.57
	Ft. Wayne	104	0.081	-1.63

Building	City	ΔkWh_{kSF}	ΔkW_{kSF}	$\Delta MMBtu_{kSF}$
	Indianapolis	137	0.063	-1.70
	South Bend	108	0.045	-1.66
	Terre Haute	162	0.064	-1.34
Primary School	Evansville	404	0.678	-2.86
	Ft. Wayne	241	0.506	-2.97
	Indianapolis	328	0.698	-3.01
	South Bend	240	0.636	-2.88
	Terre Haute	359	0.492	-2.34
Small Office	Evansville	230	0.060	-0.84
	Ft. Wayne	156	0.020	-1.02
	Indianapolis	187	0.020	-0.98
	South Bend	157	0.060	-0.98
	Terre Haute	189	0.080	-0.90
Small Retail	Evansville	260	0.125	-1.36
	Ft. Wayne	172	0.078	-1.61
	Indianapolis	210	0.125	-1.58
	South Bend	170	0.031	-1.64
	Terre Haute	245	0.094	-1.16
Warehouse	Evansville	688	0.794	-4.88
	Ft. Wayne	104	0.081	-1.63
	Indianapolis	546	0.594	-5.13
	South Bend	471	0.025	-4.49
	Terre Haute	162	0.064	-1.34

Energy Savings and Demand Reduction Factors for Hospitals

HVAC System	City	ΔkWh_{kSF}	ΔkW_{kSF}	$\Delta MMBtu_{kSF}$
Constant Volume Reheat Economizer with Air Cooled Chiller	Evansville	124	0.104	-1.57
	Indianapolis	104	0.158	-1.37
	South Bend	89	0.001	-1.19
	Ft. Wayne	107	0.085	-0.75
	Terre Haute	116	0.162	-0.71
Constant Volume Reheat Economizer with Water Cooled Chiller	Evansville	86	0.046	-1.57
	Indianapolis	78	0.042	-1.38
	South Bend	67	0.001	-1.19
	Ft. Wayne	81	0.047	-0.75
	Terre Haute	74	0.049	-0.71
Constant Volume Reheat No Economizer with Air Cooled Chiller	Evansville	188	0.104	-1.76
	Indianapolis	167	0.158	-1.56
	South Bend	145	0.001	-1.39
	Ft. Wayne	167	0.085	-0.85
	Terre Haute	166	0.162	-0.81

HVAC System	City	ΔkWh_{kSF}	ΔkW_{kSF}	$\Delta MMBtu_{kSF}$
Constant Volume Reheat No Economizer with Water Cooled Chiller	Evansville	130	0.046	-1.76
	Ft. Wayne	123	0.047	-0.85
	Indianapolis	123	0.046	-1.54
	South Bend	108	0.001	-1.36
	Terre Haute	111	0.049	-0.81
Variable Air Volume Reheat Economizer with Air Cooled Chiller	Evansville	200	0.163	-0.66
	Indianapolis	174	0.176	-0.55
	South Bend	146	0.270	-0.95
	Ft. Wayne	152	0.077	-0.80
	Terre Haute	183	0.192	-0.24
Variable Air Volume Reheat Economizer with Water Cooled Chiller	Evansville	151	0.097	-0.66
	Indianapolis	121	0.059	-0.57
	South Bend	106	0.020	-0.90
	Ft. Wayne	120	0.071	-0.83
	Terre Haute	139	0.047	-0.24

Energy Savings and Demand Reduction Factors for Hotels

HVAC System	City	ΔkWh_{kSF}	ΔkW_{kSF}	$\Delta MMBtu_{kSF}$
Constant Volume Reheat Economizer with Air Cooled Chiller	Indianapolis	528	0.177	-0.10
	South Bend	563	0.151	-0.09
	Evansville	771	0.135	-0.16
	Ft. Wayne	453	0.109	-0.17
	Terre Haute	544	0.198	-0.15
Constant Volume Reheat Economizer with Water Cooled Chiller	Indianapolis	526	0.177	-0.10
	South Bend	561	0.151	-0.09
	Evansville	772	0.135	-0.16
	Ft. Wayne	453	0.114	-0.17
	Terre Haute	545	0.198	-0.15
Constant Volume Reheat No Economizer with Air Cooled Chiller	Indianapolis	537	0.177	-0.07
	South Bend	574	0.151	-0.07
	Evansville	782	0.135	-0.15
	Ft. Wayne	464	0.109	-0.17
	Terre Haute	556	0.198	-0.14
Constant Volume Reheat No Economizer with Water Cooled Chiller	Evansville	781	0.135	-0.15
	Ft. Wayne	464	0.114	-0.16
	Indianapolis	531	0.177	-0.07
	South Bend	570	0.151	-0.07
	Terre Haute	556	0.198	-0.14
Variable Air Volume Reheat Economizer	Indianapolis	535	0.177	-0.06
	South Bend	569	0.151	-0.05
	Evansville	789	0.135	-0.07

HVAC System	City	ΔkWh_{kSF}	ΔkW_{kSF}	$\Delta MMBtu_{kSF}$
with Air Cooled Chiller	Ft. Wayne	470	0.114	-0.10
	Terre Haute	559	0.203	-0.07
Variable Air Volume Reheat Economizer with Water Cooled Chiller	Indianapolis	533	0.177	-0.06
	South Bend	567	0.146	-0.05
	Evansville	787	0.135	-0.07
	Ft. Wayne	467	0.114	-0.10
	Terre Haute	557	0.203	-0.07

Energy Saving and Demand Reduction Factors for Large Offices

HVAC System	City	ΔkWh_{kSF}	ΔkW_{kSF}	$\Delta MMBtu_{kSF}$
Constant Volume Reheat Economizer with Air Cooled Chiller	Evansville	149	0.120	-1.63
	Ft. Wayne	95	0.00	-1.99
	Indianapolis	153	0.00	-2.06
	South Bend	120	0.143	-2.59
	Terre Haute	136	0.103	-1.40
Constant Volume Reheat Economizer with Water Cooled Chiller	Evansville	101	0.00	-1.64
	Ft. Wayne	57	0.00	-1.99
	Indianapolis	120	0.00	-2.20
	South Bend	110	0.00	-2.61
	Terre Haute	95	0.00	-1.43
Constant Volume Reheat No Economizer with Air Cooled Chiller	Evansville	249	0.109	-1.47
	Ft. Wayne	167	0.103	-1.93
	Indianapolis	250	0.057	-1.77
	South Bend	188	0.149	-1.85
	Terre Haute	266	0.103	-1.56
Constant Volume Reheat No Economizer with Water Cooled Chiller	Evansville	184	0.051	-1.46
	Ft. Wayne	143	0.046	-1.93
	Indianapolis	205	0.034	-1.78
	South Bend	152	0.086	-1.85
	Terre Haute	153	0.034	-1.56
Variable Air Volume Reheat Economizer with Air Cooled Chiller	Evansville	297	0.154	-0.27
	Ft. Wayne	190	0.120	-0.87
	Indianapolis	405	0.006	0.58
	South Bend	347	0.126	-0.01
	Terre Haute	422	0.291	0.37
Variable Air Volume Reheat Economizer with Water Cooled Chiller	Evansville	220	0.029	-0.27
	Ft. Wayne	183	0.023	-0.74
	Indianapolis	350	0.00	0.58
	South Bend	252	0.069	-0.18
	Terre Haute	334	0.017	0.37

Commercial Window Film (Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-Shell-WinFilm-1
Measure Unit	Per square foot
Measure Category	Building Shell
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$267.00 per 100 square feet of window
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of reflective window film in commercial buildings. The baseline condition is double-pane clear glass with a solar heat gain coefficient (SHGC) of 0.73 and a U-value of 0.72 Btu/hr-SF-°F. The window film is assumed to provide a SHGC of 0.40 or less. Energy savings and demand reduction are realized through reductions in the building cooling loads. The approach uses DOE-2.2 simulations on a series of commercial prototypical building models. The commercial simulation models are adapted from the California DEER, with changes to reflect Indiana climate and building practices. Energy and demand impacts are normalized per 100 square feet of window.

Definition of Efficient Equipment

The efficient condition is double-pane clear glass windows with standard window film. The standard window film will lower the SHGC to 0.40.

Definition of Baseline Equipment

The baseline condition is double-pane clear glass windows without any window film, with a U-value of 0.72, and a SHGC of 0.73.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 10 years.[249]

Deemed Measure Cost

This is a retrofit-only measure. The actual installed cost should be used, but for analysis purposes, the full installed cost including labor is $267.00 per 100 square feet of window.[250]

Deemed O&M Cost Adjustments

There are no expected O&M savings associated with this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = \frac{SF}{100} * \Delta kWh_{100SF}$$

Where:

SF	=	Glazing surface area of installed window film in square feet, not including frame
ΔkWh_{100SF}	=	Unit energy savings per 100 square feet of window film (= see table in Reference Table section)

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{SF}{100} * \Delta kW_{100SF} * \text{CF}$$

Where:

ΔkW_{100SF}	=	Unit demand reduction per 100 square feet of window film (= see table in Reference Table section)
CF	=	Summer peak coincident factor (= 0.74)[251]

Since this is a retrofit measure that only applies to existing buildings with clear, double-pane windows, future code adjustments should not affect projected savings.

---

249 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008.

250 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Cost Values and Summary Documentation." December 16, 2008.

251 Duke Energy provided the coincidence factor for the commercial HVAC end-use (pending verification based on information from the utilities).

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \frac{SF}{100} * \Delta MMBtu_{100SF}$$

Where:

$\Delta MMBtu_{100SF}$ = Unit heating fossil fuel savings per 100 square feet of window film (= see table in Reference Table section)

Reference Table

Energy Saving and Demand Reduction Factors for Window Film

Building Type	ΔkWh_{100SF}*	ΔkW_{100SF}*	$\Delta MMBtu_{100SF}$*
Indianapolis			
Assembly	426	0.15	-3.96
Big Box Retail	350	0.12	-3.39
Fast Food Restaurant	317	0.14	-5.06
Full Service Restaurant	304	0.17	-7.07
Light Industrial	285	0.14	-4.00
Primary School	498	0.22	-7.40
Small Office	309	0.13	-2.70
Small Retail	323	0.15	-4.48
Warehouse	285	0.14	-4.00
Other	344	0.00	-4.67
South Bend			
Assembly	352	0.01	-3.68
Big Box Retail	319	0.08	-2.91
Fast Food Restaurant	260	0.02	-5.21
Full Service Restaurant	260	0.08	-7.02
Light Industrial	231	0.14	-4.25
Primary School	421	0.26	-6.62
Small Office	280	0.12	-2.62
Small Retail	289	0.12	-4.63
Warehouse	231	0.14	-4.25
Other	294	0.00	-4.58
Evansville			
Assembly	586	0.15	-3.12
Big Box Retail	457	0.16	-2.43
Fast Food Restaurant	391	0.14	-4.20
Full Service Restaurant	376	0.17	-5.64
Light Industrial	329	0.14	-3.59
Primary School	537	0.18	-6.76
Small Office	369	0.13	-1.92
Small Retail	416	0.16	-3.38
Warehouse	329	0.14	-3.59

Building Type	ΔkWh_{100SF}*	ΔkW_{100SF}*	$\Delta MMBtu_{100SF}$*
Other	421	0.00	-3.85
Ft. Wayne			
Assembly	335	0.15	-4.12
Big Box Retail	305	0.16	-3.35
Fast Food Restaurant	258	0.14	-5.11
Full Service Restaurant	254	0.19	-7.43
Light Industrial	199	0.16	-4.34
Primary School	442	0.39	-6.83
Small Office	265	0.14	-2.91
Small Retail	273	0.16	-4.79
Warehouse	199	0.16	-4.34
Other	281	0.00	-4.80
Terre Haute			
Assembly	417	0.13	-4.20
Big Box Retail	382	0.09	-2.13
Fast Food Restaurant	306	0.14	-4.20
Full Service Restaurant	310	0.17	-5.47
Light Industrial	273	0.09	-3.41
Primary School	505	0.20	-5.53
Small Office	304	0.11	-1.91
Small Retail	352	0.11	-3.07
Warehouse	273	0.09	-3.41
Other	347	0.00	-3.70

* Unit energy savings, demand reductions, and natural gas savings data are based on a series of prototypical small commercial building simulation runs. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development.

Roof Insulation (Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-Shell-RoofInsul-1
Measure Unit	Per square foot
Measure Category	Building Shell
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	20
Incremental Cost	$1.36 per square foot
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is improvements to the roof insulation in commercial buildings. The roof insulation R-value is assumed to increase to R-18 from the baseline level for each building type. Energy savings and demand reduction are realized through reductions in the building heating and cooling loads. The approach uses DOE-2.2 simulations on a series of commercial prototypical building models. The commercial simulation models are adapted from the California DEER study, with changes to reflect Indiana climate and building practices. Energy and demand impacts are normalized per 1,000 square feet of installed insulation.

Definition of Efficient Equipment

The efficient condition is R-18 insulation on the roof.

Definition of Baseline Equipment

The baseline condition by building type is shown in the table below.

Baseline Condition by Building Type

Building Type	Baseline R-Value
Assembly	R-12
Big Box Retail	R-13.5
Fast Food	R-13.5
Full Service Restaurant	R-13.5
Light Industrial	R-12
School	R-13.5
Small Office	R-13.5
Small Retail	R-13.5

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 20 years.[252]

Deemed Measure Cost

The full installed cost for retrofit applications is $1.36 per square foot.[253]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{SF}{1{,}000} * \Delta kWh_{kSF}$$

Where:

SF = Square footage of the roof (to be collected with the incentive form)

ΔkWh_{kSF} = Energy savings per 1,000 square feet of roof area (= dependent on building type and region; see table in Reference Table section)

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{SF}{1{,}000} * \Delta kW_{kSF} * CF$$

252 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008.

253 Ibid. "Cost Values and Summary Documentation."

Where:

ΔkW_{kSF} = Demand reduction per 1,000 square feet of roof area (= dependent on building type and region; see table in Reference Table section)

CF = Summer peak coincident factor (= 0.74)[254]

There are no expected future code changes to affect this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \frac{SF}{1{,}000} * \Delta MMBtu_{kSF}$$

Where:

$\Delta MMBtu_{kSF}$ = Unit natural gas savings per 1,000 square feet of roof space (= dependent on building type and region; see table in Reference Table section)

Reference Table

Energy Saving and Demand Reduction Factors for Roof Insulation*

Building	City	ΔkWh_{kSF}*	ΔkW_{kSF}*	$\Delta MMBtu_{kSF}$*
Assembly	Evansville	40	0.074	2.07
	Ft. Wayne	39	0.050	4.17
	Indianapolis	48	0.074	3.36
	South Bend	31	0.00	3.26
	Terre Haute	53	0.082	3.60
Big Box Retail	Evansville	6	0.045	1.90
	Ft. Wayne	4	0.025	3.12
	Indianapolis	5	0.041	2.55
	South Bend	1	0.022	2.52
	Terre Haute	1	0.022	2.67
Fast Food Restaurant	Evansville	80	0.00	3.40
	Ft. Wayne	39	0.050	3.80
	Indianapolis	60	0.050	3.75
	South Bend	38	0.00	3.40
	Terre Haute	77	0.050	4.3
Full Service Restaurant	Evansville	72	0.050	3.20
	Ft. Wayne	75	0.025	5.15
	Indianapolis	84	0.050	4.95
	South Bend	72	0.025	5.08

254 Duke Energy provided the coincidence factor for the commercial HVAC end-use (pending verification based on information from the utilities).

Building	City	ΔkWh_{kSF}*	ΔkW_{kSF}*	$\Delta MMBtu_{kSF}$*
	Terre Haute	66	0.025	3.58
Light Industrial	Evansville	73	0.022	2.87
	Ft. Wayne	53	0.014	4.41
	Indianapolis	65	0.019	3.96
	South Bend	58	0.019	4.16
	Terre Haute	65	0.019	3.30
Primary School	Evansville	196	0.298	4.52
	Ft. Wayne	106	0.232	4.48
	Indianapolis	135	0.116	4.23
	South Bend	110	0.108	4.33
	Terre Haute	181	0.110	5.05
Small Office	Evansville	57	0.040	2.02
	Ft. Wayne	38	0.06	3.12
	Indianapolis	50	0.04	2.76
	South Bend	39	0.04	2.84
	Terre Haute	50	0.040	2.48
Small Retail	Evansville	84	0.062	3.20
	Ft. Wayne	68	0.05	4.66
	Indianapolis	84	0.08	4.20
	South Bend	72	0.05	4.50
	Terre Haute	81	0.047	3.77
Warehouse	Evansville	73	0.022	2.87
	Ft. Wayne	54	0.02	4.34
	Indianapolis	60	0.121	7.53
	South Bend	23	0.011	7.32
	Terre Haute	65	0.019	3.30

* Unit energy savings, demand reductions, and natural gas savings data are based on a series of prototypical small commercial building simulation runs. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development.

High Performance Glazing (Retrofit – Early Replacement)

	Measure Details
Official Measure Code	CI-Shell-HPGlaz-1
Measure Unit	Per square foot
Measure Category	Building Shell
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	20
Incremental Cost	$54.82 per square foot of window
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of high performance glazing in commercial buildings. The baseline condition is double-pane clear glass with a solar heat gain coefficient (SHGC) of 0.73 and U-value of 0.72 Btu/hr-SF-°F. The efficient glazing must have a SHGC of 0.40 or less and U-value of 0.57 Btu/hr-SF-°F or less. Energy savings and demand reduction are realized through reductions in the building heating and cooling loads. The approach uses DOE-2.2 simulations on a series of commercial prototypical building models. The commercial simulation models are adapted from the California DEER study, with changes to reflect Indiana climate and building practices. Energy and demand impacts are normalized per 100 square feet of window.

Definition of Efficient Equipment

The efficient condition is a window with a U-value of 0.57 and a SHGC of 0.4.

Definition of Baseline Equipment

The baseline condition is a window with a U-value of 0.72 and a SHGC of 0.73.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 20 years.[255]

[255] California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. “Effective/Remaining Useful Life Values.” December 16, 2008.

Deemed Measure Cost

The full installed cost for retrofit applications is \$54.82 per square foot of window.[256]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = \frac{SF}{100} * \Delta kWh_{100SF}$$

Where:

SF	=	Glazing surface area of installed window in square feet, not including frame (= actual)
ΔkWh_{100SF}	=	Energy savings per 100 square feet of window space (= see table in Table Reference section)

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{SF}{100} * \Delta kW_{100SF} * CF$$

Where:

ΔkW_{100SF}	=	Demand reduction per 100 square feet of window space (= see table in Table Reference section)
CF	=	Summer peak coincident factor (= 0.74)[257]

Baseline Adjustment

There are no expected future code changes to affect this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \frac{SF}{100} * \Delta MMBtu_{100SF}$$

256 Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February, 19, 2010. Value derived from Efficiency Vermont project experience and conversations with suppliers.

257 Duke Energy supplied the coincidence factor for the commercial HVAC end-use (pending verification based on information from the utilities).

Where:

$\Delta MMBtu_{100SF}$ = Unit natural gas savings per 100 square feet of window space (= see table in Table Reference section)

Reference Table

Energy Saving and Demand Reduction Factors for High Performance Windows

Building Type	ΔkWh_{100SF}*	ΔkW_{100SF}*	$\Delta MMBtu_{100SF}$*
Indianapolis			
Assembly	376	0.15	-0.67
Big Box Retail	317	0.12	-0.81
Fast Food Restaurant	316	0.14	-0.84
Full Service Restaurant	331	0.17	-0.99
Light Industrial	272	0.14	-1.69
Primary School	535	0.23	-2.97
Religious Worship	210	0.19	-0.25
Small Office	300	0.14	-0.57
Small Retail	326	0.16	-1.13
Warehouse	272	0.14	-1.69
Other	326	0.00	-1.16
South Bend			
Assembly	301	0.01	-0.96
Big Box Retail	291	0.09	-0.81
Fast Food Restaurant	266	0.03	-0.43
Full Service Restaurant	289	0.08	-0.52
Light Industrial	212	0.14	-1.83
Primary School	450	0.26	-2.44
Small Office	273	0.13	-0.42
Small Retail	298	0.13	-0.88
Warehouse	212	0.14	-1.83
Other	288	0.00	-1.03
Evansville			
Assembly	510	0.15	-1.00
Big Box Retail	406	0.17	-0.78
Fast Food Restaurant	378	0.15	-0.91
Full Service Restaurant	389	0.17	-1.08
Light Industrial	320	0.14	-1.85
Primary School	574	0.19	-3.09
Small Office	351	0.13	-0.46
Small Retail	404	0.16	-1.04
Warehouse	320	0.14	-1.85
Other	406	0.00	-1.34

Building Type	ΔkWh_{100SF}*	ΔkW_{100SF}*	$\Delta MMBtu_{100SF}$*
Ft. Wayne			
Assembly	287	0.16	-0.74
Big Box Retail	280	0.17	-0.11
Fast Food Restaurant	263	0.14	-0.40
Full Service Restaurant	289	0.19	-0.72
Light Industrial	215	0.16	-1.26
Primary School	470	0.20	-2.35
Small Office	261	0.14	-0.47
Small Retail	285	0.17	-0.79
Warehouse	215	0.16	-1.26
Other	285	0.00	-0.90
Terre Haute			
Assembly	362	0.14	-0.52
Big Box Retail	338	0.10	-0.20
Fast Food Restaurant	306	0.14	-0.22
Full Service Restaurant	327	0.17	-0.17
Light Industrial	283	0.11	-0.90
Primary School	539	0.21	-1.81
Small Office	292	0.11	-0.14
Small Retail	344	0.11	-0.43
Warehouse	283	0.11	-0.90
Other	342	0.00	-0.47

* Unit energy savings, demand reduction, and natural gas savings data are based on a series of prototypical small commercial building simulation runs. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development.

Domestic Hot Water

Heat Pump Water Heaters (New Construction, Retrofit)

	Measure Details
Official Measure Code	CI-SHW-HPWH-1
Measure Unit	Per water heater
Measure Category	Domestic Hot Water
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a HPWH in place of a standard electric water heater. HPWHs can be added to existing DHW systems to improve the overall efficiency. HPWHs use refrigerants (like an ASHP) and have much higher energy factors than standard electric water heaters. HPWHs remove waste heat from surrounding air sources and preheat the DHW supply system. HPWHs come in a variety of sizes and the choice will depend on the desired temperature output and amount of hot water needed by application. The savings from HPWH will depend on the design, size (capacity), water heating requirements, building application, and climate. This measure could relate to either a retrofit or a new installation.

Definition of Efficient Equipment

The efficient equipment is a HPWH with or without an auxiliary water heating system.

Definition of Baseline Equipment

The baseline equipment is a standard electric storage tank-type water heater. This measure does *not* apply to natural gas-fired water heaters.

Deemed Lifetime of Efficient Equipment

The expected measure life is 10 years.[258]

Deemed Measure Cost

Due to the complexity of HPWH systems, incremental capital costs should be determined on a case-by-case basis. High capacity HPWHs typically have a supplemental heating source, such as an electric resistance heater. For new construction applications, the incremental capital cost for this measure should be calculated as the difference between the installed cost of the entire HPWH system (including any auxiliary heating systems) and the installed cost of a standard electric storage tank water heater of comparable capacity. For retrofit applications, the total installed cost of HPWH should be used.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{GPD * 365 * 8.3 * (T_{OUT} - T_{IN})}{3{,}412} * \left(\frac{1}{EF_{BASE}} - \frac{1}{EF_{EE}}\right)$$

Where:

GDP = Average daily gallons of hot water consumption (= determined from site-specific data)

365 = Days of operation per year

8.3 = Specific weight of water (8.3 lbs/gal) multiplied by the specify heat of water $(1.0 \frac{Btu}{lb*°F})$

T_{OUT} = Water heater set point (= actual; otherwise assume 130°F)[259]

T_{In} = Cold water temperature entering the DWH system (= depending on climate; see table below)

---

258 Estimates of measure life from utilities in the Northeast and the U.S. Department of Energy vary from 10 to 15 years. Assume 10 years as a conservative estimate. http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

259 National Association of Home Builders Research Center. *Performance Comparison of Residential Hot Water Systems.* Prepared for the National Renewable Energy Laboratory. 2002.

Groundwater Temperature (T_{IN}) by Location*

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Ft Wayne	55.6

* Burch, J. and C. Christensen, National Renewable Energy Laboratory. *Towards Development of an Algorithm for Mains Water Temperature.* 2007. American Solar Energy Society, Colorado.

3,412 = Conversion factor (Btu/kWh)

EF_{BASE} = Baseline water heater energy factor (= depending on tank size; see table below)

Federal Standard Energy Factors for Water Heaters*

Tank Volume	EF_{BASE}
≤ 55 gallons	0.960−(0.003 × Rated Storage Volume in gallons)
< 55 gallons	2.057−(0.00113 × Rated Storage Volume in gallons)

* Minimum federal standard for capacity range. 2015 Federal Energy Conservation Standard for electric water heaters (e-CFR Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32)

EF_{EE} = Energy factor of HPWH system (= actual)

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{GPH * 8.33 * (T_{OUT} - T_{IN})}{3{,}412} * \left(\frac{1}{EF_{BASE}} - \frac{1}{EF_{EE}}\right) * CF$$

Where:

GPH = Hot water consumption in gallons per hour (= determined from site-specific data)

CF = Summer peak coincidence factor (= 0.06)[260]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.[261]

260 "Technical Reference Manual (TRM) for Ohio Senate Bill 221 Energy Efficiency and Conservation Program and 09-512-GE- UNC." October 15, 2009. Based on Ohio utility supply profiles.

261 The interactive effects between space heating and cooling requirements and HPWH have been neglected for this characterization but are candidates for future study. Heat pumps remove waste heat from surrounding air sources, which can reduce cooling loads and increase heating loads for HPWHs located in a conditioned space.

High Efficiency Storage Tank Water Heater (Time of Sale, Retrofit – Early Replacement)

	Measure Details
Official Measure Code	CI-SHW-StorWH-1
Measure Unit	Per water heater
Measure Category	Domestic Hot Water
Sector(s)	Commercial
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	$300.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Stand-alone, or tank-type heaters, run off natural gas. These water heaters consist of a storage tank with an attached heat source; in this case, a high-efficiency natural gas burner. This measure achieves energy savings through the use of efficient heating equipment and superior tank insulation.

Definition of Efficient Equipment

The efficient case is a natural gas-fired tank-type water heater exceeding the efficiency requirements as mandated ASHRAE 90.1-2007.

Definition of Baseline Equipment

The baseline condition is a natural gas-fired tank-type water heater meeting the efficiency requirements as mandated by ASHRAE 90.1-2007.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 12 years.[262]

[262] The interactive effects between space heating and cooling requirements and HPWH have been neglected for this characterization but are candidates for future study. Heat pumps remove waste heat from surrounding air sources, which can reduce cooling loads and increase heating loads for HPWHs located in a conditioned space.

Deemed Measure Cost

The deemed measure cost is $300.00.[263]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

There are no expected energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \frac{GPD * 365 * 8.3 * (T_{OUT} - T_{IN})}{1{,}000{,}000} * \left(\frac{1}{\eta_{BASE}} - \frac{1}{\eta_{EE}}\right) + \frac{8{,}760 * (STBY_{BASE} - STBY_{EE})}{1{,}000{,}000}$$

Where:

GPD = Water use of equipment in gallons per day (= see table in Reference Table section)

365 = Days of water heater operation per year

8.3 = Specific weight of water (8.3 lbs/gal) multiplied by the specify heat of water (1.0 $\frac{Btu}{lb*°F}$)

T_{OUT} = Water heater set point (= actual; otherwise assume 130°F)[264]

T_{IN} = Cold water temperature entering the DWH system (= depending on climate; see table below)

Groundwater Temperature (T_{IN}) by Location*

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Ft Wayne	55.6

* Burch, J. and C. Christensen, National Renewable Energy Laboratory. *Towards Development of an Algorithm for Mains Water Temperature.* 2007. American Solar Energy Society, Colorado.

263 Ibid.

264 National Association of Home Builders Research Center. *Performance Comparison of Residential Hot Water Systems.* Prepared for the National Renewable Energy Laboratory. 2002.

η_{BASE} = Rated efficiency (%) of baseline water heater expressed as energy factor or thermal efficiency (= see table below)

Efficiency of Baseline Water Heater by Size*

Equipment Type	Size Category (Input)	η_{BASE}	$STBY_{BASE}$
Storage water heaters, natural gas	≤ 155,000 Btu/h	0.80	$(Q/800) + 110V^{1/2}$
	> 155,000 Btu/h	0.80	$(Q/800) + 110V^{1/2}$

* Minimum federal standard for capacity range. 2015 Federal Energy Conservation Standard for electric water heaters (e-CFR Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32)

V = Rated tank volume in gallons (= actual)

Q = Nameplate input rate in Btu/hr (= actual)

η_{EE} = Rated efficiency (%) of efficient water heater expressed as energy factor or thermal efficiency (= actual)

8,760 = Hours per year

$STBY_{BASE}$ = Standby losses of baseline water heater in Btu/hr (= see table above)

$STBY_{EE}$ = Standby losses of efficient water heater in Btu/hr (= actual; note: for unit rated with energy factor, $STBY_{BASE}$ = 0)

1,000,000= Conversion factor from Btu to MMBtu

Reference Table

Rated Efficiency of Baseline Water Heater by Building Type

Building Type	GPD	Rate	Notes	Source
Assembly	150	5 per seat	Water not HOT water; assume 10% hot water, 300 seats	http://www.p2pays.org/ref/42/41980.pdf
Big Box	100		Assume like Small Office	Staff estimate
Fast Food	630	0.7 GPD per meal	50 meals per hour, 18 hours per day	NY TRM
Full Service Restaurant	1,152	2.4 GPD per meal	40 meals per hour, 18 hours per day	NY TRM
Grocery	200		Assume 2x Big Box	Staff estimate
Hospital	12,000	300 GDP per bed	Water not HOT water; assume 50% hot water, 80 beds	http://www.p2pays.org/ref/42/41980.pdf
Large Office	500	1.0 GPD per person	Assume 500 people	NY TRM
Light Industrial	1,250	25 GPD per person per shift	Water not HOT water; assume 50% hot water, 100 people per day	http://www.p2pays.org/ref/42/41980.pdf

Building Type	GPD	Rate	Notes	Source
Multifamily High-Rise	920	46 GPD per unit	20 units (2 people per unit, refer to table on page 66 of SF manual 12/16/09)	NY TRM
Multifamily Low-Rise	276	46 GPD per unit	6 units (2 people per unit, refer to table on page 66 of SF manual 12/16/09)	NY TRM
Primary School	300	0.6 GPD per student	500 students; reduce days per year to reflect school calendar	NY TRM
Small Office	100	1.0 GPD per person	100 people	NY TRM
Small Retail	50		Half of Big Box	Staff estimate
Auto repair	29		1-person household	Staff estimate
Community College	1,440		Assume like Secondary School	Staff estimate
Dormitory	14,700		Single-person household – 500 students	Staff estimate
Heavy Industrial	1,250	25 GPD per person per shift	Water not HOT water; assume 50% hot water, 100 people per day	http://www.p2pays.org/ref/42/41980.pdf
Hotel	9,000		75% of hotel	Staff estimate
Industrial Refrigeration	29		Assume like Auto Repair	Staff estimate
Motel	4,500		Assume half of Hotel – laundry done on site	Staff estimate
Multi Story Retail	75		150% of Small Retail	Staff estimate
Religious	150		Assume like Assembly	Staff estimate
Secondary School	1,440	1.8 GPD per student	800 students; reduce days per year to reflect school calendar	NY TRM
University	3,450	69 GPD per student	Water not HOT water; assume 10% hot water, 500 students	http://www.p2pays.org/ref/42/41980.pdf
Warehouse	100		Assume like Small Office	Staff estimate

Tankless Water Heaters (Time of Sale, Retrofit – Early Replacement)

	Measure Details
Official Measure Code	CI-SHW-TanklessWH-1
Measure Unit	Per water heater
Measure Category	Domestic Hot Water
Sector(s)	Commercial
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	20
Incremental Cost	$871.47
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a natural gas-fired tankless or instantaneous water heater. Tankless water heaters essentially function like regular water heaters without the storage tank. When there is demand for hot water, the natural gas burner fires and heats water as it passes through the heater to the demand source. Because the water heater must heat water at the rate of flow through the device, tankless water heaters are not well suited to serve sources of significant demand. Tankless water heaters achieve savings by eliminating the standby losses that occur from stand-alone or tank-type water heaters.

Definition of Efficient Equipment

The efficient condition is a tankless natural gas-fired water heater exceeding the efficiency requirements as mandated by the 2006 International Energy Conservation Code, Table 504.2.

Definition of Baseline Equipment

The baseline condition is a natural gas-fired tank-type water heater meeting the efficiency requirements as mandated by the 2006 International Energy Conservation Code, Table 504.2.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 20 years.[265]

---

[265] CenterPoint Energy. *Triennial CIP/DSM Plan 2010-2012 Report.*

Deemed Measure Cost

The deemed measure cost for full installation is $871.74.[266] The incremental material cost is $433.72.

Deemed O&M Cost Adjustments

The expected O&M cost adjustment for this measure is $9.60.[267]

Savings Algorithm

Energy Savings

There are no expected energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \frac{GPD * 365 * 8.3 * (T_{OUT} - T_{IN})}{1{,}000{,}000} * \left(\frac{1}{\eta_{BASE}} - \frac{1}{\eta_{EE}}\right) + \frac{8{,}760 * STBY_{BASE}}{1{,}000{,}000}$$

Where:

GPD	=	Water use for equipment in gallons per day (= see table in Reference Table section)
365	=	Days of water heater operation per year
8.3	=	Specific weight of water (8.3 lbs/gal) multiplied by the specific heat of water ($1.0\,\frac{Btu}{lb*°F}$)
T_{OUT}	=	Water heater set point (= actual; otherwise assume 130°F)[268]
T_{IN}	=	Cold water temperature entering the DWH system (= depending on climate; see table below)

[266] California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Cost Values and Summary Documentation." December 16, 2008.

[267] CenterPoint Energy. *Triennial CIP/DSM Plan 2010-2012 Report.*

[268] National Association of Home Builders Research Center. *Performance Comparison of Residential Hot Water Systems.* Prepared for the National Renewable Energy Laboratory. 2002.

Groundwater Temperature (T_{IN}) by Location*

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Ft Wayne	55.6

* Burch, J. and C. Christensen, National Renewable Energy Laboratory. *Towards Development of an Algorithm for Mains Water Temperature.* 2007. American Solar Energy Society, Colorado.

η_{BASE} = Rated efficiency (%) of baseline water heater expressed as energy factor or thermal efficiency (= see table below)

Efficiency of Baseline Water Heater by Size*

Equipment Type	Size Category (Input)	η_{BASE}	$STBY_{BASE}$
Storage water heaters, natural gas	≤ 155,000 Btu/h	0.80	$(Q/800) + 110V^{1/2}$
	> 155,000 Btu/h	0.80	$(Q/800) + 110V^{1/2}$

* Minimum federal standard for capacity range. 2015 Federal Energy Conservation Standard for electric water heaters (e-CFR Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32)

V = Rated tank volume in gallons (= actual)

Q = Nameplate input rate in Btu/hr (= actual)

η_{EE} = Rated efficiency (%) of efficient water heater expressed as energy factor or thermal efficiency (= actual)

8,760 = Hours of standby loss per year

$STBY_{BASE}$ = Standby losses of baseline water heater in Btu/hr (= see table above)

1,000,000= Conversion factor from Btu to MMBtu

Reference Table

Rated Efficiency of Baseline Water Heater by Building Type

Building Type	GPD	Rate	Notes	Source
Assembly	150	5 per seat	Water not HOT water; assume 10% hot water, 300 seats	http://www.p2pays.org/ref/42/41980.pdf
Big Box	100		Assume like Small Office	Staff estimate
Fast Food	630	0.7 GPD per meal	50 meals per hour, 18 hours per day	NY TRM
Full Service Restaurant	1,152	2.4 GPD per meal	40 meals per hour, 18 hours per day	NY TRM
Grocery	200		Assume 2x Big Box	Staff estimate

Building Type	GPD	Rate	Notes	Source
Hospital	12,000	300 GDP per bed	Water not HOT water; assume 50% hot water, 80 beds	http://www.p2pays.org/ref/42/41980.pdf
Large Office	500	1.0 GPD per person	Assume 500 people	NY TRM
Light Industrial	1,250	25 GPD per person per shift	Water not HOT water; assume 50% hot water, 100 people per day	http://www.p2pays.org/ref/42/41980.pdf
Multifamily High-Rise	920	46 GPD per unit	20 units (2 people per unit, refer to table on page 66 of SF manual 12/16/09)	NY TRM
Multifamily Low-Rise	276	46 GPD per unit	6 units (2 people per unit, refer to table on page 66 of SF manual 12/16/09)	NY TRM
Primary School	300	0.6 GPD per student	500 students; reduce days per year to reflect school calendar	NY TRM
Small Office	100	1.0 GPD per person	100 people	NY TRM
Small Retail	50		Half of Big Box	Staff estimate
Auto repair	29		1-person household	Staff estimate
Community College	1,440		Assume like Secondary School	Staff estimate
Dormitory	14,700		Single-person household – 500 students	Staff estimate
Heavy Industrial	1,250	25 GPD per person per shift	Water not HOT water; assume 50% hot water, 100 people per day	http://www.p2pays.org/ref/42/41980.pdf
Hotel	9,000		75% of hotel	Staff estimate
Industrial Refrigeration	29		Assume like Auto Repair	Staff estimate
Motel	4,500		Assume half of Hotel – laundry done on site	Staff estimate
Multi Story Retail	75		150% of Small Retail	Staff estimate
Religious	150		Assume like Assembly	Staff estimate
Secondary School	1,440	1.8 GPD per student	800 students; reduce days per year to reflect school calendar	NY TRM
University	3,450	69 GPD per student	Water not HOT water; assume 10% hot water, 500 students	http://www.p2pays.org/ref/42/41980.pdf
Warehouse	100		Assume like Small Office	Staff estimate

Food Service

Spray Nozzles for Food Service (Retrofit)

	Measure Details
Official Measure Code	CI-SHW-PRSV-1
Measure Unit	Per nozzle
Measure Category	Food Service
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	Varies by project
Effective Useful Life (years)	5
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Pre-rinse valves use a spray of water to remove food waste from dishes prior to cleaning in a dishwasher. They reduce water consumption, water heating cost, and waste water (sewer) charges. Pre-rinse spray valves include a nozzle, squeeze lever, and dish guard bumper. The spray valves usually have a clip to lock the handle in the "on" position, and are inexpensive and easily interchangeable with different manufacturers' assemblies. The primary impacts of this measure will be water savings. Energy savings depend on the type of water heating fuel; if the facility does not have electric water heating, there are no electric savings for this measure; if the facility does not have fossil fuel water heating, there are no MMBtu savings for this measure.

Definition of Efficient Equipment

The efficient equipment is a pre-rinse spray valve with a flow rate of 1.6 gallons per minute, and with a rate of cleaning performance of 26 seconds per plate or less.

Definition of Baseline Equipment

The baseline equipment is a spray valve with a flow rate of 3 gallons per minute.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 5 years.[269]

Deemed Measure Cost

The actual measure installation cost should be used (including material and labor).

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

If water heating is electric-based:

$$\Delta kWh = \Delta Water * HOT_{\%} * 8.3 * (\mathrm{T}_{OUT} - \mathrm{T}_{IN}) * \frac{1}{EFF_E * 3{,}412}$$

Where:

ΔWater	=	Water savings in gallons (= see calculation in Water Impact Descriptions and Calculation section)
$HOT_{\%}$	=	Percentage of water used by pre-rinse spray valve that is heated (= 69%)[270]
8.3	=	Specific weight of water (8.3 lbs/gal) multiplied by the specific heat of water ($1.0 \frac{Btu}{lb*°F}$)
T_{OUT}	=	Water heater set point (= actual; otherwise assume 130°F)[271]
T_{IN}	=	Cold water temperature entering the DWH system (= depending on climate; see table below)

[269] Federal Energy Management Program. *How to Buy a Low-Flow Pre-Rinse Spray Valve*. 2004. Used common assumption across efficiency programs.

[270] Navigant Consulting. *Measures and Assumptions for DSM Planning.* Prepared for the Ontario Energy Board. 2009. This factor is a candidate for future improvement through evaluation.

[271] National Association of Home Builders Research Center. *Performance Comparison of Residential Hot Water Systems.* Prepared for the National Renewable Energy Laboratory. 2002.

Groundwater Temperature (T_{IN}) by Location*

City	Groundwater Temperature (°F)
Indianapolis	58.1
South Bend	57.4
Terre Haute	60.5
Evansville	62.8
Ft Wayne	55.6

* Burch, J. and C. Christensen, National Renewable Energy Laboratory. *Towards Development of an Algorithm for Mains Water Temperature.* 2007. American Solar Energy Society, Colorado.

EFF_E = Water heater thermal efficiency (= 0.97)[272]

3,412 = Factor to convert from Btu to kWh

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure since there is insufficient peak coincident data.

Fossil Fuel Impact Descriptions and Calculation

If water heating is fossil fuel-based:

$$\Delta \text{MMBtu} = \Delta Water * HOT_{\%} * 8.33 * (\text{T}_{OUT} - \text{T}_{IN}) * \frac{1}{EFF_G} * 10^{-6}$$

Where:

ΔWater = Water savings in gallons (= see calculation in Water Impact Descriptions and Calculation section)

$HOT_{\%}$ = Percentage of water used by pre-rinse spray valve that is heated (= 69%)

EFF_G = Water heater thermal efficiency (= 0.58)[273]

10^{-6} = Factor to convert Btu to MMBtu

Water Impact Descriptions and Calculation

$$\Delta \text{Water} = (FLO_{BASE} - FLO_{EFF}) * 60 * \text{H} * 365$$

272 ASHRAE 90.1-2007. Performance requirement for electric resistance water heaters.

273 This is the baseline natural gas water heater thermal efficiency submitted in the natural gas utilities' 2009 proposed predetermined values and protocols to the Ohio Public Utility Commission (case no. 09-512-GE-UNC).

Where:

FLO_{BASE} = Flow rate of baseline spray nozzle (= 3 gallons per minute)

FLO_{EFF} = Flow rate of efficient equipment (= 1.6 gallons per minute)

60 = Minutes per hour

365 = Days per year

H = Hours used per day (= depending on facility type; see table below)

Hours per Day by Facility Type*

Facility Type	Hours of Pre-Rinse Spray Valve Use per Day
Full Service Restaurant	4
Other	2
Limited Service (Fast Food) Restaurant	1

* Pacific Gas & Electric savings estimates, algorithms, and sources from 2005.

ENERGY STAR Hot Food Holding Cabinet (Time of Sale)

	Measure Details
Official Measure Code	CI-Food-HoldCab-1
Measure Unit	Per cabinet
Measure Category	Food Services
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by size
Peak Demand Reduction (kW)	Varies by size
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by size
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	$1,110.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Commercial insulated hot food holding cabinet models that meet program requirements incorporate better insulation reduced heat loss, and may offer additional energy-saving devices such as magnetic door electric gaskets, auto-door closures, or Dutch doors. The insulation of the cabinet also offers better temperature uniformity within the cabinet from top to bottom. This means that qualified hot food holding cabinets are more efficient at maintaining food temperature while using less energy.

Definition of Efficient Equipment

The efficient equipment is an ENERGY STAR-qualified hot food holding cabinet with an idle energy rate of 0.04 kW per cubic foot.

Definition of Baseline Equipment

The baseline equipment is a standard hot food holding cabinet with an idle energy rate of 0.1 kW per cubic foot.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 12 years.[274]

274 Food Service Technology Center. Default value from life cycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/holdcabcalc.php

Deemed Measure Cost

The incremental cost for ENERGY STAR hot food holding cabinet is $1,110.00.[275]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \mathrm{kWh} = \frac{W_{FOOT\ BASE} - W_{FOOT\ EFF}}{1{,}000} * V * HOURS$$

Where:

$W_{FOOT\ BASE}$ = Electrical demand per cubic foot of baseline equipment (= use table below)

$W_{FOOT\ EFF}$ = Electrical demand per cubic foot of efficient equipment (= actual; otherwise, use table below)[276]

1,000 = Conversion from watts to kW

V = Internal volume of the holding cabinet in cubic feet (= actual)

HOURS = Annual operating hours (= 5,475)[277]

Parameters Based on Cabinet Size

Parameter	Small	Medium	Large
V	V < 13	13 ≤ V < 28	28 ≤ V
$W_{FOOT\ BASE}$	40	40	40
$W_{FOOT\ EFF}$	21.5 * V	(2 * V) + 254	(3.8 * V) + 203.5

* Food Service Technology Center. Default value from life cycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/holdcabcalc.php

275 New York State Energy Research and Development Authority. *Deemed Savings Database.*

276 ENERGY STAR requirements: http://www.energystar.gov/index.cfm?c=hfhc.pr_crit_hfhc

277 Food Service Technology Center. Based on assumption that restaurant is open 15 hours a day, 365 days a year.

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{W_{FOOT\ BASE} - W_{FOOT\ EFF}}{1{,}000} * VOLUME * CF$$

Where:

CF = Summer peak coincidence factor (= 0.84)[278]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

278 RLW Analytics. *Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures.* Spring 2007.

Steam Cookers (Time of Sale)

	Measure Details
Official Measure Code	CI-Food-StmCook-1
Measure Unit	Per steam cooker
Measure Category	Food Services
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by pan quantity
Peak Demand Reduction (kW)	Varies by pan quantity
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by pan quantity
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	Varies by pan quantity
Effective Useful Life (years)	12
Incremental Cost	$3,500.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Energy-efficient steam cookers that have earned the ENERGY STAR designation offer shorter cook times, higher production rates, and reduced heat loss due to better insulation and a more efficient steam delivery system. Energy usage calculations are based on 12 hours a day, 365 days per year, with one preheat and cooking 100 pounds of food per day.

Definition of Efficient Equipment

The efficient condition is installing an ENERGY STAR-qualified steam cooker.

Definition of Baseline Equipment

The baseline condition is a conventional boiler-style steam cooker meeting minimum federal standards for electricity and water consumption.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 12 years.[279]

[279] Food Service Technology Center. Default value from life cycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/esteamercalc.php

Deemed Measure Cost

The incremental cost of an ENERGY STAR steam cooker is $3,500.00.[280]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = kWh_{BASE} - kWh_{EFF}$$

$$kWh_{BASE} = \left(\frac{LB*E_{FOOD}}{EFF} + IDLE*\left(HOURS_{DAY} - \frac{LB}{PC} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY}\right)*DAYS$$

$$kWh_{EFF} = \left(\frac{LB*E_{FOOD}}{EFF} + IDLE*\left(HOURS_{DAY} - \frac{LB}{PC} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY}\right)*DAYS$$

Where:

kWh_{BASE} = Annual energy usage of baseline equipment

kWh_{EFF} = Annual energy usage of efficient equipment

$HOURS_{DAY}$ = Daily operating hours (= 12)[281]

PRE_{TIME} = Preheat time for a steamer to reach operating temperature when turned on (= 15 minutes/day)[282]

PRE_{ENERGY} = Preheat energy (= 1.5 kWh/day)[283]

E_{FOOD} = American Society for Testing Materials (ASTM) Energy to Food; the amount of energy absorbed by the food during cooking (= 0.0308 kWh/lb)

DAYS = Operating days per year (= 365)

The following variables are dependent on the pan capacity of efficient equipment, which is site specific (see table below).

EFF = Heavy load cooking energy efficiency percentage

IDLE = Idle energy rate

---

280 Average of New York State Energy Research and Development Authority *Deemed Savings Database* and ENERGY STAR website.

281 Food Service Technology Center. Based on assumption that restaurant is open 12 hours a day, 365 days a year.

282 Food Service Technology Center. *Commercial Cooking Appliance Technology Assessment.* Chapter 8: Steamers. 2002.

283 Ibid.

PC = Production capacity (lbs/hr)

LB = Pounds of food cooked per day (lbs/day)

Parameters that Vary by Number of Pans*

Number of Pans	Parameter	Baseline Model	Efficient Model
3	Idle Energy Rate (kW)*	1	0.24
	Production Capacity (lb/hr)	70	50
	Pounds of Food Cooked per Day	100	100
	Heavy Load Cooking Energy Efficiency**	20%	59%
4	Idle Energy Rate (kW)	1.325	0.27
	Production Capacity (lb/hr)	87	67
	Pounds of Food Cooked per Day	128	128
	Heavy Load Cooking Energy Efficiency**	20%	52%
5	Idle Energy Rate (kW)	1.675	0.24
	Production Capacity (lb/hr)	103	83
	Pounds of Food Cooked per Day	160	160
	Heavy Load Cooking Energy Efficiency**	20%	62%
6	Idle Energy Rate (kW)	2	0.31
	Production Capacity (lb/hr)	120	100
	Pounds of Food Cooked per Day	192	192
	Heavy Load Cooking Energy Efficiency**	20%	62%

* Values for ASTM parameters for baseline and efficient conditions (unless otherwise noted) were determined by FSTC according to ASTM F1484, the Standard Test Method for Performance of Steam Cookers. These parameters include the three of the four listed in the table below: Idle Energy Rate, Production Capacity, and Heavy Load Cooking Efficiency.

** Efficient values calculated from a list of ENERGY STAR qualified products. See “ES Steam Cooker Analysis.xls” for details.

Summary Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{HOURS} * CF$$

Where:

ΔkWh = Annual energy savings

HOURS = Equivalent full load hours (= 4,380)

CF = Summer peak coincidence factor (= 0.84)[284]

[284] RLW Analytics. *Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures*. Spring 2007.

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

Water Impact Descriptions and Calculation

$$\Delta\text{Water} = (Rate_{BASE} - Rate_{EFF}) * EFLH = 30 * \text{EFLH}$$

Where:

ΔWater	=	Annual water savings in gallons
$Rate_{BASE}$	=	Water consumption rate of baseline equipment (= 40 gal/hr)[285]
$Rate_{EFF}$	=	Water consumption rate of efficient equipment (= 10 gal/hr)[286]
EFLH	=	Equivalent full load hours (= 4,380)

---

[285] Food Service Technology Center. *Commercial Cooking Appliance Technology Assessment.* Chapter 8: Steamers. 2002.

[286] Ibid.

ENERGY STAR Fryers (Time of Sale)

	Measure Details
Official Measure Code	CI-Food-Fryer-1
Measure Unit	Per fryer
Measure Category	Food Service
Sector(s)	Commercial
Annual Energy Savings (kWh)	983
Peak Demand Reduction (kW)	0.22
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	11,796
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	$500.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Commercial fryers that have earned the ENERGY STAR designation offer shorter cook times and higher production rates through advanced burner and heat exchanger designs. Fry pot insulation reduces standby losses, resulting in a lower idle energy rate. ENERGY STAR fryers are up to 30% more efficient than standard models. Energy savings estimates are based on a 15-inch fryer.

Definition of Efficient Equipment

The efficient equipment is an ENERGY STAR-qualified electric fryer.

Definition of Baseline Equipment

The baseline equipment is a standard electric fryer with a heavy load efficiency of 75%.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 12 years.[287]

Deemed Measure Cost

The incremental cost for commercial combination ovens is $500.00.[288]

[287] Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/efryer.php

[288] New York State Energy Research and Development Authority. *Deemed Savings Database*.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = kWh_{BASE} - kWh_{EFF}$$

$$\text{kWh}_{\text{BASE}} = \left(\frac{LB*E_{FOOD}}{EFF} + \frac{IDLE}{1{,}000} * \left(HOURS_{DAY} - \frac{LB}{PC} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY}\right) * DAYS$$

$$\text{kWh}_{\text{EFF}} = \left(\frac{LB*E_{FOOD}}{EFF} + \frac{IDLE}{1{,}000} * \left(HOURS_{DAY} - \frac{LB}{PC} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY}\right) * DAYS$$

Where:

kWh_{BASE}	=	Annual energy usage of baseline equipment
kWh_{EFF}	=	Annual energy usage of efficient equipment
$HOURS_{DAY}$	=	Daily operating hours (= 16)[289]
PRE_{TIME}	=	Preheat time for a fryer to reach operating temperature when turned on (= 15 min/day)[290]
E_{FOOD}	=	ASTM Energy to Food; the amount of energy absorbed by the food during cooking (= 0.167 kWh/lb)[291]
LB	=	Pounds of food cooked per day (= 150 lbs/day)[292]
DAYS	=	Days of operation in year (= 365)
EFF	=	Heavy load cooking energy efficiency
IDLE	=	Idle energy rate (kW)
PC	=	Production capacity (lbs/hr)
PRE_{ENERGY}	=	Preheat energy kilowatt-hours per day (= see table below)

289 Food Service Technology Center. Based on assumption that restaurant is open 16 hours a day, 365 days a year.

290 Food Service Technology Center. *Commercial Cooking Appliance Technology Assessment.* Chapter 7: Fryers. 2002.

291 American Society for Testing and Materials. *Industry Standard for Commercial Ovens.*

292 Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php

Performance Metrics: Baseline and Efficient Values

Metric	Baseline Model*	Energy Efficient Model**
PRE_{ENERGY}	2.3	1.7
IDLE	1.05	0.84
EFF	75%	84%
PC	65	70

* Food Service Technology Center. Default value from life cycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php
** For calculation, use actual values for these metrics if available. Table is populated with efficient values that reflect averages from a list of qualifying models found on the ENERGY STAR website.

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{HOURS} * CF$$

Where:

ΔkWh = Annual energy savings

HOURS = Equivalent full load hours (= 5,840)

CF = Summer peak coincidence factor (= 0.84)[293]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

[293] RLW Analytics. *Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures*. Spring 2007.

ENERGY STAR Combination Oven (Time of Sale)

	Measure Details
Official Measure Code	CI-Food-CombiOven-1
Measure Unit	Per oven
Measure Category	Food Services
Sector(s)	Commercial
Annual Energy Savings (kWh)	18,432
Peak Demand Reduction (kW)	3.53
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	221,184
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	87,600 gallons per year
Effective Useful Life (years)	12
Incremental Cost	$2,125.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

A combination oven is a convection oven that includes the added capability to inject steam into the oven cavity, and which typically offers at least three distinct cooking modes.

Definition of Efficient Equipment

The efficient equipment is an electric combination oven with a heavy load cooking energy efficiency of at least 60%.

Definition of Baseline Equipment

The baseline equipment is a typical low-efficiency oven with a heavy load efficiency of 44%.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 12 years.[294]

Deemed Measure Cost

The incremental cost for commercial combination ovens is $2,125.00.[295]

---

294 Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php

295 New York State Energy Research and Development Authority. *Deemed Savings Database*.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = kWh_{BASE} - kWh_{EFF}$$

$$\text{kWh}_{\text{BASE}} = \left(\frac{LB * E_{FOOD}}{EFF} + IDLE * \left(HOURS_{DAY} - \frac{LB}{PC} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY}\right) * DAYS$$

$$\text{kWh}_{\text{EFF}} = \left(\frac{LB * E_{FOOD}}{EFF} + IDLE * \left(HOURS_{DAY} - \frac{LB}{PC} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY}\right) * DAYS$$

Where:

kWh_{BASE}	=	Annual energy usage of baseline equipment
kWh_{EFF}	=	Annual energy usage of efficient equipment
$HOURS_{DAY}$	=	Daily operating hours (= 12)[296]
DAYS	=	Days per year of operation (= 365)
PRE_{TIME}	=	Preheat time for a steamer to reach operating temperature when turned on (= 15 min/day)[297]
E_{FOOD}	=	ASTM Energy to Food; the amount of energy absorbed by the food during cooking (= 0.0732 kWh/lb)[298]
LB	=	Pounds of food cooked per day (= 200)[299]
EFF	=	Heavy load cooking energy efficiency
IDLE	=	Idle energy rate (kW))
PC	=	Production capacity (lb/hr)
PRE_{ENERGY}	=	Preheat energy kilowatt-hours per day (= see table below)

---

296 Food Service Technology Center. Based on assumption that restaurant is open 12 hours a day, 365 days a year.

297 Food Service Technology Center. *Commercial Cooking Appliance Technology Assessment.* Chapter 7: Ovens. 2002.

298 American Society for Testing and Materials. *Industry Standard for Commercial Ovens.*

299 Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php

Performance Metrics: Baseline and Efficient Values*

Metric	Baseline Model	Energy-Efficient Model
PRE_{ENERGY} (kWh)	3	1.5
IDLE (kW)	7.5	3
EFF	44%	60%
PC (lb/hr)	80	100

* Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{HOURS} * CF$$

Where:

ΔkWh = Annual energy savings

HOURS = Equivalent full load hours (= 4,380)

CF = Summer peak coincidence factor (= 0.84)[300]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

Water Impact Descriptions and Calculation

The water savings for commercial combination ovens are 87,600 gallons per year.[301]

300 RLW Analytics. *Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures*. Spring 2007.

301 Food Service Technology Center. Based on assumption that baseline ovens use water at an average rate of 40 gallons per hour while efficient models use water at an average rate of 20 gallons per hour.

ENERGY STAR Convection Oven (Time of Sale)

	Measure Details
Official Measure Code	CI-Food-ConvOven-1
Measure Unit	Per oven
Measure Category	Food Service
Sector(s)	Commercial
Annual Energy Savings (kWh)	3,235
Peak Demand Reduction (kW)	0.62
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	38,820
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	$1,113.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Commercial convection ovens that are ENERGY STAR-certified have higher heavy load cooking efficiencies and lower idle energy rates, making them an average of 20% more efficient than standard models. Energy savings estimates are for ovens using full size (18-inch x 36-inch) sheet pans.

Definition of Efficient Equipment

The efficient equipment is an ENERGY STAR-qualified electric convection oven.

Definition of Baseline Equipment

The baseline equipment is a standard convection oven with a heavy load efficiency of 65%.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 12 years.[302]

Deemed Measure Cost

The incremental cost for commercial convection ovens is $1,113.00.[303]

[302] Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php

[303] New York State Energy Research and Development Authority. *Deemed Savings Database.*

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = kWh_{BASE} - kWh_{EFF}$$

$$kWh_{BASE} = \left(\frac{LB * E_{FOOD}}{EFF} + \frac{IDLE}{1{,}000} * \left(HOURS_{DAY} - \frac{LB}{PC} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY}\right) * DAYS$$

$$kWh_{EFF} = \left(\frac{LB * E_{FOOD}}{EFF} + \frac{IDLE}{1{,}000} * \left(HOURS_{DAY} - \frac{LB}{PC} - \frac{PRE_{TIME}}{60}\right) + PRE_{ENERGY}\right) * DAYS$$

Where:

kWh_{BASE}	=	Annual energy usage of baseline equipment
kWh_{EFF}	=	Annual energy usage of efficient equipment
$HOURS_{DAY}$	=	Daily operating hours (= 12)[304]
DAYS	=	Days per year of operation (= 365)
PRE_{TIME}	=	Preheat time for a steamer to reach operating temperature when turned on (= 15 min/day)[305]
E_{FOOD}	=	ASTM Energy to Food; the amount of energy absorbed by the food during cooking (= 0.0732 kWh/lb)[306]
LB	=	Pounds of food cooked (= 100 lb/day)[307]
EFF	=	Heavy load cooking energy efficiency percentage (= see table below)
IDLE	=	Idle energy rate (= see table below)
PC	=	Production capacity in pounds per hour (= see table below)
PRE_{ENERGY}	=	Preheat energy in kilowatt-hours per day (= see table below)

304 Food Service Technology Center. Based on assumption that restaurant is open 12 hours a day, 365 days a year.

305 Food Service Technology Center. *Commercial Cooking Appliance Technology Assessment*. Chapter 7: Ovens. 2002.

306 American Society for Testing and Materials. *Industry Standard for Commercial Ovens*.

307 Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php

Performance Metrics: Baseline and Efficient Values*

Metric	Baseline Model	Energy-Efficient Model
PRE_{ENERGY} (kWh)	1.5	1
IDLE (kW)	2	1.3**
EFF	65%	74%**
PC (lb/hr)	70	80

* Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php

** For calculation, use actual values for these metrics, if available. Table is populated with efficient values which reflect averages from a list of qualifying models found on the ENERGY STAR website.

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{HOURS} * CF$$

Where:

ΔkWh = Annual energy savings

HOURS = Equivalent full load hours (= 4,380)

CF = Summer peak coincidence factor (= 0.84)[308]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

308 RLW Analytics. *Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures*. Spring 2007.

ENERGY STAR Griddle (Time of Sale)

	Measure Details
Official Measure Code	CI-Food-Griddle-1
Measure Unit	Per griddle
Measure Category	Food Service
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	
Lifetime Fossil Fuel Savings (MMBtu)	
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	$2,090.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

ENERGY STAR-qualified commercial griddles have higher cooking energy efficiency and lower idle energy rates than standard equipment. This results in more energy being absorbed by the food compared with the total energy use, and less wasted energy when the griddle is in standby mode.

Definition of Efficient Equipment

The efficient equipment is an ENERGY STAR-qualified griddle with a cooking energy efficiency greater than 70%.

Definition of Baseline Equipment

The baseline equipment is a conventional electric griddle with a cooking energy efficiency of 60%.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 12 years.[309]

Deemed Measure Cost

The incremental cost of an ENERGY STAR griddle is $2,090.00.[310]

---

[309] Food Service Technology Center. Default value from lifecycle cost calculator. Available online: http://www.fishnick.com/saveenergy/tools/calculators/egridcalc.php

[310] New York State Energy Research and Development Agency. *Deemed Savings Database, Rev. 12*. 2008.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = kWh_{BASE} - kWh_{EE}$$

$$kWh_{BASE} = \left(\frac{LB * E_{FOOD}}{\eta_{BASE}} + \mathrm{IE}_{BASE} * \left(H - \frac{LB}{PC_{BASE}} - \frac{T_P}{60}\right) + E_{P,BASE}\right) * DAYS$$

$$kWh_{EFF} = \left(\frac{LB * E_{FOOD}}{\eta_{EFF}} + \mathrm{IE}_{EFF} * \left(H - \frac{LB}{PC_{EFF}} - \frac{T_{PRE}}{60}\right) + E_{P,EFF}\right) * DAYS$$

Where:

kWh_{BASE}	=	Annual energy usage of baseline equipment
kWh_{EFF}	=	Annual energy usage of efficient equipment
LB	=	Pounds of food cooked per day (= actual; otherwise = 100)
E_{FOOD}	=	ASTM Energy to Food; the amount of energy absorbed by the food during cooking (= 0.139 kWh/lb)[311]
η_{BASE}	=	Heavy load cooking energy efficiency of baseline griddle (= see table below)
IE_{BASE}	=	Idle energy rate of baseline griddle (= see table below)
H	=	Daily operating hours (= actual; otherwise = 12)[312]
PC_{BASE}	=	Production capacity of baseline griddle (= see table below)
T_P	=	Preheat time for a steamer to reach operating temperature when turned on (= actual; otherwise 15 min/day)[313]
60	=	Minutes per hour
$E_{P,BASE}$	=	Preheat energy per day for baseline griddle (= see table below)
DAYS	=	Operating days per year (= actual; otherwise = 365)
η_{EFF}	=	Heavy load cooking energy efficiency of efficient griddle (= actual, otherwise, see table below)

311 American Society for Testing and Materials. Industry Standard.

312 Food Service Technology Center. Based on assumption that restaurant is open 12 hours a day, 365 days a year.

313 Food Service Technology Center. *Commercial Cooking Appliance Technology Assessment*. Chapter 3: Griddles. 2002.

IE_{EFF} = Idle energy rate of efficient griddle (= see table below)

PC_{EFF} = Production capacity of efficient griddle (= see table below)

$E_{P,EFF}$ = Preheat energy per day for efficient griddle (= see table below)

Efficient Griddle Performance Metrics: Baseline and Efficient Values*

Parameter	Baseline Model	Efficient Model
η (%)	60%	75%
IE (kW)	2.4	0.05
PC (lb/hr)	35	51
E_{PRE} (kWh/day)	4	2

* An average pan width of 3 feet has been assumed based on a survey of available equipment. Baseline values based on assumptions from FSTC lifecycle cost calculator. Efficient values reflect averages from a list of qualifying models found on the ENERGY STAR website (accessed June 2015).

Summary Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{HOURS} * CF$$

Where:

ΔkWh = Annual energy savings

HOURS = Annual operating hours (= 4,380)

CF = Summer peak coincidence factor (= 0.84)[314]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

314 Verification of summer peak coincidence factor is pending further information from the utilities.

HVAC

Electric Chiller (Time of Sale)

	Measure Details
Official Measure Code	CI-HVAC-chiller-1
Measure Unit	Per chiller
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by equipment type and location
Peak Demand Reduction (kW)	Varies by equipment type and location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by equipment type and location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	20
Incremental Cost	Varies by equipment type and location
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure relates to the installation of a new electric chiller meeting the efficiency standards presented below. This measure could relate to replacing an existing unit at the end of its useful life, or installing a new system in an existing building (i.e., time of sale). Only single-chiller applications should be assessed with this methodology. Multiple chiller projects should be evaluated on a custom basis.

Definition of Efficient Equipment

The efficient equipment is assumed to exceed the efficiency requirements of ASHRAE Standard 90.1-2007 Table 6.8.1.

Definition of Baseline Equipment

The baseline equipment is assumed to meet the efficiency requirements of the ASHRAE Standard 90.1-2007 Table 6.8.1.

Deemed Lifetime of Efficient Equipment

The expected measure life is 20 years.[315]

[315] California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05.* Effective/Remaining Useful Life Values. December 16, 2008. Available online: http://deeresources.com/deer0911planning/downloads/EUL_Summary_10-1-08.xls

Deemed Measure Cost

The incremental capital cost for this measure is provided below.

Incremental Capital Cost by Equipment Type

Equipment Type	Size Category	IPLV	COP	Incremental Cost ($/ton)
Air-Cooled Electrically Operated	All Capacities	3.36	3.08	$58.58
		3.66	3.36	$106.23
Water-Cooled Screw Chiller	<150 Ton	5.58	4.95	$55.63
		6.28	5.58	$111.25
	150 - 300 Ton	6.17	5.41	$39.76
		6.89	6.17	$79.52
	>300 Ton	6.89	6.06	$27.94
		7.64	6.89	$55.87
Water-Cooled Centrifugal Chiller	<150 Ton	5.86	5.58	$83.05
		6.63	6.28	$166.10
	150 - 300 Ton	6.51	6.17	$61.44
		7.33	6.89	$122.87
	>300 Ton	7.18	6.76	$46.11
		7.99	7.64	$92.22

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = TONS * \left(\frac{3.516}{IPLV_{BASE}} - \frac{3.516}{IPLV_{EE}}\right) * EFLH$$

Where:

TONS = Chiller nominal cooling capacity in tons (= actual; 1 ton = 12,000 Btu/hr)

3.516 = Conversion factor to express integrated part load value in kW per ton

$IPLV_{BASE}$ = Efficiency of baseline equipment expressed as integrated part load value (= dependent on chiller type; see table below)

Baseline Efficiency Values by Chiller Type and Capacity

Equipment Type	Size Category	Baseline Efficiency ($IPLV_{BASE}$, COP_{BASE})
Air cooled, with condenser, electrically operated	All capacities	3.05 IPLV, 2.80 COP
Air cooled, without condenser, electrically operated	All capacities	3.45 IPLV, 3.10 COP
Water cooled, electrically operated, positive displacement (reciprocating)	All capacities	5.05 IPLV, 4.20 COP
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	< 150 tons	5.20 IPLV, 4.45 COP
	≥ 150 tons and < 300 tons	5.60 IPLV, 4.90 COP
	≥ 300 tons	6.15 IPLV, 5.50 COP
Water cooled, electrically operated, centrifugal	< 150 tons	5.25 IPLV, 5.00 COP
	≥ 150 tons and < 300 tons	5.90 IPLV, 5.55 COP
	≥ 300 tons	6.40 IPLV, 6.10 COP

Source: ASHRAE 90.1-2007 Table 6.8.1B.

$IPLV_{EE}$ = Efficiency of high-efficiency equipment expressed as integrated part load value (= actual)[316]

EFLH = Equivalent full load hours (= dependent on location and building type, see table below)

Equivalent Full Load Hours by Building Type and Location

Building	System	Indianapolis	South Bend	Evansville	Ft. Wayne	Terre Haute
Community College	Constant Volume No Economizer	1,314	1,090	1,632	1,124	1,320
	Constant Volume Economizer	966	840	1,167	821	955
	Variable Air Volume Economizer	736	621	881	642	680
Hotel	Constant Volume No Economizer	3,999	3,766	4,424	3,999	4,240
	Constant Volume Economizer	3,786	3,541	4,238	3,786	4,034
	Variable Air Volume Economizer	3,732	3,480	4,161	3,732	3,899
Large Retail	Constant Volume No Economizer	2,065	1,899	2,243	2,006	2,164
	Constant Volume Economizer	1,289	1,118	1,545	1,183	1,405
	Variable Air Volume Economizer	1,065	904	1,297	969	1,196
University	Constant Volume No Economizer	1,927	1,805	2,140	1,958	1,833
	Constant Volume Economizer	727	739	917	754	682
	Variable Air Volume Economizer	950	927	1,157	884	795

316 Integrated Part Load Value is simply a seasonal average efficiency rating calculated in accordance with ARI Standard 550/590. It may be calculated using any measure of efficiency (EER, kW/ton, COP), but for consistency with IECC 2006, it is expressed in terms of COP here.

Building	System	Indianapolis	South Bend	Evansville	Ft. Wayne	Terre Haute
Large Office	Constant Volume No Economizer	3,302	2,786	3,300	3,107	3,197
	Constant Volume Economizer	876	897	1,118	916	981
	Variable Air Volume Economizer	992	864	1,042	801	999
High School	Constant Volume No Economizer	1,039	1,003	1,125	995	979
	Constant Volume Economizer	558	519	696	513	570
	Variable Air Volume Economizer	426	359	505	397	383
Hospital	Constant Volume No Economizer	3,777	3,199	4,267	3,538	3,870
	Constant Volume Economizer	2,182	1,830	2,684	1,997	2,416
	Variable Air Volume Economizer	1,554	1,365	1,860	1,442	1,746

Summer Peak Coincident Demand Reduction

$$\Delta kW = TONS * \left(\frac{3.516}{COP_{BASE}} - \frac{3.516}{COP_{EE}}\right) * CF$$

Where:

COP_{BASE} = Efficiency of baseline equipment (= dependent on chiller type; see table above)

COP_{ee} = Efficiency of high-efficiency equipment (= actual)

CF = Summer peak coincidence factor (= 74%)[317]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

[317] The summer peak coincidence factor has been preserved from the *Technical Reference Manual (TRM) for Ohio Senate Bill 221 Energy Efficiency and Conservation Program and 09-512-GE-UNC*, dated October 15, 2009. This is likely a conservative estimate, and is recommended for further study.

Chiller Tune-Up

	Measure Details
Official Measure Code	CI-HVAC-ChillerTune-1
Measure Unit	Per Unit
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by equipment type and location
Peak Demand Reduction (kW)	Varies by equipment type and location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by equipment type and location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	Varies by equipment type and location
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the tune-up of an existing air-cooled or water-cooled chiller. The tune-up consists of tube cleaning, chilled and condenser water temperature adjustments, and reciprocating compressor unloading switch adjustments.

Definition of Efficient Equipment

The efficient condition is an existing chiller post tune-up.

Definition of Baseline Equipment

The baseline condition is an existing chiller pre tune-up.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 5 years.

Deemed Measure Cost

The incremental cost for this measure varies.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = TONS * \frac{3.516}{IPLV_{BASE}} * EFLH * ESF$$

Where:

TONS = Chiller nominal cooling capacity in tons (= actual; 1 ton = 12,000 Btu/hr)

3.516 = Conversion factor to express integrated part load value in kW per ton

$IPLV_{BASE}$ = Efficiency of existing equipment expressed as integrated part load value (= dependent on chiller type; see table below)

Baseline Efficiency Values by Chiller Type and Capacity

Equipment Type	Size Category	Baseline Efficiency ($IPLV_{BASE}$, COP_{BASE})
Air cooled, with condenser, electrically operated	All capacities	3.05 IPLV, 2.80 COP
Air cooled, without condenser, electrically operated	All capacities	3.45 IPLV, 3.10 COP
Water cooled, electrically operated, positive displacement (reciprocating)	All capacities	5.05 IPLV, 4.20 COP
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	< 150 tons	5.20 IPLV, 4.45 COP
	≥ 150 tons and < 300 tons	5.60 IPLV, 4.90 COP
	≥ 300 tons	6.15 IPLV, 5.50 COP
Water cooled, electrically operated, centrifugal	< 150 tons	5.25 IPLV, 5.00 COP
	≥ 150 tons and < 300 tons	5.90 IPLV, 5.55 COP
	≥ 300 tons	6.40 IPLV, 6.10 COP

Source: ASHRAE 90.1-2007 Table 6.8.1B.

ESF = Energy savings factor (= 0.08)

EFLH = Equivalent full load hours (= dependent on location and building type;[318] see table below)

Equivalent Full Load Hours by Building Type and Location

Building	System	Indianapolis	South Bend	Evansville	Ft. Wayne	Terre Haute
Community College	CAV no econ	1,314	1,090	1,632	1,124	1,320
	CAV econ	966	840	1,167	821	955
	VAV econ	736	621	881	642	680
Hotel	CAV no econ	3,999	3,766	4,424	3,999	4,240
	CAV econ	3,786	3,541	4,238	3,786	4,034

[318] EFLH data were derived from building energy simulation models. See Appendix A.

Building	System	Indianapolis	South Bend	Evansville	Ft. Wayne	Terre Haute
	VAV econ	3,732	3,480	4,161	3,732	3,899
Large Retail	CAV no econ	2,065	1,899	2,243	2,006	2,164
	CAV econ	1,289	1,118	1,545	1,183	1,405
	VAV econ	1,065	904	1,297	969	1,196
University	CAV no econ	1,927	1,805	2,140	1,958	1,833
	CAV econ	727	739	917	754	682
	VAV econ	950	927	1,157	884	795
Large Office	CAV no econ	3,302	2,786	3,300	3,107	3,197
	CAV econ	876	897	1,118	916	981
	VAV econ	992	864	1,042	801	999
High School	CAV no econ	1,039	1,003	1,125	995	979
	CAV econ	558	519	696	513	570
	VAV econ	426	359	505	397	383
Hospital	CAV no econ	3,777	3,199	4,267	3,538	3,870
	CAV econ	2,182	1,830	2,684	1,997	2,416
	VAV econ	1,554	1,365	1,860	1,442	1,746

For example, energy savings for the tune-up of a 300-ton chiller with an IPLV of 6.0 serving an office with a variable air volume system in Indianapolis is calculated as:

$$\Delta\text{kWh} = TONS * \frac{3.516}{IPLV_{BASE}} * EFLH * ESF = 300 * \frac{3.516}{6.0} * 992 * 0.08 = 13{,}951\text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta\text{kW} = TONS * \frac{3.516}{COP_{BASE}} * CF * DSF$$

Where:

COP_{BASE} = Efficiency of baseline equipment (= dependent on chiller type; see table below)

Baseline Efficiency Values by Chiller Type and Capacity

Equipment Type	Size Category	Baseline Efficiency ($IPLV_{BASE}$, COP_{BASE})
Air cooled, with condenser, electrically operated	All capacities	3.05 IPLV, 2.80 COP
Air cooled, without condenser, electrically operated	All capacities	3.45 IPLV, 3.10 COP
Water cooled, electrically operated, positive displacement (reciprocating)	All capacities	5.05 IPLV, 4.20 COP
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	< 150 tons	5.20 IPLV, 4.45 COP
	≥ 150 tons and < 300 tons	5.60 IPLV, 4.90 COP
	≥ 300 tons	6.15 IPLV, 5.50 COP
Water cooled, electrically operated, centrifugal	< 150 tons	5.25 IPLV, 5.00 COP
	≥ 150 tons and < 300 tons	5.90 IPLV, 5.55 COP
	≥ 300 tons	6.40 IPLV, 6.10 COP

Source: ASHRAE 90.1-2007 Table 6.8.1B.

CF = Summer peak coincidence factor (= 74%)

DSF = Demand savings factor (= 0.08)

For example, demand reduction for the tune-up of a 300-ton chiller with a COP of 5.0 is calculated as:

$$\Delta \text{kW} = TONS * \frac{3.516}{COP_{BASE}} * CF * DSF = 300 * \frac{3.516}{5} * 0.74 * 0.08 = 12.489 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

ENERGY STAR Room Air Conditioner for Commercial Use (Time of Sale)

	Measure Details
Official Measure Code	CI-HVAC-RAC-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by capacity and location
Peak Demand Reduction (kW)	Varies by capacity and location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by capacity and location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure relates to the purchase and installation of a room air conditioning unit that meets either the ENERGY STAR[319] or Consortium for Energy Efficiency Super-Efficient Home Appliances Initiative Tier 1[320] minimum qualifying efficiency specifications, in place of a baseline unit meeting minimum federal standard efficiency ratings. Applicable units are with and without louvered sides, and without reverse cycle (i.e., heating) or casement.

Definition of Efficient Equipment

To qualify for this measure, the new room air conditioning unit must meet either the ENERGY STAR or Consortium for Energy Efficiency Super-Efficient Home Appliances Initiative Tier 1 efficiency standards.

Definition of Baseline Equipment

The baseline assumption is a new room air conditioning unit that meets the current minimum federal efficiency standard.

---

319 U.S. Environmental Protection Agency. ENERGY STAR Program Requirements for Room Air Conditioners, Partner Commitments." Accessed July 17, 2010. http://www.energystar.gov/ia/partners/product_specs/program_reqs/room_air_conditioners_prog_req.pdf

320 Consortium for Energy Efficiency. "CEE Super-Efficient Home Appliances Initiative – High-Efficiency Specifications for Room Air Conditioners." Accessed July 17, 2010. http://www.cee1.org/resid/seha/rm-ac/rm-ac_specs.pdf

Deemed Lifetime of Efficient Equipment

The measure life is 12 years.[321]

Deemed Measure Cost

The incremental cost for this measure is $40.00 for an ENERGY STAR unit and $80.00 for a Consortium for Energy Efficiency Tier 1 unit.[322]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = EFLH * Btuh * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}}{1{,}000}$$

Where:

Btuh = Cooling capacity of the unit in Btuh (= actual)

EER_{BASE} = Energy efficiency ratio of the baseline equipment (= see table below)[323]

Federal Standards for Baseline Energy Efficiency Ratio

Capacity (Btuh)	With Louvered Sides	Without Louvered Sides	Casement Only	Casement Slider
< 8,000	≥ 11	≥ 10	≥ 8.7	≥ 9.5
8,000 to 13,999	≥ 10.9	≥ 9.6	≥ 8.7	≥ 9.5
14,000 to 19,999	≥ 10.7	≥ 9.3	≥ 8.7	≥ 9.5
≥ 20,000	≥ 9.4	≥ 9.4	≥ 8.7	≥ 9.5

EER_{EE} = Energy efficiency ratio of the energy-efficient equipment (= actual; otherwise, see table below)[324]

[321] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

[322] Based on field study conducted by Efficiency Vermont.

[323] Minimum Federal Standard for capacity range. 2015 Federal Energy Conservation Standard for Room ACs (e-CFR Title 10, Chapter II, Subchapter D, Part 430, Subpart C, Section 430.32)

[324] ENERGY STAR standards from: http://www.energystar.gov/index.cfm?c=roomac.pr_crit_room_ac
CEE Tier 1 standards from: http://library.cee1.org/sites/default/files/library/9296/CEE_ResApp_RoomAirConditionerSpecification_2003_Updated_Again.pdf

ENERGY STAR and CEE SEHA Standards for Efficient Equipment Energy Efficiency Ratio

Capacity (Btuh)	CEE SEHA Tier 1	ENERGY STAR			
	With Louvered Sides	With Louvered Sides	Without Louvered Sides	Casement Only	Casement Slider
< 8,000	≥ 11.2	≥ 11.2	≥ 10.4	≥ 10.0	≥ 10.9
8,000 to 13,999	≥ 11.3	≥ 11.3	≥ 9.8	≥ 10.0	≥ 10.9
14,000 to 19,999	≥ 11.2	≥ 11.2	≥ 9.8	≥ 10.0	≥ 10.9
≥ 20,000	≥ 9.8	≥ 9.8	≥ 9.8	≥ 10.0	≥ 10.9

EFLH = Cooling equivalent full load hours (= see table below)

Equivalent Full Load Hours by City

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	810	721	1,047	716	955
Auto Repair	538	484	721	431	675
Big Box Retail	1,123	1,006	1,422	1,056	1,251
Fast Food Restaurant	798	738	1,066	694	905
Full Service Restaurant	729	641	967	633	837
Grocery	1,123	1,006	1,422	1,056	1,251
Light Industrial	690	598	842	642	760
Primary School	514	456	573	454	503
Religious Worship	401	360	516	357	444
Small Office	1,096	1,015	1,299	1,035	1,151
Small Retail	1,032	906	1,294	977	1,142
Warehouse	690	598	842	642	760
Other	795	711	1,001	725	886

Summer Peak Coincident Demand Reduction

$$\Delta kW = Btuh * \frac{\frac{1}{EER_{BASE}} - \frac{1}{EER_{eEE}}}{1{,}000} * CF$$

Where:

CF = Summer peak coincidence factor (= 0.74)[325]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

[325] Coincidence factor supplied by Duke Energy for the commercial HVAC end-use. Pending verification based on information from the utilities.

Single-Package and Split System Unitary Air Conditioners (Time of Sale, New Construction)

	Measure Details
Official Measure Code	CI-HVAC-AC-1
Measure Unit	Per unit
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by system type and capacity
Peak Demand Reduction (kW)	Varies by system type and capacity
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by system type and capacity
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$100.00 per ton
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of high-efficiency unitary air-, water-, and evaporative cooled air conditioning equipment, both single-package and split systems. Air conditioning systems are a major consumer of electricity and systems that exceed baseline efficiencies can save considerable amounts of energy. This measure applies to the replacement of an existing unit at the end of its useful life or to the installation of a new unit in a new or existing building.

Definition of Efficient Equipment

The efficient equipment is a high-efficiency air-, water-, or evaporative cooled air conditioner that exceeds the energy efficiency requirements of ASHRAE 90.1-2007.

Definition of Baseline Equipment

The baseline equipment is assumed to be a standard-efficiency air-, water-, or evaporative cooled air conditioner that meets the energy efficiency requirements of ASHRAE 90.1-2007. The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

Deemed Lifetime of Efficient Equipment

The expected measure life is 15 years.[326]

Deemed Measure Cost

The incremental capital cost for this measure is $100.00 per ton.[327]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

For units with cooling capacities less than 65 kBtuh:

$$\Delta\text{kWh} = Btuh * \left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right) * \frac{EFLH}{1{,}000}$$

For units with cooling capacities equal to or greater than 65 kBtuh:

$$\Delta\text{kWh} = Btuh * \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right) * \frac{EFLH}{1{,}000}$$

Where:

Btuh	=	Capacity of the cooling equipment actually installed (1 ton of cooling capacity equals 12 kBtuh)
$SEER_{BASE}$	=	Seasonal energy efficiency ratio of the baseline equipment (= see table below)

[326] GDS Associates, Inc. *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007.

[327] Based on a review of TRM incremental cost assumptions from California, Vermont, and Wisconsin.

Seasonal Energy Efficiency Ratio by Equipment Size

Size Category	Subcategory	Baseline Condition ASHRAE 90.1-2007*
<65,000 Btuh	Split system	13.0 SEER
	Single package	13.0 SEER
≥65,000 Btuh and <135,000 Btuh	Split system	11.0 EER
	Single package	11.2 IEER
≥135,000 Btuh and <240,000 Btuh	Split system	10.8 EER
	Single package	11.0 IEER
≥240,000 Btuh and <760,000 Btuh	Split system	9.8 EER
	Single package	9.9 IEER
≥760,000 Btuh	Split system	9.5 EER
	Single package	9.6 IEER

* As mandated by federal equipment manufacturing standards:
http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/74fr12058.pdf

$SEER_{EE}$ = Seasonal energy efficiency ratio of the energy efficient equipment (= actual)

$IEER_{BASE}$ = Integrated energy efficiency ratio of the baseline equipment (= see table above)

$IEER_{EE}$ = Integrated energy efficiency ratio of the energy efficient equipment (= actual)

EFLH = Cooling equivalent full load hours (= see table below)

Equivalent Full Load Hours by Building Type and City

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	810	721	1,047	716	955
Auto Repair	538	484	721	431	675
Big Box Retail	1,123	1,006	1,422	1,056	1,251
Fast Food Restaurant	798	738	1,066	694	905
Full Service Restaurant	729	641	967	633	837
Grocery	1,123	1,006	1,422	1,056	1,251
Light Industrial	690	598	842	642	760
Primary School	514	456	573	454	503
Religious Worship	401	360	516	357	444
Small Office	1,096	1,015	1,299	1,035	1,151
Small Retail	1,032	906	1,294	977	1,142
Warehouse	690	598	842	642	760
Other	795	711	1,001	725	886

Summer Peak Coincident Demand Reduction

$$\Delta\mathrm{kW} = \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right) * \mathrm{Btu} * \frac{CF}{1000}$$

Where:

EER_{BASE} = Energy efficiency ratio of baseline equipment (= see table above)

EER_{EE} = Energy efficiency ratio of energy-efficient equipment (= actual)

For air-cooled air conditioners < 65 kBtuh, if the actual EER is unknown, assume the following conversion from SEER to EER: EER = SEER/1.1.

CF = Summer peak coincidence factor (= 0.74)[328]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

[328] Duke Energy supplied the coincidence factor for the commercial HVAC end-use (pending verification based on information from the utilities).

Heat Pump Systems (Time of Sale, New Construction)

	Measure Details
Official Measure Code	CI-HVAC-ASHP-1
Measure Unit	Per heat pump
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by building type and location
Peak Demand Reduction (kW)	Varies by building type and location
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by building type and location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$100.00 per ton
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure applies to the installation of high-efficiency air cooled, water source, ground water source, and ground source heat pump systems. This measure could apply to replacing an existing unit at the end of its useful life or installing a new unit in a new or existing building.

Definition of Efficient Equipment

The efficient equipment is a high-efficiency air cooled, water source, ground water source, or ground source heat pump system that exceeds the energy efficiency requirements of ASHRAE 90.1-2007.

Definition of Baseline Equipment

The baseline equipment is a standard efficiency air cooled, water source, ground water source, or ground source heat pump system that meets the energy efficiency requirements of ASHRAE 90.1-2007. The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

Deemed Lifetime of Efficient Equipment

The expected measure life is 15 years.[329]

[329] GDS Associates, Inc. *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures.* June 2007.

Deemed Measure Cost

For analysis purposes, the incremental capital cost for this measure is $100.00 per ton for air-cooled units.[330] The incremental cost for all other equipment types should be determined on a site-specific basis.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

For air cooled units with cooling capacities less than 65 kBtuh:

$$\Delta kWh = \text{Annual kWh Savings}_{COOL} + \text{Annual kWh Savings}_{HEAT}$$

$$\text{Annual kWh Savings}_{COOL} = kBtuh_{COOL} * \left(\frac{1}{SEER_{BASE}} - \frac{1}{SEER_{EE}}\right) * EFLH_{COOL}$$

$$\text{Annual kWh Savings}_{HEAT} = kBtuh_{HEAT} * \left(\frac{1}{HSPF_{BASE}} - \frac{1}{HSPF_{EE}}\right) * EFLH_{HEAT}$$

For air cooled units with cooling capacities greater than or equal to 65 kBtuh:

$$\Delta kWh = \text{Annual kWh Savings}_{COOL} + \text{Annual kWh Savings}_{HEAT}$$

$$\text{Annual kWh Savings}_{COOL} = \left(\frac{1}{IEER_{BASE}} - \frac{1}{IEER_{EE}}\right) * EFLH_{COOL} * kBtuh_{COOL}$$

$$\text{Annual kWh Savings}_{HEAT} = \left(\frac{1}{COP_{BASE}} - \frac{1}{COP_{EE}}\right) * EFLH_{HEAT} * \frac{kBtuh_{HEAT}}{3.412}$$

Where:

$kBtuh_{COOL}$ = Cooling capacity of equipment in kBtu per hour (= actual; 1 ton of cooling capacity equals 12 kBtuh)

$SEER_{BASE}$ = Seasonal energy efficiency ratio of baseline equipment (= see table below)

330 Based on a review of TRM incremental cost assumptions from California, Vermont, and Wisconsin.

Baseline Efficiencies by Size

Size Category	Subcategory	Baseline Condition (ASHRAE 90.1-2007)
<65,000 Btuh	Split system	13.0 SEER / 7.7 HSPF
	Single package	13.0 SEER / 7.7 HSPF
≥65,000 Btuh and <135,000 Btuh	Split system and single package	11.0 EER / 11.2 IEER / 3.3 COP
≥135,000 Btuh and <240,000 Btuh	Split system and single package	10.8 EER / 11.0 IEER / 3.2 COP
≥240,000 Btuh	Split system and single package	9.8 EER / 9.9 IEER / 3.2 COP

$SEER_{EE}$ = Seasonal energy efficiency ratio of energy efficient equipment (= actual)

$EFLH_{COOL}$ = Cooling mode equivalent full load hours (= see table below)

Cooling Equivalent Full Load Hours by Building Type

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	810	721	1,047	716	955
Auto Repair	538	484	721	431	675
Big Box Retail	1,123	1,006	1,422	1,056	1,251
Fast Food Restaurant	798	738	1,066	694	905
Full Service Restaurant	729	641	967	633	837
Grocery	1,123	1,006	1,422	1,056	1,251
Light Industrial	690	598	842	642	760
Primary School	514	456	573	454	503
Religious Worship	401	360	516	357	444
Small Office	1,096	1,015	1,299	1,035	1,151
Small Retail	1,032	906	1,294	977	1,142
Warehouse	690	598	842	642	760
Other	795	711	1,001	725	886

$HSPF_{BASE}$ = Heating seasonal performance factor of baseline equipment (= see table above, "Baseline Efficiencies by Size")

$HSPF_{EE}$ = Heating seasonal performance factor of energy efficient equipment (= actual)

$EFLH_{heat}$ = Heating mode equivalent full load hours (= see table below)

Heating Equivalent Full Load Hours by Building Type

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	874	954	611	1,009	659
Auto Repair	3,319	3,930	2,582	3,299	2,918
Big Box Retail	519	538	325	607	367
Fast Food Restaurant	1,253	1,383	824	1,463	907
Full Service Restaurant	1,164	1,396	768	1,441	893
Grocery	519	538	325	607	367
Light Industrial	1,113	1,205	718	1,289	775
Primary School	1,192	1,266	785	1,359	845
Religious Worship	923	1,070	677	1,085	779
Small Office	670	710	487	826	526
Small Retail	939	977	591	1,125	661
Warehouse	1,113	1,205	718	1,289	775
Other	1,133	1,264	784	1,283	873

$IEER_{BASE}$ = Integrated energy efficiency ratio of baseline equipment (= see table above, "Baseline Efficiencies by Size")

$IEER_{EE}$ = Integrated energy efficiency ratio of energy efficient equipment (= actual)

$kBtuh_{HEAT}$ = Heating capacity of the equipment in kBtu per hour (= actual)

3.412 = Btus per watt-hour

COP_{BASE} = Coefficient of performance of baseline equipment (= see table above)

COP_{EE} = Coefficient of performance of energy efficient equipment (= actual)

Summer Peak Coincident Demand Reduction

$$\Delta kW = kBtuh_{COOL} * \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EE}}\right) * CF$$

Where:

EER_{BASE} = Energy efficiency ratio of baseline equipment (= see table above)

EER_{ee} = Energy efficiency ratio of energy efficient equipment (= actual)

CF = Summer peak coincidence factor (= 0.74)[331]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

331 Duke Energy provided the coincidence factor for the commercial HVAC end-use (pending information from the utilities).

Outside Air Economizer with Dual-Enthalpy Sensors (Time of Sale, Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-HVAC-Econ-1
Measure Unit	HVAC
Measure Category	Per HVAC system
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by building type and location
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by building type and location
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$400.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is to upgrade the outside air dry-bulb economizer to a dual enthalpy controlled economizer. The new control system will continuously monitor the enthalpy of both the outside air and return air, controlling and adjusting the system dampers based on the two readings.

Definition of Efficient Equipment

The efficient equipment is a dual-enthalpy economizer on the HVAC system.

Definition of Baseline Equipment

The existing condition is an outside air dry-bulb economizer.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 10 years.[332]

332 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008.

Deemed Measure Cost

The incremental cost for this measure is $400.00.[333]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = TONS * \Delta kWh_{TON}$$

Where:

TONS = Rated capacity of unit controlled by economizer (= actual; collect with application)

ΔkWh_{TON} = Energy savings per ton, based on building and region (see table below)

Dual Enthalpy Economizer Savings (kWh/Ton)*

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	22	21	24	23	32
Big Box Retail	137	125	145	139	215
Fast Food Restaurant	34	32	37	33	35
Full Service Restaurant	19	18	18	18	31
Hospital	1,014	1,033	1,125	1,212	1,149
Hotel	766	823	1,444	1,641	1,563
Large Office	996	947	999	980	1,056
Light Industrial	40	39	38	34	40
Primary School	54	47	50	50	84
Small Office	183	176	173	192	186
Small Retail	115	105	109	110	146
Warehouse	40	39	38	34	40
Other	285	290	350	367	380

* Unit energy savings, demand reduction, and natural gas savings data is based on a series of prototypical small commercial building simulation runs. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development.

---

333 Efficiency Vermont. *Technical Reference Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February 19, 2010. Value derived from Efficiency Vermont project experience and conversations with suppliers.

For example, the energy savings from an economizer on a 10-ton air conditioning unit in a big-box retail building in Indianapolis would be:

$$\Delta kWh = 10 * 137 = 1{,}370\ kWh$$

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

There are no expected fossil fuel impacts associated with this measure.

Demand Controlled Ventilation

	Measure Details
Official Measure Code	CI-HVAC-DCV-1
Measure Unit	Per square foot
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by building type and location
Peak Demand Reduction (kW)	Varies by building type and location
Annual Fossil Fuel Savings (MMBtu)	Varies by building type and location
Lifetime Energy Savings (kWh)	Varies by building type and location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by building type and location
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$115.00 per 1,000 square feet of floor area
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of a demand controlled ventilation (DCV) systems with an air-side economizer with zone-level CO_2 sensor controls to packaged rooftop equipment. The savings represent the combined effect of the DCV and the air-side economizer.

Definition of Efficient Equipment

The efficient condition is an HVAC system with DCV systems added.

Definition of Baseline Equipment

The baseline condition is an HVAC system without DCV systems.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 15 years.

Deemed Measure Cost

The incremental cost for this measure is $115.00 per 1,000 square feet of floor area.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = \frac{SF}{1{,}000} * \Delta kWh_{kSF}$$

Where:

SF	=	Conditioned square footage served by system with DCV controls installed
ΔkWh_{kSF}	=	Energy savings per 1,000 square feet of conditioned floor area (= dependent on building type and region, see table in Reference Table section)

For example, the energy savings from a DCV system being installed on an HVAC system serving a 2,000 square foot small retail store in Indianapolis would be:

$$\Delta \text{kWh} = \frac{SF}{1{,}000} * \Delta kWh_{kSF} = \frac{2{,}000}{1{,}000} * 668 = 1{,}336 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{SF}{1{,}000} * \Delta kW_{kSF} * CF$$

Where:

ΔkW_{kSF}	=	Demand reduction per 1,000 square feet of conditioned floor area (= dependent on building type and region, see table in Reference Table section)
CF	=	Summer peak coincident peak (= 0.74)

For example, the demand reduction from a DCV system being installed on an HVAC system serving a 2,000 square foot small retail store in Indianapolis would be:

$$\Delta \text{kW} = \frac{2{,}000}{1{,}000} * 0.109 * 0.74 = 0.161 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \frac{SF}{1{,}000} * \Delta MMBtu_{kSF}$$

Where:

$\Delta MMBtu_{kSF}$	=	Unit natural gas savings per 1,000 square feet of conditioned floor space (= dependent on building type and region, see table in Reference Table section)

For example, the natural gas savings from a DCV system being installed on an HVAC system serving a 2,000 square foot small retail store in Indianapolis would be:

$$\Delta \text{MMBtu} = \frac{SF}{1{,}000} * \Delta MMBtu_{kSF} = \frac{2{,}000}{1{,}000} * 29.7 = 59.4 \text{ MMBtu}$$

Reference Table

Building	City	kWh	kW	MMBtu
Assembly	Evansville	747	0.394	78.2
	Ft. Wayne	536	0.129	98.0
	Indianapolis	599	0.138	97.4
	South Bend	629	0.224	100.1
	Terre Haute	614	0.181	98.8
Big Box Retail	Evansville	742	0.314	9.8
	Ft. Wayne	547	0.212	15.6
	Indianapolis	578	0.383	16.1
	South Bend	676	0.505	16.1
	Terre Haute	627	0.444	16.1
Fast Food Restaurant	Evansville	1,817	0.588	84.0
	Ft. Wayne	1,193	0.588	122.7
	Indianapolis	1,408	0.588	125.2
	South Bend	1,428	0.850	129.0
	Terre Haute	1,418	0.325	127.1
Full Service Restaurant	Evansville	1,046	0.325	62.7
	Ft. Wayne	739	0.325	91.9
	Indianapolis	836	0.175	93.3
	South Bend	874	0.475	97.0
	Terre Haute	855	0.325	95.2
Light Industrial	Evansville	129	0.040	7.6
	Ft. Wayne	105	0.032	11.5
	Indianapolis	124	0.033	11.8
	South Bend	101	0.069	12.0
	Terre Haute	113	0.051	11.9
Primary School	Evansville	668	1.122	39.5
	Ft. Wayne	412	0.616	56.1
	Indianapolis	496	1.322	55.9
	South Bend	519	1.986	58.9
	Terre Haute	508	1.654	57.4
Small Office	Evansville	732	0.00	5.9
	Ft. Wayne	644	0.00	8.9
	Indianapolis	658	0.00	9.2
	South Bend	670	0.00	9.6

Building	City	kWh	kW	MMBtu
	Terre Haute	664	0.00	9.4
Small Retail	Evansville	827	0.156	18.3
	Ft. Wayne	633	0.078	28.8
	Indianapolis	668	0.109	29.7
	South Bend	737	0.422	31.6
	Terre Haute	703	0.266	30.7
Warehouse	Evansville	11	0.003	0.6
	Ft. Wayne	14	0.004	1.5
	Indianapolis	20	0.005	1.9
	South Bend	24	0.016	2.9
	Terre Haute	22	0.010	2.3

Chilled Water Reset Controls (Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-HVAC-CHWReset-1
Measure Unit	Per reset
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by system and location
Peak Demand Reduction (kW)	Varies by system and location
Annual Fossil Fuel Savings (MMBtu)	Varies by system and location
Lifetime Energy Savings (kWh)	Varies by system and location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by system and location
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$681.34 per control
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of chilled water reset controls in large commercial buildings with built-up HVAC systems. Reset controls allow the chillers to operate at a higher chilled water temperature during periods of low cooling loads. The baseline condition is a constant chilled water temperature of 45°F. The reset strategies use a 5°F reset.[334] Energy savings are realized through improved chiller efficiency. Data for both air-cooled and water-cooled chillers are shown. The approach uses DOE-2.2 simulations on a series of commercial prototypical building models, adapted from the California DEER study, with changes to reflect Indiana climate and building practices. Energy and demand impacts are normalized per ton of chiller capacity controlled.

Definition of Efficient Equipment

The efficient condition is a chilled water reset with the maximum chilled water temperature of 50°F.

Definition of Baseline Equipment

The baseline condition is a fixed chilled water temperature of 45°F.

[334] ASHRAE 90.1 2007 requires chilled and hot water temperature resets for systems with a capacity greater than 300,000 Btu/hr. To avoid incenting code, this applies to smaller systems and retrofits only.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 10 years.[335]

Deemed Measure Cost

The full installed cost for this measure is $681.34 per control.[336]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = TONS * \Delta kWh_{TON}$$

Where:

TONS	=	Rated capacity of unit controlled by reset controller (= actual, to collect with application)
ΔkWh_{TON}	=	Energy savings per ton (= dependent on whether chiller is air cooled or water cooled, see tables in Reference Tables section).

For example, the energy savings from a chilled water reset on a 10-ton variable air volume, water-cooled chiller in an Indianapolis large office would be:

$$\Delta kWh = 10 * 102 = 1{,}020 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = TONS * \Delta kW_{TON} * CF$$

Where:

ΔkW_{TON}	=	Demand reduction per ton (=dependent on whether chiller is air cooled or water cooled, see tables in Reference Tables section)
CF	=	Summer peak coincident factor (= 0.74)[337]

335 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, “Effective/Remaining Useful Life Values”, California Public Utilities Commission, December 16, 2008

336 Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010. Value derived from Efficiency Vermont project experience and conversations with suppliers.

337 Duke Energy provided the coincidence factor for the commercial HVAC end-use (pending information from the utilities).

For example, the demand reduction from a chilled water reset on a 10-ton variable air volume, water-cooled chiller in an Indianapolis large office:

$$\Delta\text{kW} = 10 * 0.023 * 0.74 = 0.17 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta\text{MMBtu} = TONS * \Delta MMBtu_{TON}$$

Where:

$\Delta MMBtu_{TON}$ = Natural gas savings per ton (= see tables in Reference Tables section)

For example, the natural gas savings from a chilled water reset on a 10-ton variable air volume, water-cooled chiller in an Indianapolis large office:

$$\Delta\text{MMBtu} = 10 * 0.12 = 1.2 \text{ MMBtu}$$

Reference Tables

Chilled Water Reset Controls - Hospitals

System	City	kWh*	kW*	MMBtu*
Constant Volume Reheat Economizers	Evansville	332	0.052	0.25
	Indianapolis	308	0.036	0.30
	South Bend	287	0.001	0.29
	Ft. Wayne	309	0.037	0.49
	Terre Haute	316	0.034	0.43
Constant Volume Reheat No Economizers	Evansville	237	0.035	0.17
	Ft. Wayne	245	0.024	0.25
	Indianapolis	223	0.024	0.19
	South Bend	211	0.001	0.18
	Terre Haute	240	0.023	0.22
Variable Air Volume Reheat Economizers	Evansville	120	0.001	0.13
	Indianapolis	123	0.011	0.25
	South Bend	122	0.007	0.29
	Ft. Wayne	152	0.019	0.26
	Terre Haute	154	0.083	0.16

* Unit energy savings, demand reduction, and natural gas savings data is based on a series of prototypical commercial building simulation runs. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development.

Chilled Water Reset Controls - Hotels

System	City	kWh*	kW*	MMBtu*
Constant Volume Reheat Economizers	Indianapolis	121	0.016	0.01
	South Bend	114	0.016	0.01
	Evansville	147	0.016	-0.02
	Ft. Wayne	155	0.014	-0.01
	Terre Haute	139	0.020	-0.01
Constant Volume Reheat No Economizers	Evansville	155	0.016	-0.01
	Ft. Wayne	160	0.014	0.01
	Indianapolis	56	0.015	0.00
	South Bend	51	0.017	0.00
	Terre Haute	153	0.020	0.00
Variable Air Volume Reheat Economizers	Indianapolis	125	0.016	0.00
	South Bend	121	0.016	0.00
	Evansville	173	0.018	0.02
	Ft. Wayne	177	0.014	0.05
	Terre Haute	168	0.020	0.02

* Unit energy savings, demand reduction, and natural gas savings data is based on a series of prototypical commercial building simulation runs. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development.

Chilled Water Reset Controls - Large Office

System	City	kWh*	kW*	MMBtu*
Constant Volume Reheat Economizers with Water Cooled Chiller	Evansville	125	0.011	0.24
	Ft. Wayne	130	0.016	0.26
	Indianapolis	122	0.011	0.19
	South Bend	125	0.010	0.25
	Terre Haute	112	0.007	0.19
Constant Volume Reheat No Economizers with Water Cooled Chiller	Evansville	168	0.024	0.16
	Ft. Wayne	162	0.017	0.15
	Indianapolis	164	0.019	0.13
	South Bend	154	0.014	0.16
	Terre Haute	171	0.009	0.10
Variable Air Volume Reheat Economizers with Water Cooled Chiller	Evansville	104	0.026	0.11
	Ft. Wayne	112	0.013	0.14
	Indianapolis	102	0.023	0.12
	South Bend	104	0.008	0.10
	Terre Haute	103	0.023	0.10

* Unit energy savings, demand reduction, and natural gas savings data is based on a series of prototypical commercial building simulation runs. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development.

Variable Frequency Drives for HVAC Applications (Time of Sale, Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-HVAC-VFD-1
Measure Unit	Per VFD
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by system
Peak Demand Reduction (kW)	Varies by system
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by system
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a variable frequency drive (VFD) on an HVAC system pump or fan motor. The VFD will modulate the speed of the motor when it is not needed to run at full load. Since the power of the motor is proportional to the cube of the speed, this will result in significant energy savings.

Definition of Efficient Equipment

The efficient condition is a VFD on an HVAC system pump or fan motor.

Definition of Baseline Equipment

For VFDs on fans, the baseline is a variable volume fan with variable inlet vanes. For VFDs on pumps, the baseline is a constant volume motor.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 15 years.[338]

Deemed Measure Cost

The full installed cost for this measure is dependent on horsepower (see table below).

338 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05.* "Effective/Remaining Useful Life Values." December 16, 2008.

Deemed Measure Cost by Horsepower

HP	Total Installed Cost*
5	$1,330
7.5	$1,622
10	$1,898
15	$2,518
20	$3,059

* Equipment costs from Granger 2008 Catalog pp. 286-289, average across available voltages and models. Labor costs from RSMeans Mechanical Cost Data, 2008. Used average cost adjustment for all cities listed in Indiana.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = hp * SF_{kWh}$$

Where:

hp = Nameplate horsepower of motor controlled by VFD

SF_{kWh} = Energy savings factor for installing a VFD (= dependent on horsepower, see table)

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = hp * SF_{kW}$$

Where:

SF_{kW} = Demand reduction factor for installing a VFD (= dependent on horsepower, see table)

Fossil Fuel Impact Descriptions and Calculation

There are no expected fossil fuel impacts associated with this measure.

Reference Tables

Energy and Demand Savings Factors for Hospitals

Measure	City	System	SF_{kWh} (kWh/unit)	SF_{kW} (kW/unit)
VFD Return Fan	Indianapolis	VAV reheat econ	1,836	0.250
	South Bend		1,758	0.221
	Evansville		1,907	0.257
	Fort Wayne		1,774	0.238
	Terre Haute		1,857	0.244
VFD Supply Fan	Indianapolis		2,069	0.306
	South Bend		1,994	0.269
	Evansville		2,205	0.309
	Fort Wayne		1,982	0.572
	Terre Haute		2,184	0.297
VFD Tower Fan	Indianapolis	CV reheat no econ	933	0.00
		CV reheat econ	784	0.00
		VAV reheat econ	477	0.00
	South Bend	CV reheat no econ	861	0.00
		CV reheat econ	711	0.00
		VAV reheat econ	452	0.00
	Evansville	CV reheat no econ	1,091	0.00
		CV reheat econ	937	0.00
		VAV reheat econ	538	0.00
	Fort Wayne	CV reheat no econ	846	0.00
		CV reheat econ	713	0.00
		VAV reheat econ	421	0.00
	Terre Haute	CV reheat no econ	1,003	0.00
		CV reheat econ	848	0.00
		VAV reheat econ	545	0.00
VFD CHW Pump	Indianapolis	CV reheat no econ	6,655	0.735
		CV reheat econ	6,814	0.735
		VAV reheat econ	6,685	0.709
	South Bend	CV reheat no econ	6,722	0.511
		CV reheat econ	6,814	0.511
		VAV reheat econ	6,718	0.689
	Evansville	CV reheat no econ	6,639	0.763
		CV reheat econ	6,833	0.763
		VAV reheat econ	6,669	0.723
	Fort Wayne	CV reheat no econ	6,671	0.719
		CV reheat econ	6,789	0.719
		VAV reheat econ	6,689	1.314
	Terre Haute	CV reheat no econ	6,586	0.696
		CV reheat econ	6,747	0.697

Measure	City	System	SF_{kWh} (kWh/unit)	SF_{kW} (kW/unit)
		VAV reheat econ	6,645	0.697
VFD HW Pump	Indianapolis	CV reheat no econ	6,146	0.766
		CV reheat econ	5,665	0.766
		VAV reheat econ	5,142	0.829
	South Bend	CV reheat no econ	6,242	0.622
		CV reheat econ	5,738	0.622
		VAV reheat econ	5,375	0.826
	Evansville	CV reheat no econ	6,057	0.761
		CV reheat econ	5,622	0.761
		VAV reheat econ	5,409	0.852
	Fort Wayne	CV reheat no econ	6,226	0.764
		CV reheat econ	5,720	0.764
		VAV reheat econ	5,369	0.820
	Terre Haute	CV reheat no econ	6,091	0.779
		CV reheat econ	5,647	0.779
		VAV reheat econ	5,211	0.851
VFD CW Pump	Indianapolis	CV reheat no econ	1,989	0.097
		CV reheat econ	1,995	0.097
		VAV reheat econ	2,083	0.097
	South Bend	CV reheat no econ	1,979	0.095
		CV reheat econ	1,985	0.095
		VAV reheat econ	2,069	0.097
	Evansville	CV reheat no econ	2,005	0.097
		CV reheat econ	2,011	0.097
		VAV reheat econ	2,085	0.234
	Fort Wayne	CV reheat no econ	2,007	0.095
		CV reheat econ	2,010	0.095
		VAV reheat econ	2,082	0.234
	Terre Haute	CV reheat no econ	1,953	0.096
		CV reheat econ	1,956	0.096
		VAV reheat econ	2,078	0.096

Energy and Demand Savings Factors for Hotels

Measure	City	System	SF_{kWh} (kWh/unit)	SF_{kW} (kW/unit)
VFD Return Fan	Indianapolis	VAV reheat econ	276	0.133
	South Bend		276	0.117
	Evansville		150	0.00
	Fort Wayne		243	0.126
	Terre Haute		200	0.065
VFD Supply Fan	Indianapolis		163	0.126
	South Bend		164	0.121

Measure	City	System	SF_{kWh} (kWh/unit)	SF_{kW} (kW/unit)
	Evansville		59	0.004
	Fort Wayne		127	0.124
	Terre Haute		95	0.052
VFD Tower Fan	Indianapolis	CV reheat no econ	1,416	0.00
		CV reheat econ	1,124	0.00
		VAV reheat econ	832	0.00
	South Bend	CV reheat no econ	1,536	0.00
		CV reheat econ	1,193	0.00
		VAV reheat econ	850	0.00
	Evansville	CV reheat no econ	1,428	0.00
		CV reheat econ	1,176	0.00
		VAV reheat econ	924	0.00
	Fort Wayne	CV reheat no econ	1,378	0.00
		CV reheat econ	1,103	0.00
		VAV reheat econ	828	0.00
	Terre Haute	CV reheat no econ	1,349	0.00
		CV reheat econ	1,076	0.00
		VAV reheat econ	804	0.00
VFD CHW Pump	Indianapolis	CV reheat no econ	6,657	0.639
		CV reheat econ	6,938	0.639
		VAV reheat econ	6,977	0.609
	South Bend	CV reheat no econ	6,709	0.646
		CV reheat econ	7,021	0.646
		VAV reheat econ	7,109	0.612
	Evansville	CV reheat no econ	6,596	0.597
		CV reheat econ	6,857	0.597
		VAV reheat econ	6,874	0.597
	Fort Wayne	CV reheat no econ	6,760	0.606
		CV reheat econ	7,014	0.606
		VAV reheat econ	7,085	0.606
	Terre Haute	CV reheat no econ	6,643	0.594
		CV reheat econ	6,898	0.594
		VAV reheat econ	6,945	0.621
VFD HW Pump	Indianapolis	CV reheat no econ	7,903	0.704
		CV reheat econ	6,557	0.704
		VAV reheat econ	6,574	0.704
	South Bend	CV reheat no econ	7,978	0.704
		CV reheat econ	6,521	0.704
		VAV reheat econ	6,540	0.704
	Evansville	CV reheat no econ	8,086	0.704
		CV reheat econ	6,681	0.704
		VAV reheat econ	6,720	0.704

Measure	City	System	SF_{kWh} (kWh/unit)	SF_{kW} (kW/unit)
	Fort Wayne	CV reheat no econ	8,117	0.704
		CV reheat econ	6,592	0.704
		VAV reheat econ	6,621	0.704
	Terre Haute	CV reheat no econ	8,037	0.704
		CV reheat econ	6,607	0.704
		VAV reheat econ	6,610	0.704
VFD CW Pump	Indianapolis	CV reheat no econ	77	0.00
		CV reheat econ	72	0.00
		VAV reheat econ	67	0.00
	South Bend	CV reheat no econ	82	0.00
		CV reheat econ	75	0.00
		VAV reheat econ	67	0.00
	Evansville	CV reheat no econ	79	0.00
		CV reheat econ	73	0.00
		VAV reheat econ	67	0.00
	Fort Wayne	CV reheat no econ	79	0.00
		CV reheat econ	72	0.00
		VAV reheat econ	64	0.00
	Terre Haute	CV reheat no econ	78	0.00
		CV reheat econ	72	0.00
		VAV reheat econ	67	0.00

Energy and Demand Savings Factors for Large Offices

Measure	City	System	SF_{kWh} (kWh/unit)	SF_{kW} (kW/unit)
VFD Return Fan	Indianapolis	VAV reheat econ	1,406	0.287
	South Bend		1,339	0.189
	Evansville		1,387	0.239
	Fort Wayne		1,384	0.225
	Terre Haute		1,415	0.287
VFD Supply Fan	Indianapolis		1,771	0.356
	South Bend		1,689	0.234
	Evansville		1,782	0.297
	Fort Wayne		1,771	0.350
	Terre Haute		1,790	0.356
VFD Tower Fan	Indianapolis	CV reheat no econ	49	0.00
		CV reheat econ	71	0.00
		VAV reheat econ	10	0.00
	South Bend	CV reheat no econ	39	0.00
		CV reheat econ	59	0.00
		VAV reheat econ	28	0.00
	Evansville	CV reheat no econ	63	0.00

Measure	City	System	SF_{kWh} (kWh/unit)	SF_{kW} (kW/unit)
		CV reheat econ	77	0.00
		VAV reheat econ	45	0.00
	Fort Wayne	CV reheat no econ	23	0.00
		CV reheat econ	38	0.00
		VAV reheat econ	11	0.00
	Terre Haute	CV reheat no econ	84	0.00
		CV reheat econ	107	0.00
		VAV reheat econ	35	0.00
VFD CHW Pump	Indianapolis	CV reheat no econ	3,865	0.474
		CV reheat econ	4,099	0.476
		VAV reheat econ	4,016	0.432
	South Bend	CV reheat no econ	3,947	0.417
		CV reheat econ	4,249	0.417
		VAV reheat econ	4,101	0.159
	Evansville	CV reheat no econ	3,913	0.595
		CV reheat econ	4,064	0.587
		VAV reheat econ	3,701	0.390
	Fort Wayne	CV reheat no econ	4,114	0.441
		CV reheat econ	4,354	0.441
		VAV reheat econ	4,242	0.140
	Terre Haute	CV reheat no econ	3,603	0.423
		CV reheat econ	3,778	0.423
		VAV reheat econ	3,783	0.483
VFD HW Pump	Indianapolis	CV reheat no econ	3,933	1.001
		CV reheat econ	3,470	1.001
		VAV reheat econ	4,010	0.903
	South Bend	CV reheat no econ	3,557	0.887
		CV reheat econ	3,122	0.882
		VAV reheat econ	4,139	0.877
	Evansville	CV reheat no econ	3,637	0.833
		CV reheat econ	3,349	0.852
		VAV reheat econ	4,431	0.979
	Fort Wayne	CV reheat no econ	3,699	0.962
		CV reheat econ	3,183	0.971
		VAV reheat econ	4,038	2.035
	Terre Haute	CV reheat no econ	4,391	1.039
		CV reheat econ	3,840	1.035
		VAV reheat econ	4,206	0.961
VFD CW Pump	Indianapolis	CV reheat no econ	951	0.100
		CV reheat econ	1,123	0.100
		VAV reheat econ	1,328	0.100
	South Bend	CV reheat no econ	1,047	0.102

Measure	City	System	SF_{kWh} (kWh/unit)	SF_{kW} (kW/unit)
		CV reheat econ	1,165	0.100
		VAV reheat econ	1,298	0.100
	Evansville	CV reheat no econ	908	0.102
		CV reheat econ	1,028	0.100
		VAV reheat econ	1,206	0.102
	Fort Wayne	CV reheat no econ	1,079	0.101
		CV reheat econ	1,200	0.101
		VAV reheat econ	1,367	0.100
	Terre Haute	CV reheat no econ	826	0.101
		CV reheat econ	1,038	0.100
		VAV reheat econ	1,258	0.101

Energy Efficient Furnace (Time of Sale, Retrofit – Early Replacement)

	Measure Details
Official Measure Code	CI-HVAC-Furnace-1
Measure Unit	Per furnace
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by location
Peak Demand Reduction (kW)	Varies by location
Annual Fossil Fuel Savings (MMBtu)	Varies by location
Lifetime Energy Savings (kWh)	Varies by location
Lifetime Fossil Fuel Savings (MMBtu)	Varies by location
Water Savings (gal/yr)	0
Effective Useful Life (years)	20
Incremental Cost	$900.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of a high-efficiency natural gas furnace in lieu of a standard efficiency natural gas furnace. High-efficiency natural gas furnaces achieve savings through the use of a sealed, super insulated combustion chamber, more efficient burners, and multiple heat exchangers that remove a significant portion of the waste heat from the flue gasses. Because multiple heat exchangers are used to remove waste heat from the escaping flue gasses, most of the flue gasses condense and must be drained. Furnaces equipped with ECM fan motors can save additional electric energy.

Definition of Efficient Equipment

The efficient equipment is a natural gas-fired furnace with a minimum AFUE of 93%.

Definition of Baseline Equipment

The baseline equipment is a natural gas-fired furnace with an AFUE of 80%.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 20 years.[339]

[339] Based on engineering modeling by Michael Blasnik (M. Blasnik & Associates) and KEMA in support of "Application of Columbia Gas of Ohio, Inc. to Establish Demand Side Management Programs for Residential and Commercial Consumers," Filed with the Ohio Public Utilities Commission, Case No. 08-0833-GA-UNC, July 1, 2008.

Deemed Measure Cost

Incremental costs for this measure are estimated at $900.00.[340]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.[341]

Savings Algorithm

Energy Savings

If the furnace is equipped with ECM fan motors, the following algorithm can be used to calculate energy savings; otherwise, electric energy savings are zero:

$$\Delta kWh = CAP * EFLH_H * \left(10 * \frac{\eta_{EE}}{\eta_{BASE}} - 5\right)$$

Where:

CAP = Heating input capacity of installed equipment in MMBtu/hr

$EFLH_H$ = Equivalent full load heating hours (= dependent on building type and location, see table below)

Equivalent Full Load Heating Hours by Building Type and Location

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	874	954	611	1,009	659
Auto Repair	3,319	3,930	2,582	3,299	2,918
Big Box Retail	519	538	325	607	367
Fast Food Restaurant	1,253	1,383	824	1,463	907
Full Service Restaurant	1,164	1,396	768	1,441	893
Grocery	519	538	325	607	367
Light Industrial	1,113	1,205	718	1,289	775
Primary School	1,192	1,266	785	1,359	845
Religious Worship	923	1,070	677	1,085	779
Small Office	670	710	487	826	526
Small Retail	939	977	591	1,125	661
Warehouse	1,113	1,205	718	1,289	775
Other	1,133	1,264	784	1,283	873

340 Ibid.

341 Ibid.

10 = Non-ECM kWh per MMBtu of heating fuel consumption[342]

5 = ECM kWh per MMBtu of heating fuel consumption[343]

η_{EE} = Installed equipment efficiency (= actual)

η_{BASE} = Baseline equipment efficiency (= actual, otherwise, 80%)[344]

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta\text{MMBtu} = CAP * EFLH_H * \left(\frac{\eta_{BASE}}{\eta_{EE}} - 1\right) - MMBtu_{ECM}$$

Where:

$MMBtu_{ECM}$ = Increased heating fuel consumption due to decreased fan motor waste heat (for furnaces with ECM fan ONLY)

$$\Delta MMBtu_{ECM} = 0.019 * CAP * EFLH_H * \frac{\eta_{BASE}}{\eta_{EE}}$$

342 Adapted from "Electricity Use by New Furnaces: A Wisconsin Field Study," Energy Center of Wisconsin, October 2003. Assumes ECM fan motor savings scale linearly with annual fuel consumption.

343 Adapted from "Electricity Use by New Furnaces: A Wisconsin Field Study," Energy Center of Wisconsin, October 2003. Assumes ECM fan motor savings scale linearly with annual fuel consumption.

344 *ASHRAE 90.1-2007 Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters, Minimum Efficiency Requirements*. Dependent on equipment type and capacity. Minimum efficiency levels range from 78% to 81% and are either expressed as AFUE, combustion efficiency, or thermal efficiency. For analysis purposes, assume 80%.

Stack Damper (Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-HVAC-StackDamp-1
Measure Unit	Per damper
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	100
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	1,200
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	$150.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of a servo-controlled, exhaust vent stack damper on a boiler. The vent damper should be installed in the flue pipe, between the heating equipment and the chimney. A stack damper works like a flue damper on a fireplace by reducing draft, improving comfort, and minimizing heat loss. The vent damper can either be controlled by a heat sensor installed directly in the vent stack or by a mechanical switch connected to the thermostat, which is wired to work in unison with the ignition control switch on the boiler.

In combustion appliances that are directly vented to the atmosphere, there is a decrease in operating efficiency during standby, start-up, and shut-down. During these times, warm room air is drawn through the stack via the draft hood or dilution air inlet at a rate proportional to the stack height, diameter, and outdoor temperature. The most air is drawn through the vent immediately after the appliance shuts off and the flue is still hot. A vent damper can prevent residual heat from being drawn up the warm vent stack by closing itself. Vent dampers can also reduce the amount of air that passes through the furnace or boiler heat exchanger by regulating the start-up exhaust pressure, which can increase operating efficiency by reducing the time needed to achieve steady-state operating conditions. Lastly, by reducing air infiltration in the building, vent dampers can help to retain humidity, which can improve comfort during periods of high heating degree days.

Definition of Efficient Equipment

The efficient equipment is a vent stack with a damper installed.

Definition of Baseline Equipment

The baseline condition is a vent stack with no stack damper installed.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 12 years.[345]

Deemed Measure Cost

Incremental costs for this measure are estimated at $150.00.[346]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

There are not expected electrical energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = 100 \text{ MMBtu}$$ [347]

[345] CenterPoint Energy. *Triennial CIP/DSM Plan 2010-2012 Report*.

[346] Manufacturer research suggests a range of $80.00 to $200.00 in materials cost, depending on size, safety controls, and motor quality, as well as one to two hour average installation time.

[347] CenterPoint Energy – Triennial CIP/DSM Plan 2010-2012 Report. Based on information published by Natural Resources Canada and the Minneapolis Energy Office, savings estimates for stack dampers range from to 0 to 9.5% of total boiler gas consumption. This implies that the boiler capacity assumed to determine the deemed savings value is quite large and may overstate savings for smaller boilers. If significant participation for this measure is realized, it is suggested that the deemed savings estimate be abandoned in favor of a deemed calculated approach.

Natural Gas-Fired Infrared Heater (Time of Sale)

	Measure Details
Official Measure Code	CI-HVAC-IRHeater-1
Measure Unit	Per heater
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	11.4
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	171
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$920.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of a natural gas-fired infrared heater.

Definition of Efficient Equipment

An infrared heater heats primarily through radiation and conduction, as opposed to traditional forced-air space heaters that heat through convection. Infrared heaters are able to heat more efficiently because they directly heat the objects in the space, including the floor slab, which then radiate heat into the air space. With a forced hot air system, the heated air rises to the ceiling and stratifies, gradually working its way down to the floor level. The floor slab and equipment act as heat sinks, causing the ceiling level to be much warmer than the floor area, which will cause the forced air system to work much harder to heat the same space. What is more, forced-air systems can experience drastic losses of heated air-to-ventilation air changes. There is also a negligible amount of electricity use (burner ignition and natural gas valve) compared to a forced-air system that requires large fans to move air around the conditioned space.

Definition of Baseline Equipment

The baseline equipment is a standard natural gas-fired convection space heater.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 15 years.[348]

Deemed Measure Cost

Incremental costs for this measure are estimated at $920.00.[349]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

There are not expected electrical energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu = 11.4\ MMBtu^{350}$$

---

[348] Based on engineering modeling by GSE in support of "Application of Columbia Gas of Ohio, Inc., to Establish Demand Side Management Programs for Residential and Commercial Consumers," Filed with the Ohio Public Utilities Commission, Case No. 08-0833-GA-UNC, July 1, 2008. A review of savings assumptions used in Massachusetts indicates that this estimate is very conservative. The proposed value is only 85% of what is assumed for Massachusetts and should be considered for future study if this measure receives significant participation.

[349] Ibid.

[350] Ibid.

Energy Efficient Boiler (Time of Sale)

	Measure Details
Official Measure Code	CI-HVAC-Boiler-1
Measure Unit	Per boiler
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by system and location
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by system and location
Water Savings (gal/yr)	0
Effective Useful Life (years)	20
Incremental Cost	$5,000.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the replacement of an irreparable existing boiler with a high-efficiency, natural gas-fired steam or hot water boiler. High-efficiency boilers achieve natural gas savings through a sealed combustion chamber and multiple heat exchangers that remove a significant portion of the waste heat from flue gasses. Because multiple heat exchangers are used to remove waste heat from the escaping flue gasses, some of the flue gasses condense and must be drained.

Definition of Efficient Equipment

The efficient equipment is a natural gas-fired hot water or steam boiler exceeding the efficiency requirements as mandated by ASHRAE 90.1-2007.

Definition of Baseline Equipment

The baseline equipment is a natural gas-fired boiler meeting the efficiency requirements as mandated by ASHRAE 90.1-2007.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 20 years.[351]

[351] Based on engineering modeling by Michael Blasnik (M. Blasnik & Associates) in support of “Application of Columbia Gas of Ohio, Inc., to Establish Demand Side Management Programs for Residential and Commercial Consumers,” Filed with the Ohio Public Utilities Commission, Case No. 08-0833-GA-UNC, July 1, 2008.

Deemed Measure Cost

The incremental cost is estimated at $5,000.00.[352]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.[353]

Savings Algorithm

Energy Savings

There are no expected energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\text{Annual MMBtu Savings} = CAP * EFLH_H * \frac{\eta_{EE}}{\eta_{BASE}} - 1$$

Where:

CAP = Equipment heating input capacity in MMBtu/hr (= actual)

$EFLH_h$ = Equivalent full load heating hours (= determined with site-specific data; otherwise see table below)

Small Commercial Building Heating EFLH

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	874	954	611	1,009	659
Auto Repair	3,319	3,930	2,582	3,299	2,918
Big Box Retail	519	538	325	607	367
Fast Food Restaurant	1,253	1,383	824	1,463	907
Full Service Restaurant	1,164	1,396	768	1,441	893
Grocery	519	538	325	607	367
Light Industrial	1,113	1,205	718	1,289	775
Primary School	1,192	1,266	785	1,359	845
Religious Worship	923	1,070	677	1,085	779
Small Office	670	710	487	826	526
Small Retail	939	977	591	1,125	661
Warehouse	1,113	1,205	718	1,289	775
Other	1,133	1,264	784	1,283	873

352 Ibid.

353 Ibid.

Large Commercial Building Heating EFLH

Building Type	System	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Hotel	CAV no econ	703	697	585	703	782
	CAV econ	877	898	784	877	958
	VAV econ	401	367	229	401	437
Large Office	CAV no econ	2,627	2,066	1,785	2,543	2,389
	CAV econ	2,566	2,087	1,761	2,526	2,328
	VAV econ	531	333	294	538	386
Hospital	CAV no econ	3,503	3,073	3,476	3,227	3,005
	CAV econ	3,713	3,359	3,625	3,504	3,367
	VAV econ	604	604	363	613	302

η_{EE} = Installed equipment efficiency; expressed as AFUE, combustion efficiency, or thermal efficiency (= actual)

η_{BASE} = Baseline equipment efficiency; expressed as AFUE, combustion efficiency, or thermal efficiency (= see table below)

Equipment Type	Size Category (Input)	Subcategory Or Rating Condition	Minimum Efficiency*
Boilers, natural gas fired	< 300,000 Btu/hr	Hot water	80% AFUE
		Steam	75% AFUE
	≥ 300,000 Btu/hr and ≤ 2,500,000 Btu/hr	Minimum capacity	75% Thermal Efficiency
	>2,500,000 Btu/hr	Hot water	80% Combustion Efficiency
		Steam	80% Combustion Efficiency

* ASHRAE 90.1-2007 Boilers, Gas- and Oil-Fired, Minimum Efficiency Requirements.

Commercial Boiler Tune-Up

	Measure Details
Official Measure Code	CI-HVAC-BoilerTune-1
Measure Unit	Per tune-up
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by system and location
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by system and location
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	$850.00
Important Comments	
Effective Date	January 2012
End Date	TBD

Description

This measure is the tune-up of an existing commercial boiler to improve the seasonal heating efficiency.

Definition of Efficient Equipment

The efficient condition is the boiler after a tune-up is performed.

Definition of Baseline Equipment

The baseline condition is the existing boiler before a tune-up is performed.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 5 years.

Deemed Measure Cost

The incremental cost for this measure is $850.00[354] per boiler tune-up.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

354 This reflects tune-up costs for commercial boilers as listed in the Michigan Efficiency Measures Database.

Savings Algorithm

Energy Savings

There are no expected energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu = CAP * EFLH_H * ESF$$

Where:

CAP = Equipment heating input capacity in MMBtu/hr (= actual)

$EFLH_H$ = Equivalent full load heating hours (= actual; otherwise see table below)

ESF = Energy savings factor (= 0.02)[355]

Small Commercial Building Heating EFLH

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	874	954	611	1,009	659
Auto Repair	3,319	3,930	2,582	3,299	2,918
Big Box Retail	519	538	325	607	367
Fast Food Restaurant	1,253	1,383	824	1,463	907
Full Service Restaurant	1,164	1,396	768	1,441	893
Grocery	519	538	325	607	367
Light Industrial	1,113	1,205	718	1,289	775
Primary School	1,192	1,266	785	1,359	845
Religious Worship	923	1,070	677	1,085	779
Small Office	670	710	487	826	526
Small Retail	939	977	591	1,125	661
Warehouse	1,113	1,205	718	1,289	775
Other	1,133	1,264	784	1,283	873

355 The Michigan Efficiency Measures Database uses energy savings of approximately 2% for commercial boiler tune ups.

Large Commercial Building Heating EFLH

Building Type	System	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Hotel	CAV no econ	703	697	585	703	782
	CAV econ	877	898	784	877	958
	VAV econ	401	367	229	401	437
Large Office	CAV no econ	2,627	2,066	1,785	2,543	2,389
	CAV econ	2,566	2,087	1,761	2,526	2,328
	VAV econ	531	333	294	538	386
Hospital	CAV no econ	3,503	3,073	3,476	3,227	3,005
	CAV econ	3,713	3,359	3,625	3,504	3,367
	VAV econ	604	604	363	613	302

For example, the fossil fuel impacts from conducting a tune-up of a 3,000,000 Btu/hr boiler serving a large office with a VAV system in Indianapolis would be:

$$\Delta MMBtu = 3{,}000{,}000 \, * \, 531 * \, 0.02 \, * \, 10^{-6} = 31.9 \, MMBtu$$

Boiler Combustion Controls

	Measure Details
Official Measure Code	CI-HVAC-BlrCombCtrl-1
Measure Unit	Per Control
Measure Category	HVAC
Sector(s)	Commercial
Annual Energy Savings (kWh)	0
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	Varies by system
Lifetime Energy Savings (kWh)	0
Lifetime Fossil Fuel Savings (MMBtu)	Varies by system
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$0.85 per kBtuh of boiler output
Important Comments	
Effective Date	January 2012
End Date	TBD

Description

This measure is an oxygen trim control for a commercial boiler, which provides a 1.1% improvement in boiler efficiency.[356]

Definition of Efficient Equipment

The efficient condition is an existing boiler with an oxygen trim controller installed.

Definition of Baseline Equipment

The baseline condition is an existing boiler without oxygen trim controls.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 10 years.

Deemed Measure Cost

The incremental cost for this measure is $0.85 per kBtuh of boiler output.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

[356] Oxygen trim control savings taken from Michigan Boiler Oxygen Trim Control Work paper, prepared by Franklin Energy Services for the Michigan Efficiency Measures Database.

Savings Algorithm

Energy Savings

There are no expected energy savings associated with this measure.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu = CAP * EFLH_H * ESF * 10^{-6}$$

Where:

CAP = Equipment heating input capacity in Btuh (= actual)

ESF = Energy savings factor (= 0.011)

$EFLH_H$ = Equivalent full load heating hours (= actual; otherwise see table below)

Small Commercial Building Heating EFLH

Building	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Assembly	874	954	611	1,009	659
Auto Repair	3,319	3,930	2,582	3,299	2,918
Big Box Retail	519	538	325	607	367
Fast Food Restaurant	1,253	1,383	824	1,463	907
Full Service Restaurant	1,164	1,396	768	1,441	893
Grocery	519	538	325	607	367
Light Industrial	1,113	1,205	718	1,289	775
Primary School	1,192	1,266	785	1,359	845
Religious Worship	923	1,070	677	1,085	779
Small Office	670	710	487	826	526
Small Retail	939	977	591	1,125	661
Warehouse	1,113	1,205	718	1,289	775
Other	1,133	1,264	784	1,283	873

Large Commercial Building Heating EFLH

Building Type	System	Indianapolis	South Bend	Evansville	Ft Wayne	Terre Haute
Hotel	CAV no econ	703	697	585	703	782
	CAV econ	877	898	784	877	958
	VAV econ	401	367	229	401	437
Large Office	CAV no econ	2,627	2,066	1,785	2,543	2,389
	CAV econ	2,566	2,087	1,761	2,526	2,328
	VAV econ	531	333	294	538	386
Hospital	CAV no econ	3,503	3,073	3,476	3,227	3,005
	CAV econ	3,713	3,359	3,625	3,504	3,367
	VAV econ	604	604	363	613	302

For example, the fossil fuel impact from installing combustion controls on a 3,000,000 Btuh boiler serving a large office with a VAV system in Indianapolis would be:

$$\text{Annual MMBtu Savings} = CAP * EFLH_H * ESF * 10^{-6}$$
$$= 3{,}000{,}000 * 531 * 0.011 * 10^{-6} = 17.5 \text{ MMBtu}$$

Lighting

C&I Lighting Controls (Time of Sale, Retrofit)

	Measure Details
Official Measure Code	CI-Ltg-Control-1
Measure Unit	Per control
Measure Category	Lighting
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	8
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of a new lighting control on a new or existing lighting system. Lighting control types include wall- or ceiling-mounted occupancy sensors, fixture-mounted occupancy sensors, remote-mounted daylight dimming sensors, fixture-mounted daylight dimming sensors, central lighting controls (time clocks), and switching controls for multi-level lighting. This measure relates to installing a new system in an existing building or a new construction application (i.e., time of sale). Lighting controls required by state energy codes are not eligible.

Definition of Efficient Equipment

The efficient equipment is a lighting system controlled by one of the lighting controls systems listed above.

Definition of Baseline Equipment

The baseline equipment is an uncontrolled lighting system operated by a manual switch.

Deemed Lifetime of Efficient Equipment

The expected measure lifetime for all lighting controls is 8 years.[357]

---

[357] California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008.

Deemed Measure Cost

The incremental capital cost for this measure is provided below.

Deemed Incremental Measure Cost by Type of Lighting Control

Lighting Control Type	Incremental Cost
Wall-Mounted Occupancy Sensors	$42*
Ceiling-Mounted Occupancy Sensors	$66*
Fixture-Mounted Occupancy Sensors	$125**
Remote-Mounted Daylight Dimming Sensors	$65**
Fixture-Mounted Daylight Dimming Sensors	$50**
Switching Controls for Multi-Level Lighting	$274*
Central Lighting Controls (Time Clocks)	$103***

* Source: Goldberg et al., KEMA. *State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs: Incremental Cost Study*. October 28, 2009.

** Source: Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions.* February, 19, 2010.

*** Source: California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. “Cost Values and Summary Documentation.” December 16, 2008.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = kW_{CONTROLLED} * Hours * (1 + WHF_E) * ESF$$

Where:

$kW_{CONTROLLED}$ = Total lighting load connected to the control in kW (= actual)

HOURS = Total lighting operating hours before lighting controls are installed (= actual from audit report; otherwise see table below)

Lighting Hours of Operation by Building Type

Building Type	HOURS	Source
Food Sales	5,544	OH TRM*
Food Service	3,357	Duke OH** + NC***
Health Care	6,802	Duke OH + NC
Hotel/Motel	3,754	Duke OH + NC
Office	3,253	Duke OH
Public Assembly	2,867	Duke OH + NC
Public Services (non-food)	3,299	Duke OH
Retail	4,984	Duke OH, I&M

Warehouse	3,824	Duke OH, I&M
School	2,379	Duke OH, I&M
College	3,749	Duke OH + NC
Industrial – 1 Shift	2,857	OH TRM
Industrial – 2 Shift	4,730	OH TRM
Industrial – 3 Shift	6,631	OH TRM
Exterior	4,300	OH TRM
Other	4,408	Duke OH

* Source: Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0.* March 22, 2010.

** Source: Hall, et al., TecMarket Works. *Evaluation of the Non-Residential Smart Saver Prescriptive Program in Ohio.* Prepared for Duke Energy Inc. 2010.

*** Source: Hall, et al., TecMarket Works. *Evaluation of the Non-Residential Smart Saver Prescriptive Program in North and South Carolina*. Prepared for Duke Energy Inc. 2011.

WHF_E = Lighting-HVAC interaction factor for energy representing the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting (= 0 if exterior lighting; otherwise see Appendix B)

ESF = Energy savings factor; the percentage of operating hours reduced due to installing occupancy lighting controls or time clocks, or the percentage of wattage reduction multiplied by the hours of dimming for dimming lighting controls and multilevel switching (= dependent on control type, see table below)

Energy Saving Factor Percentage by Lighting Control Type

Lighting Control Type	ESF*
Wall- or Ceiling-Mounted Occupancy Sensors	30%
Fixture-Mounted Occupancy Sensors	30%
Remote-Mounted Daylight Dimming Sensors	30%
Fixture-Mounted Daylight Dimming Sensors	30%
Switching Controls for Multi-Level Lighting	30%
Central Lighting Controls (Time Clocks)	10%

* Sources: (1) Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February, 19, 2010. (2) TecMarket Works. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Measures in Commercial and Industrial Programs.* September 1, 2009. (3) Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0.* March 22, 2010.

Summer Peak Coincident Demand Reduction

$$\Delta kW = kW_{CONTROLLED} * (1 + WHF_D) * CF$$

Where:

WHF_D = Lighting-HVAC interaction factor for demand representing the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting (= 0 if exterior lighting, otherwise see Appendix B)

CF = Summer peak coincidence factor (= dependent on control type, see table below)

Summer Peak Coincidence Factor by Lighting Control Type

Lighting Control Type	CF
Wall- or Ceiling-Mounted Occupancy Sensors	0.15*
Fixture-Mounted Occupancy Sensors	0.15*
Remote-Mounted Daylight Dimming Sensors	0.90**
Fixture-Mounted Daylight Dimming Sensors	0.90**
Switching Controls for Multi-Level Lighting	0.77**
Central Lighting Controls (Time Clocks)	0.00***

* Source: RLW Analytics. *Coincidence Factor Study Residential and Commercial Industrial Lighting Measures.* Spring 2007.
** Source: Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0.* March 22, 2010.
*** This is a conservative assumption based on professional judgment considering that time clocks are unlikely to produce significant savings during the summer peak period.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \Delta kWh * WHF_G$$

Where:

WHF_G = Lighting-HVAC interaction factor for natural gas heating impacts representing the increased natural gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting (= 0 if exterior lighting, otherwise see Appendix B)

Lighting Systems (Non-Controls) (Time of Sale, New Construction)

	Measure Details
Official Measure Code	CI-Ltg-FixtRep-NC-1
Measure Unit	Per unit
Measure Category	Lighting
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	Varies by project
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of new lighting equipment with an efficiency that exceeds that of the equipment that would have been installed following standard market practices. This characterization includes CFLs and fixtures, linear fluorescent lamps and fixtures, linear fluorescent fixtures replacing HID fixtures in high-bay applications, and HID fixtures. This measure could relate to replacing an existing unit at the end of its useful life or installing a new unit in a new or existing facility.

Definition of Efficient Equipment

The efficient equipment must have a higher efficiency than the existing equipment and meet program-specific equipment criteria.

Definition of Baseline Equipment

The assumed baseline equipment varies by technology type.

The assumed baseline for installation of a high bay fluorescent fixture is a metal halide system. The Energy Independence and Security Act of 2007 (EISA) requires that as of January 1, 2009, metal halide fixtures designed for use with lamps ≥150 W and ≤500W must use “probe start” ballasts with ballast efficiency ≥94% or “pulse start” ballasts with ballast efficiency ≥88. It is therefore likely that new metal halide fixtures will utilize “pulse start” technology. Therefore, the assumed baseline system is a magnetic ballast “pulse start” metal halide system.

The assumed baseline for installation of a fluorescent fixture varies by the efficient system installed. High Performance and Reduced Wattage T8s must comply with the requirements as published by the Consortium for Energy Efficiency[358].

Deemed Lifetime of Efficient Equipment

The expected measure lifetime is dependent on technology type; see table below.

Measure Lifetime by Technology Type

Technology Type	Lifetime
Screw-in CFL	3.2 years*
CFL Fixture	12 years**
High Bay Fluorescent Fixture	15 years***
High-Efficiency Linear Fluorescent Fixtures (4 foot lamps)	15 years+
High-Efficiency Linear Fluorescent Fixtures (all other lamp sizes)	15 years***
Metal Halide Track Lighting	15 years***
Ceramic Metal Halide	15 years***

* Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0*. March 22, 2010. Assumes a 12,000 hours lamp lifetime with extended burn times per start typical in commercial applications. Assumes 3,730 annual lighting operating hours for the commercial sector. Lamp lifetime is calculated as: 12,000 / 3,730 = 3.2 years.
** California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008.
*** GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007.
+ See discussion in Energy Savings section and Summer Peak Coincident Demand Reduction section.

Deemed Measure Cost

The incremental capital costs for this measure vary by the assumed baseline and efficient equipment scenarios (see table below).

358 The Consortium for Energy Efficiency publishes the High Performance T8 Specifications and the Reduced Wattage T8 Specifications periodically including a list of qualifying equipment at the following address: http://www.cee1.org

Incremental Costs by Measure Type

Measure Type	Incremental Cost
Screw-in CFL	$3.00*
CFL Fixture (1-lamp)	$35.00**
CFL Fixture (2-lamp)	$40.00**
High Bay Fluorescent Fixture	$150.00***
High-Efficiency Linear Fluorescent Fixture	$25.00+
20 Watt Ceramic Metal Halide	$130.00***
39 Watt Ceramic Metal Halide	$130.00***
50 Watt Ceramic Metal Halide	$95.00***
70 Watt Ceramic Metal Halide	$95.00***
100 Watt Ceramic Metal Halide	$90.00***
150 Watt Ceramic Metal Halide	$90.00***
20 Watt Metal Halide Track	$155.00***
39 Watt Metal Halide Track	$155.00***
70 Watt Metal Halide Track	$145.00***

* Based on a review of TRM assumptions from Connecticut, New Jersey, New York, and Vermont.

** Based on review of TRM assumptions from California, New York, Vermont, and Northwestern states.

*** Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February, 19, 2010.

+ Ibid, p. 110 (incremental costs vary from $20 to $27.50 for 1 to 4 lamps).

Deemed O&M Cost Adjustment

In order to account for the shift in baseline due to federal legislation, the levelized baseline replacement cost over the lifetime of the CFL is calculated using the key assumptions shown in the table below.

Baseline Replacement Cost Assumptions

	Standard Incandescent	Efficient Incandescent
Replacement Cost	$0.50	$2.00
Component Life (years; based on lamp life / assumed annual run hours)	0.27*	0.81**

* Assumes rated life of incandescent bulb of approximately 1,000 hours.

** Best estimate of future technology from Ohio Technical Reference Manual.

The calculated net present value of the baseline replacement costs for CFL is $7.50.

Deemed O&M cost adjustments for high-bay fluorescent fixtures were developed assuming a typical baseline system and two typical efficient equipment scenarios. For T5HO high bay fixtures replacing pulse-start metal halide fixtures, the levelized annual baseline replacement cost assumption is $5.87. For

T8VHO high bay fixtures replacing pulse-start metal halide fixtures, the levelized annual baseline replacement cost assumption is -$1.69. The assumptions used to calculate these adjustments are detailed below.

- Baseline 320 Watt Metal-Halide Lamp Cost: $25.00
- Baseline 320 Watt Lamp Life: 15,000 hrs
- Baseline Lamp Labor Cost: $5.00 (15 min @ $20 per hour labor)
- Baseline 320 Watt Ballast Cost: $60.00
- Baseline Ballast Life: 40,000 hrs
- Baseline Ballast Labor Cost: $22.50 (30 min @ $45 per hour labor)
- T5 High-Bay Lamp Cost: $5.00 per lamp (assumes 4 lamps fixture)
- T5 High-Bay Lamp Life: 20,000 hrs
- T5 High-Bay Lamp Labor Cost: $6.67 (20 min @ $20 per hour labor)
- T5 High-Bay Ballast Cost: $51.00
- T5 High-Bay Ballast Life: 70,000 hrs
- T5 High-Bay Ballast Labor Cost: $22.50 (30 min @ $45 per hour labor)
- T8 High-Bay Lamp Cost: $10.00 per lamp (assumes 6 lamp fixture)
- T8 High-Bay Lamp Life: 18,000 hrs
- T8 High-Bay Lamp Labor Cost: $13.33 (40 min @ $20 per hour labor)
- T8 High-Bay Ballast Cost: $100.00 (2 ballasts)
- T8 High-Bay Ballast Life: 70,000 hrs
- T8 High-Bay Ballast Labor Cost: $45.00 (60 min @ $45 per hour labor)

O&M cost adjustments were developed assuming a typical baseline and efficient equipment scenario. For ceramic metal halide fixtures replacing halogen fixtures, the levelized annual baseline replacement cost assumption is $24.29. The assumptions used to calculate these adjustments are detailed below.

- Baseline 75 Watt Halogen Lamp Cost: $30.00 (3 lamps)
- Baseline 75 Watt Halogen Lamp Life: 2,500 hrs
- Baseline 75 Watt Halogen Lamp Labor Cost: $2.67
- 70 Watt CMH Lamp Cost: $60.00
- 70 Watt CMH Lamp Life: 12,000 hrs
- 70 Watt CMH Lamp Labor Cost: $2.67
- 70 Watt CMH Ballast Cost: $90.00
- 70 Watt CMH Ballast Life: 40,000 hrs
- 70 Watt CMH Ballast Labor Cost: $22.50 (30 min @ $45 per hour labor)

Savings Algorithm

Energy Savings

Non-CFLs

$$\Delta kWh = (WATTS_{BASE} - WATTS_{EE}) * Hours * \frac{(1+WHF_E)}{1{,}000}$$

Where:

$WATTS_{BASE}$ = Connected wattage of baseline fixtures (= assumed baseline wattage for time of sale application; see Appendix D – Standard Wattage Table) [359]

$WATTS_{EE}$ = Connected wattage of high-efficiency fixtures (= actual; otherwise see Appendix D – Standard Wattage Table)[360]

HOURS = Annual lighting operating hours (= actual from audit report or application; otherwise assume default values dependent on building type as shown in table below)

Annual Lighting Operating Hours by Building Type

Building Type	HOURS	Source
Food Sales	5,544	OH TRM*
Food Service	3,357	Duke OH** + NC***
Health Care	6,802	Duke OH + NC
Hotel/Motel	3,754	Duke OH + NC
Office	3,253	Duke OH
Public Assembly	2,867	Duke OH + NC
Public Services (non-food)	3,299	Duke OH
Retail	4,984	Duke OH, I&M
Warehouse	3,824	Duke OH, I&M
School	2,379	Duke OH, I&M
College	3,749	Duke OH + NC
Industrial – 1 Shift	2,857	OH TRM
Industrial – 2 Shift	4,730	OH TRM
Industrial – 3 Shift	6,631	OH TRM

359 In cases where Appendix D – Standard Wattage Table does not provide sufficient results, The Consortium for Energy Efficiency publishes the High Performance T8 Specifications and the Reduced Wattage T8 Specifications periodically including a list of qualifying equipment at the following address: http://www.cee1.org

360 Ibid

Exterior	4,300	OH TRM
Other	4,408	Duke OH

* Source: Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0.* March 22, 2010.
** Source: Hall, et al., TecMarket Works. *Evaluation of the Non-Residential Smart Saver Prescriptive Program in Ohio*. Prepared for Duke Energy Inc. 2010.
*** Source: Hall, et al., TecMarket Works. *Evaluation of the Non-Residential Smart Saver Prescriptive Program in North and South Carolina*. Prepared for Duke Energy Inc. 2011.

WHF_E = Lighting-HVAC interaction factor for energy representing the reduced electric space cooling requirements due to reduced waste heat rejected by the efficient lighting (= see Appendix B)

1,000 = Conversion factor from watts to kilowatts

CFL Bulbs and Fixtures

This measure is installing a new ENERGY STAR-certified CFL (for those equipment types with an ENERGY STAR category). This measure could relate to replacing an existing unit at the end of its useful life, or installing a new unit in a new or existing building (i.e., time of sale). This measure applies to installing a screw-in CFL to replace a standard general service incandescent lamp.

$$\text{Annual kWh Savings} = WATTS_{EE} * \text{DWM} * Hours * \frac{(1+WHF_E)}{1{,}000}$$

Where:

DWM = Delta Watts Multiplier (use table below) [361]

[361] Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0*.March 22, 2010. Source document cited several evaluations indicating that the overall average existing incandescent lamp was 75.7 watts, and that the overall average replacement lamp was 20.0 watts for CFLs smaller or equal to 32 watts. For the purposes of the characterization, it was assumed that the baseline and efficient wattages were directly proportional, and W_{BASE} to W_{EFF} ratio was 3.79 to 1, which means the DWM was 2.79. Since 2014 however, federal legislation stemming from the Energy Independence and Security Act of 2007 has required all general-purpose light bulbs between 40 and 100W to be approximately 30% more energy efficient than incandescent bulbs, in essence beginning the phase out of standard incandescent bulbs. New DWMs were calculated by finding the new baseline after incandescent bulb wattage was reduced (from 100W to 72W, 75W to 53W, 60W to 43W, and 40W to 29W). For example, prior to the phase-out, the average-sized CFL replacing a 60W incandescent was 60/ (3.79) = 16 W. Now that the 60W incandescent is replaced by a 43W halogen, the delta watts becomes 43 – 16 = 27, and the delta watts multiplier becomes 27/16 = 1.69.

Delta Watts Multiplier for Calculating Energy Savings

CFL Wattage	Delta Watts Multiplier
15 or less	1.72
16-20	1.69
21 or more	1.73

Summer Peak Coincident Demand Reduction

Non-CFLs

$$\Delta \text{kW} = (WATTS_{BASE} - WATTS_{EE}) * CF * \frac{(1+WHF_D)}{1{,}000}$$

Where:

WHF_D = Lighting-HVAC waste heat factor for demand that represents the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

CF = Summer peak coincidence factor (= dependent on building type as shown in table below)

Summer Peak Coincidence Factor by Building Type

Building Type	CF*
Food Sales	0.92
Food Service	0.83
Health Care	0.78
Hotel/Motel	0.37
Office	0.76
Public Assembly	0.65
Public Services (non-food)	0.64
Retail	0.84
Warehouse	0.79
School	0.50
College	0.68
Industrial	0.76
Garage	1.00**

Building Type	CF*
Exterior	0.00***
Other	0.65

* Methodology adapted from: Kuiken et al., KEMA. *State of Wisconsin Public Service Commission of Wisconsin Focus on Energy Evaluation Business Programs: Deemed Savings Parameter Development*. November 13, 2009. (defining the summer peak coincident period as June through August on weekdays between 3:00 p.m. and 6:00 p.m., unless otherwise noted).
** Assumption consistent with 8,760 operating hours.
*** Assumes that no exterior lighting is operating during summer peak demand.

CFL Bulbs and Fixtures

$$\Delta \text{kW} = WATTS_{EE} * \text{DWM} * Hours * \frac{(1+WHF_D)}{1{,}000}$$

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \Delta kWh * WHF_G$$

Where:

WHF_G = Lighting-HVAC interaction factor for natural gas heating impacts that represents the increased natural gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

Lighting Power Density Reduction (New Construction)

	Measure Details
Official Measure Code	CI-Ltg-LPD-1
Measure Unit	Per unit
Measure Category	Lighting
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	Varies by project
Important Comments	
Effective Date	
End Date	

Description

This measure is implementing various lighting design principles to create a quality and appropriate lighting experience while reducing unnecessary light usage. This is often done by a professional in a new construction situation. Techniques like maximizing daylighting, task lighting, and efficient fixtures are used to create a system of optimal functionality while reducing total lighting power density.

Definition of Efficient Equipment

The efficient condition is high-efficiency equipment consisting of a lighting system that exceeds the lighting power density requirements as mandated by ASHRAE 90.1-2007 Table 9.5.1 or Table 9.6.1.

Definition of Baseline Equipment

The baseline efficiency assumes compliance with lighting power density requirements as mandated by ASHRAE 90.1-2007 Table 9.5.1 or Table 9.6.1.

Deemed Lifetime of Efficient Equipment

The expected measure life is 15 years.[362]

[362] GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures.* June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

Deemed Measure Cost

The incremental capital costs for this measure vary by the assumed baseline and efficient equipment scenarios.

Deemed O&M Cost Adjustments

There are no cost adjustments associated with this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{LPD_{BASE} - LPD_{EE}}{1{,}000} * AREA * HOURS * (1 + WHF_E)$$

Where:

LPD_{BASE} = Allowed lighting power density (watts per square foot) based on energy code requirements for building or space type (= see ASHRAE 90.1-2007 Table 9.5.1 or Table 9.6.1)

LPD_{EE} = Installed lighting wattage per square foot of the efficient lighting system for building type as determined by site-surveys or design diagrams (= actual)

1,000 = Conversion factor from watts to kilowatts

AREA = Square footage of building (= determined from site-specific information)

HOURS = Annual operating hours of lighting system (= actual from audit report or application; otherwise assume default values dependent on building type as shown in table below)

Annual Lighting Operating Hours by Building Type

Building Type	HOURS	Source
Food Sales	5,544	OH TRM*
Food Service	3,357	Duke OH** + NC***
Health Care	6,802	Duke OH + NC
Hotel/Motel	3,754	Duke OH + NC
Office	3,253	Duke OH
Public Assembly	2,867	Duke OH + NC
Public Services (non-food)	3,299	Duke OH
Retail	4,984	Duke OH, I&M
Warehouse	3,824	Duke OH, I&M
School	2,379	Duke OH, I&M
College	3,749	Duke OH + NC
Industrial – 1 Shift	2,857	OH TRM
Industrial – 2 Shift	4,730	OH TRM
Industrial – 3 Shift	6,631	OH TRM

Building Type	HOURS	Source
Exterior	4,300	OH TRM
Other	4,408	Duke OH

* Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0*. March 22, 2010.
** Hall, et al., TecMarket Works. *Evaluation of the Non-Residential Smart Saver Prescriptive Program in Ohio*. Prepared for Duke Energy Inc. 2010.
*** Hall, et al., TecMarket Works. *Evaluation of the Non-Residential Smart Saver Prescriptive Program in North and South Carolina*. Prepared for Duke Energy Inc. 2011.

WHF_E = Lighting-HVAC interaction factor for energy representing the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{LPD_{BASE} - LPD_{EE}}{1{,}000} * AREA * CF * (1 + WHF_D)$$

Where:

WHF_D = Lighting-HVAC waste heat factor for demand representing the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

CF = Summer peak coincidence factor (= dependent on building type as shown in table below)

Summer Peak Coincidence Factor by Building Type

Building Type	CF*
Food Sales	0.92
Food Service	0.83
Health Care	0.78
Hotel/Motel	0.37
Office	0.76
Public Assembly	0.65
Public Services (non-food)	0.64
Retail	0.84
Warehouse	0.79
School	0.50
College	0.68
Industrial	0.76
Garage	1.00**

Building Type	CF*
Exterior	0.00***
Other	0.65

* Methodology adapted from: Kuiken et al., KEMA. *State of Wisconsin Public Service Commission of Wisconsin Focus on Energy Evaluation Business Programs: Deemed Savings Parameter Development*. November 13, 2009. (defining the summer peak coincident period as June through August on weekdays between 3:00 p.m. and 6:00 p.m., unless otherwise noted).

** Assumption consistent with 8,760 operating hours.

*** Assumes that no exterior lighting is operating during summer peak demand.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \Delta kWh * WHF_G$$

Where:

WHF_G = Lighting-HVAC interaction factor for natural gas heating impacts representing the increased natural gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

Lighting Systems (Non-Controls) (Early Replacement, Retrofit)

	Measure Details
Official Measure Code	CI-Ltg-FixtRep-ER-1
Measure Unit	Per unit
Measure Category	Lighting
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	Varies by project
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing new lighting equipment with efficiency that exceeds that of the existing equipment. This applies to CFLs and fixtures, linear fluorescent lamps and fixtures, linear fluorescent fixtures replacing HID fixtures in high bay applications, HID fixtures, and delamping. This measure could relate to the early replacement of an existing unit before the end of its useful life or the retrofit of a unit in an existing facility.

Note: See the Lighting Systems (Non-Controls) (Time of Sale, New Construction) measure above for calculation procedures for commercial screw-in CFLs and CFL fixtures.

Definition of Efficient Equipment

The efficient equipment must have higher efficiency than the existing equipment.

Definition of Baseline Equipment

The baseline equipment is the existing equipment before efficient equipment is installed. Default assumptions of the baseline equipment are presented in the tables below.

Deemed Lifetime of Efficient Equipment

The expected measure lifetime is dependent on technology type as shown in the table below.

Deemed Lifetime by Measure Type

Measure Type	Lifetime
Screw-in CFL	3.2 years*
Hardwired CFL	12 years**
High Bay Fluorescent Fixture	7 years***
High-Efficiency Linear Fluorescent Fixture	15 years***
Pulse Start Metal Halide	7.5 years+
Metal Halide Track Lighting	5 years***
Ceramic Metal Halide	15 years++
Delamping	10+++

* Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0*. March 22, 2010. Assumes a 12,000 hour lamp lifetime with extended burn times per start typical in commercial applications. Assumes 3,730 annual lighting operating hours for the commercial sector. The lamp lifetime is calculated as: 12,000 / 3,730 = 3.2 years.

** California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008.

*** GDS Associates. *Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures*. June 2007. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

+ The Energy Independence and Security Act of 2007 requires that as of January 1, 2009, metal halide fixtures designed for use with lamps ≥ 150 watts and ≤ 500 watts must use probe start ballasts with ballast efficiency ≥ 94% or pulse start ballasts with ballast efficiency ≥ 88%. This essentially means that new metal halide fixtures will use pulse start technology. Assuming that the age of the existing equipment being replaced is half of the total expected lifetime for a metal halide fixture (7.5 years), savings are only achieved for half of the lifetime of the new fixture (at which point the customer would have had to replace the inefficient technology with pulse start technology, negating any savings).

++ Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions.* February, 19, 2010.

+++ Based on a review of delamping measure life assumptions ranging from 9 to 16 years in California, Iowa, and Oregon as presented in: Energy & Resource Solutions. *Measure Life Study*. November 17, 2005. The high end of this range exceeds the assumed fixture lifetime and has been adjusted down to a more conservative 10 years to reflect expected persistence issues.

Deemed Measure Cost

The actual lighting measure installation cost should be used (including material and labor).

Deemed O&M Cost Adjustments

The deemed O&M cost adjustments should be determined on a case-by-case basis.

Savings Algorithm

Energy Savings

$$\Delta kWh = (WATTS_{BASE} - WATTS_{EE}) * HOURS * \frac{1+WHF_E}{1{,}000}$$

Where:

$WATTS_{BASE}$= Connected wattage of the baseline fixtures (= actual for early replacement application; otherwise see Appendix D – Standard Wattage Table) [363]

$WATTS_{EE}$ = Connected wattage of high-efficiency fixtures (= actual; otherwise see Appendix D – Standard Wattage Table) [364]

HOURS = Annual lighting operating hours (= actual from audit report or application; otherwise assume default values dependent on building type as shown in table below)

Annual Lighting Operating Hours by Building Type

Building Type	HOURS	Source
Food Sales	5,544	OH TRM*
Food Service	3,357	Duke OH** + NC***
Health Care	6,802	Duke OH + NC
Hotel/Motel	3,754	Duke OH + NC
Office	3,253	Duke OH
Public Assembly	2,867	Duke OH + NC
Public Services (non-food)	3,299	Duke OH
Retail	4,984	Duke OH, I&M
Warehouse	3,824	Duke OH, I&M
School	2,379	Duke OH, I&M
College	3,749	Duke OH + NC
Industrial – 1 Shift	2,857	OH TRM
Industrial – 2 Shift	4,730	OH TRM
Industrial – 3 Shift	6,631	OH TRM

363 In cases where Appendix D – Standard Wattage Table does not provide sufficient results, The Consortium for Energy Efficiency publishes the High Performance T8 Specifications and the Reduced Wattage T8 Specifications periodically including a list of qualifying equipment at the following address: http://www.cee1.org

364 Ibid

Exterior	4,300	OH TRM
Other	4,408	Duke OH

* Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0*. March 22, 2010.
** Hall, et al., TecMarket Works. *Evaluation of the Non-Residential Smart Saver Prescriptive Program in Ohio*. Prepared for Duke Energy Inc. 2010.
*** Hall, et al., TecMarket Works. *Evaluation of the Non-Residential Smart Saver Prescriptive Program in North and South Carolina*. Prepared for Duke Energy Inc. 2011.

WHF_E = Lighting-HVAC interaction factor for energy representing the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

1 / 1,000 = Conversion factor from watts to kilowatts

Summer Peak Coincident Demand Reduction

$$\Delta kW = (WATTS_{BASE} - WATTS_{EE}) * CF * \frac{1+WHF_D}{1{,}000}$$

Where:

WHF_D = Lighting-HVAC waste heat factor for demand representing the reduced electric space cooling requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

CF = Summer peak coincidence factor (= dependent on building type, see table below)

Summer Peak Coincidence Factor by Building Type

Building Type	CF*
Food Sales	0.92
Food Service	0.83
Health Care	0.78
Hotel/Motel	0.37
Office	0.76
Public Assembly	0.65
Public Services (non-food)	0.64
Retail	0.84
Warehouse	0.79
School	0.50
College	0.68
Industrial	0.76
Garage	1.00**

Exterior	0.00***
Other	0.65

* Methodology adapted from: Kuiken et al., KEMA. *State of Wisconsin Public Service Commission of Wisconsin Focus on Energy Evaluation Business Programs: Deemed Savings Parameter Development.* November 13, 2009. (defining summer peak coincident period as June through August on weekdays between 3:00 p.m. and 6:00 p.m., unless otherwise noted).
** Assumption consistent with 8,760 operating hours.
*** Assumes that no exterior lighting is operating during summer peak demand.

Fossil Fuel Impact Descriptions and Calculation

$$\Delta \text{MMBtu} = \Delta kWh \, * \, WHF_G$$

Where:

WHF_G = Lighting-HVAC interaction factor for natural gas heating impacts representing the increased natural gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

LED Exit Signs (Retrofit)

	Measure Details
Official Measure Code	CI-Ltg-LEDExit-1
Measure Unit	Per sign
Measure Category	Lighting
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	Varies by project
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	Varies by project
Water Savings (gal/yr)	0
Effective Useful Life (years)	16
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

These exit signs have a string of very small (typically red or green) glowing LEDs arranged in a circle or oval. The LEDs may also be arranged in a line on the side, top, or bottom of the exit sign. LED exit signs provide the best balance of safety, low maintenance, and very low energy usage compared to other exit sign technologies.

Definition of Efficient Equipment

The efficient equipment is an exit sign illuminated by light emitting diodes.

Definition of Baseline Equipment

The baseline equipment is a fluorescent exit sign.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 16 years.[365]

365 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008.

Deemed Measure Cost

The deemed measure cost is $30.00.[366]

Deemed O&M Cost Adjustments

The stream of replacement costs over the lifetime of the measure results in a net present value of $59.00. This computes to a levelized annual baseline replacement cost of $6.04.[367]

Savings Algorithm

Energy Savings

$$\Delta kWh = kW_{SAVE} * HOURS * ISR * (1 + WHF_E)$$

Where:

kW_{SAVE} = The difference in connected load between baseline equipment and efficient equipment (= 0.009)[368]

HOURS = Annual operating hours (= 8,760)

ISR = In-service rate; the percentage of rebated units actually in service (= 98%)[369]

WHF_E = Waste heat factor for energy accounting for cooling savings from efficient lighting (= see Appendix B)

Summer Peak Coincident Demand Reduction

$$\Delta kW = kW_{SAVE} * ISR * (1 + WHF_D)$$

---

366 New York State Energy Research and Development Authority. *Deemed Savings Database*. Labor cost assumes 25 minutes @ $18/hr.

367 This calculation assumes a replacement baseline CFL cost of $4.00 with an estimated labor cost of $5.00 (assuming $20/hour and a task time of 15 minutes). Lamp life is approximated as 2 years, assuming a 16,000 hour lamp life operating 8,760 hours per year.

368 Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February, 19, 2010.

369 Ibid.

Where:

ISR = In-service rate; the percentage of rebated units actually in service (= 98%)[370]

kW_{SAVE} = The difference in connected load between baseline equipment and efficient equipment (= 0.009)[371]

WHF_D = Waste heat factor for demand to account for cooling savings from efficient lighting (= see Appendix B)

The summer peak coincidence factor for this measure is 100%.[372]

Fossil Fuel Impact Descriptions and Calculation

$$\Delta MMBtu = \Delta kWh * WHF_G$$

Where:

WHF_G = Lighting-HVAC interaction factor for natural gas heating impacts representing the increased natural gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting (= see Appendix B)

370 Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February, 19, 2010.

371 Ibid.

372 Assuming continuous operation of an LED exit sign, the summer peak coincidence factor is 1.0.

Traffic Signals (Retrofit)

	Measure Details
Official Measure Code	CI-Ltg-LEDTraffic-1
Measure Unit	Per signal
Measure Category	Lighting
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is illuminating traffic and pedestrian signals with LEDs instead of incandescent lamps.

Definition of Efficient Equipment

The efficient condition is LED traffic and pedestrian signals.

Definition of Baseline Equipment

The baseline condition is incandescent traffic and pedestrian signals.

Deemed Lifetime of Efficient Equipment

The assumed lifetime of an LED traffic signal is 100,000 hours (manufacturer estimate), capped at 10 years.[373] The life in years is calculated by dividing 100,000 hours by the annual operating hours for the particular signal type.

Deemed Measure Cost

The actual measure installation cost should be used (including material and labor).

373 Suozzo, Margaret. "A Market Transformation Opportunity Assessment for LED Traffic Signals." Paper presented at the annual meeting for the American Council for an Energy-Efficient Economy, April 1, 1998. Available online: http://www.cee1.org/gov/led/led- ace3/ace3led.pdf

Deemed O&M Cost Adjustments

Because LEDs last much longer than incandescent bulbs, they offer O&M savings from avoided replacement lamps and the labor to install them. The following assumptions[374] are used to calculate the O&M savings:

- Incandescent bulb cost: $3.00 per bulb
- Labor cost to replace incandescent lamp: $60.00 per signal
- Life of incandescent bulb: 8,000 hours

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{W_{BASE} - W_{EFF}}{1{,}000} * HOURS$$

Where:

W_{BASE} = Connected load of baseline equipment (= see table in Reference Table section)

W_{eff} = The connected load of the efficient equipment (= see table in Reference Table section)

HOURS = Annual operating hours of the lamp (= see table in Reference Table section)

1,000 = Conversion factor from watts to kilowatts

For example, the energy savings from an 8-inch red, round signal would be:

$$\Delta kWh = \frac{69 - 7}{1{,}000} * 4{,}818 = 299 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{W_{BASE} - W_{EFF}}{1{,}000} * CF$$

[374] Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February, 19, 2010.

Where:

W_{BASE} = Connected load of baseline equipment (= see table in Reference Table section)

W_{EFF} = Connected load of efficient equipment (= see table in Reference Table section)

CF = Summer peak coincidence factor (= see table below)[375]

Coincidence Factors by Traffic Lamp Type

Lamp Type	CF
Red Balls	0.55
Red Arrows	0.86
Green Balls	0.43
Green Arrow	0.08
Yellow Balls	0.02
Yellow Flashing	0.50
Yellow Arrow	0.08
Pedestrian	1.00

For example, the demand reduction from an 8-inch red, round signal would be:

$$\Delta kW = \frac{69-7}{1{,}000} * 0.55 = 0.0341 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

Reference Table

Traffic Signals Technology Equivalencies (Incandescent to LED)*

Traffic Fixture Type	Fixture Size and Color	HOURS	Efficient Fixture Wattage	Baseline Fixture Wattage	Energy Savings (kWh)	Demand Reduction (kW)
Flashing Signal	8” Red	4,380	7	69	272	0.034
	12” Red	4,380	6	150	631	0.079
	8” Yellow	4,380	10	69	258	0.03
	12” Yellow	4380	13	150	600	0.069
Round Signals	8” Red	4,818	7	69	299	0.034

375 Pennsylvania Public Utility Commission. Technical Reference Manual for Pennsylvania Act 129 Energy Efficiency and Conservation Program and Act 213 Alternative Energy Portfolio Standards. June 2015

	12" Red	4,818	6	150	694	0.079
	8" Yellow	175	10	69	10	0.001
	12" Yellow	175	13	150	24	0.003
	8" Green	3,767	9	69	226	0.026
	12" Green	3,767	12	150	520	0.059
Turn Arrows	8" Red	7,358	5	116	817	0.095
	12" Red	7,358	6	116	809	0.095
	8" Yellow	701	7	116	76	0.009
	12" Yellow	701	9	116	75	0.009
	8" Green	701	7	116	76	0.009
	12" Green	701	7	116	76	0.009
Pedestrian Sign	12" Hand	8,760	8	116	946	0.108

* Pennsylvania Public Utility Commission. *Technical Reference Manual for Pennsylvania Act 129 Energy Efficiency and Conservation Program and Act 213 Alternative Energy Portfolio Standards*. June 2015.

Reference specifications for above traffic signal wattages are from the following manufacturers:

1. 8" incandescent traffic signal bulbs: General Electric Traffic Signal Model 17325-69A21/TS
2. 12" incandescent traffic signal bulbs: General Electric Signal Model 35327-150PAR46/TS
3. Incandescent arrows and hand/man pedestrian signs: General Electric Traffic Signal Model 19010-116A21/TS
4. 8" and 12" LED traffic signals: Leotek Models TSL-ES08 and TSL-ES12
5. 8" LED yellow arrows: General Electric Model DR4-YTA2-01A
6. 8" LED green arrows: General Electric Model DR4-GCA2-01A
7. 12" LED yellow arrows: Dialight Model 431-3334-001X
8. 12" LED green arrows: Dialight Model 432-2324-001X
9. LED hand/man pedestrian signs: Dialight 430-6450-001X

Light Tube Commercial Skylight (Time of Sale)

	Measure Details
Official Measure Code	CI-Ltg-LiteTube-1
Measure Unit	Per light tube
Measure Category	Lighting
Sector(s)	Commercial
Annual Energy Savings (kWh)	250
Peak Demand Reduction (kW)	0.104
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by project
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	10
Incremental Cost	$500.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is a tubular skylight 10-inches to 21-inches in diameter with a prismatic or translucent lens installed on the roof of a commercial facility. The lens reflects light captured from the 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 businesses in single-story commercial buildings.

Definition of Efficient Equipment

The efficient equipment is a tubular skylight that concentrates and directs light from the roof to an area inside the facility.

Definition of Baseline Equipment

The baseline equipment is a T8 fluorescent lamp with comparable luminosity. The specifications for the baseline lamp depend on the size of the light tube being installed.

Deemed Lifetime of Efficient Equipment

The estimated useful life for a light tube commercial skylight is 10 years.[376]

[376] Equal to the manufacturer standard warranty.

Deemed Measure Cost

If available, actual incremental cost should be used. For analysis purposes, assume an incremental cost for a light tube commercial skylight of $500.00.[377]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = kW_F * EFLH$$

Where:

kW_F	=	Kilowatts saved per fixture (= see table)
EFLH	=	Equivalent full load hours (= 2,400)[378]

Energy Savings per Fixture

Brand/Size	Lumen Output*	Equivalent Fixture	kW	kWh
Solatube 21”	13,500-20,500	2-3LF32T8 172 Watt	0.172	412.8
14”	6,000-9,100	1-3LF32T8	0.086	206.4
10”	3,000-4,600	3-18 Watt quad	0.054	129.6
Average			**0.104**	**249.6**

* Solatube. *Test Report No.: Solatube40.IES - Preliminary BETA Test Report.* 2005. Available online: http://www.mainegreenbuilding.com/files/file/solatube/stb_lumens_datasheet.pdf

Summer Peak Coincident Demand Reduction

$$\Delta kW = kW_F * CF$$

Where:

ΔkW_F	=	Kilowatts saved per fixture (= see table above, “Energy Savings per Fixture”)
CF	=	Coincidence factor (= 0.75)[379]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

377 Based on a review of available manufacturer pricing information.

378 Based on replacing electric lighting with daylight for 8 hour a day, 300 day a year.

379 Determined by taking the average of several building types for the 4p-5p peak period from the following report: RLW Analytics. Coincidence Factor Study - Residential and Commercial Industrial Lighting Measures. Spring 2007.

Plug Load

Vending Machine Occupancy Sensors (Time of Sale, New Construction, Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-Plug-Vending-1
Measure Unit	Per control
Measure Category	Plug Load
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by equipment type
Peak Demand Reduction (kW)	Varies by equipment type
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by equipment type
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	\$215.50 (Refrigerated), \$108.00 (Non-Refrigerated)
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is the installation of new controls on refrigerated beverage vending machines, non-refrigerated snack vending machines, and glass front refrigerated coolers. Controls can significantly reduce the energy consumption of vending machine and refrigeration systems. Qualifying controls must power these systems down during periods of inactivity but, in the case of refrigerated machines, must always maintain a cool product that meets customer expectations. This measure relates to installing a new control on a new or existing unit. This measure should **not** be applied to ENERGY STAR-qualified vending machines, which already have built-in controls.

Definition of Efficient Equipment

The efficient equipment is a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler with a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Definition of Baseline Equipment

The baseline equipment is a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler without a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Deemed Lifetime of Efficient Equipment

The expected measure life is 5 years.[380]

Deemed Measure Cost

The actual measure installation cost should be used (including material and labor), but the following can be assumed for analysis purposes:[381]

- Refrigerated Vending Machine: $215.50
- Non-Refrigerated Vending Machine: $108.00

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = \frac{WATTS_{BASE}}{1{,}000} * HOURS * ESF$$

Where:

$WATTS_{BASE}$ = Connected kilowatts of controlled equipment (= actual, see table below)

Equipment Type	$WATTS_{BASE}$*
Refrigerated Beverage Vending Machines	400
Non-Refrigerated Snack Vending Machines	85
Glass Front Refrigerated Coolers	460

* USA Technologies. *Energy Management Product Sheets*. July 2006.

1,000 = Conversion factor from watts to kilowatts

HOURS = Operating hours of connected equipment (= 8,760)

ESF = Energy savings factor; represents the percentage reduction in annual kWh consumption of equipment controlled (= see table below)

---

380 Energy & Resource Solutions. *Measure Life Study*. Prepared for the Massachusetts Joint Utilities. November 2005.

381 *2005 Database for Energy-Efficiency Resources (DEER), Version 2005.21*. "Cost Data for Supporting Documents."

Equipment Type	Energy Savings Factor*
Refrigerated Beverage Vending Machines	46%
Non-Refrigerated Snack Vending Machines	46%
Glass Front Refrigerated Coolers	30%

* USA Technologies. *Energy Management Product Sheets*. July 2006.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.[382]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

382 Assumed that the peak period is coincident with periods of high traffic, diminishing the demand reduction potential of occupancy based controls.

Commercial Plug Load – Smart Strip Plug Outlets (Time of Use, Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-Plug-Strip-1
Measure Unit	Per smart strip
Measure Category	Plug Load
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by measure
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	
Lifetime Fossil Fuel Savings (MMBtu)	
Water Savings (gal/yr)	0
Effective Useful Life (years)	8
Incremental Cost	$15.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

A smart strip plug outlet is a multi-plug power strip with the ability to automatically disconnect specific loads plugged in depending on the power draw of a control load, which is also plugged in. The energy savings are measured by estimating the number of hours that electronic devices at typical workstations are either in sleep mode or shut off and the standby loads consumed by the devices at those times. The smart strip will eliminate these standby loads and result in measureable energy savings. A smart strip plug outlet is purchased through a retail outlet and installed in an office environment where standby loads are uncontrolled.

Definition of Efficient Equipment

The efficient condition assumes that peripheral electronic office equipment is plugged into the controlled smart strip outlets, resulting in a reduction in standby load. No savings are associated with the control load, or loads plugged into the uncontrolled outlets.

Definition of Baseline Equipment

The baseline condition is a mix of typical office equipment (computer and peripherals) with uncontrolled standby load.

Deemed Lifetime of Efficient Equipment

The estimated useful life for a smart strip plug outlet is 8 years.[383]

Deemed Measure Cost

The estimated incremental cost for smart strip plug outlets is $15.00.[384]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{WORKDAYS * \Delta Wh_{WORKDAY} + (365 - WORKDAYS) * \Delta Wh_{NON\_WORKDAY}}{1,000}$$

383 British Columbia Hydro. *Smart Strip Electrical Savings and Usability.* October 2008.

384 Research Into Action, Inc. *Electronics and Energy Efficiency: A Plug Load Characterization Study.* Prepared for Southern California Edison. 2010. (This reflects the incremental costs over a standard power strip with surge protection with average market price of $35 for controlled power strip and $20 for baseline plug strip with surge protection.)

Where:

WORKDAYS = Average number of workdays, or business days, in a year (= 240)[385]

$\Delta Wh_{WORKDAY}$ = Energy savings from devices plugged into the strip on work days (= 62.7 Wh; see table below)

Standby Power Consumption from Devices Using Smart Strip Plug Outlets*

Plug Load	Watts in Standby	Hours in Standby	Watts When Off	Hours Off, Workday	Hours Off, Non-Workday	% of Strips	Weighted ΔWh, Workday	Weighted ΔWh, Non-Workday
LCD Monitor	1.4	4	1.1	12	24	69%	13.2	18.7
CRT Monitor	12.1	4	0.8	12	24	25%	14.5	4.8
Printer (average of laser and ink)	N/A	0	1.4	20	24	43%	12.2	14.7
Multifunction Printer (average of laser and ink)	N/A	0	4.2	20	24	12%	10.1	12.1
Speakers	1.8	4	1.8	12	24	1%	0.3	0.4
Scanner	N/A	0	2.5	20	24	7%	3.5	4.2
Copier	N/A	0	1.5	20	24	5%	1.5	1.8
Modem	3.9	16	3.8	0	24	8%	4.9	7.4
Charger	2.2	0	0.3	20	24	50%	2.6	3.1
Total							**62.7**	**67.1**

* Standby and off load values from Lawrence Berkeley National Laboratory. "Standby Power Summary Table." Last updated 2015. http://standby.lbl.gov/summary-table.html. Hours of operation based on engineering estimates.

$\Delta Wh_{NON\text{-}WORKDAY}$ = Energy savings from devices plugged into the strip on non-work days (= 67.1 Wh)

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.[386]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

385 This value is assuming two weeks of vacation and two weeks of holidays annually.

386 This is based on the assumption that most office equipment will be operating during the peak coincident hour.

Plug Load Occupancy Sensor (Retrofit)

	Measure Details
Official Measure Code	CI-Plug-OccSens-1
Measure Unit	Per control
Measure Category	Plug Load
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by device
Peak Demand Reduction (kW)	0
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by device
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	8
Incremental Cost	$70.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Plug load occupancy sensors control low wattage office equipment using an occupancy sensor. They typically use an infrared sensor to monitor movement, and use a smart strip to turn off connected devices, or put them in standby mode, when no one is present.

Definition of Efficient Equipment

The installed equipment must be a ‘smart’ power strip with both control and peripheral outlets, and an occupancy sensor.

Definition of Baseline Equipment

The baseline condition assumes a mix of typical document station office equipment (printers, scanners, fax machines, etc.) with uncontrolled standby load.

Deemed Lifetime of Efficient Equipment

The estimated useful life for a smart strip plug outlet is 8 years.[387]

Deemed Measure Cost

The incremental cost for this measure is $70.00.[388]

---

387 British Columbia Hydro. *Smart Strip Electrical Savings and Usability*. October 2008. Unit can only take one surge, then need to be replaced.

388 Research Into Action. *Plug Load Characterization Study*. Prepared for Southern California Edison. 2010.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = WORKDAYS * \frac{\Delta Wh_{SLEEP}}{1{,}000}$$

Where:

WORKDAYS = Average number of workdays, or business days, in a year (= 240)[389]

ΔWh_{SLEEP} = Daily energy savings from devices plugged into strip when in sleep mode (= 704 Wh; see table below)

Standby Power Consumption for Devices Using Smart Strip Plug Outlets* (All values in Watts)

Computer Peripherals	Connected Load When On	Connected Load in Sleep	Hours in Sleep Mode	Daily Savings (ΔWh_{SLEEP})
Laser Printer	131	2	4	516
Multi-function device, laser (scanner, fax)	50	3	4	188
Total				**704**

* Standby loads from: Lawrence Berkeley National Laboratory. "Standby Power Summary Table." Last updated 2015. http://standby.lbl.gov/summary-table.html.
Hours of operation based on engineering estimations.

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.[390]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

389 Assumes two weeks of vacation and two weeks of holidays annually.

390 Based on the assumption that office equipment will be running during the peak period.

Process

High Efficiency Pumps

	Measure Details
Official Measure Code	CI-Proc-Pump-1
Measure Unit	Per pump motor
Measure Category	Process
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by horsepower
Peak Demand Reduction (kW)	Varies by horsepower
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by horsepower
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is pump efficiency improvements in commercial and industrial applications.

Definition of Efficient Equipment

The efficient condition is an efficient pump and motor combination, with an EISA-compliant motor.

Definition of Baseline Equipment

The baseline condition is a standard efficiency pump and motor combination.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 15 years.

Deemed Measure Cost

The incremental cost for this measure is shown below.

Incremental Cost by Motor Size

Motor Size (hp)	Incremental Cost (per hp)
1.5	$233.33
2	$175.00
3	$116.67
5	$68.20
7.5	$66.40
10	$33.20
15	$39.00
20	$42.50

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = hp * 0.746 * \left(\frac{1}{\eta Motor_{BASE} * \eta Pump_{BASE}} - \frac{1}{\eta Motor_{Eff} * \eta Pump_{Eff}}\right) * LF * \frac{Hrs}{year}$$

Where:

hp	=	Horsepower of motor
$\eta Pump_{BASE}$	=	Baseline pump efficiency
$\eta Pump_{EFF}$	=	Efficient pump efficiency
$\eta Motor_{BASE}$	=	Baseline pump motor efficiency
$\eta Motor_{EFF}$	=	Efficient pump motor efficiency
LF	=	Motor load factor (= 0.66)
Hrs/year	=	Hours of pump operation per year (= actual; otherwise use 3,680)

Pump and motor efficiency are a function of the motor size, shown in table below.

Pump and Motor Efficiency by Motor Size

Motor Size (hp)	$\eta Pump_{BASE}$	$\eta Pump_{EFF}$	$\eta Motor_{BASE}$	$\eta Motor_{EFF}$
1.5	0.60	0.63	0.80	0.86
2	0.60	0.63	0.80	0.87
3	0.60	0.65	0.81	0.90
5	0.60	0.68	0.82	0.90
7.5	0.64	0.73	0.82	0.91
10	0.66	0.75	0.85	0.92
15	0.69	0.77	0.86	0.93
20	0.72	0.77	0.87	0.93

Some pump replacements may not involve a motor replacement. If the existing motor is retained, use the baseline motor efficiency in the calculations.

For example, the energy savings from upgrading a 10 hp pump and motor would be:

$$\Delta kWh = 10 * 0.746 * \left(\frac{1}{0.85 * 0.66} - \frac{1}{0.92 * 0.75}\right) * 0.66 * 3{,}680 = 6{,}038 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

$$\Delta kW = HP * 0.746 * \left(\frac{1}{\eta Motor_{BASE} * \eta Pump_{BASE}} - \frac{1}{\eta Motor_{Eff} * \eta Pump_{Eff}}\right) * LF * CF$$

Where:

CF = Summer peak coincidence factor (= 0.78)

For example, the demand reduction from upgrading a 10 hp pump and motor would be:

$$\Delta kW = 10 * 0.746 * \left(\frac{1}{0.85 * 0.66} - \frac{1}{0.92 * 0.75}\right) * 0.66 * 0.78 = 1.28 \text{ kW}$$

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

Deemed Savings for this Measure

Deemed values for Annual kWh and Summer Coincident Peak kW Savings as a function of pump motor size are estimated below.

Motor Size (hp)	kWh savings per year	kW savings
1.5	617	0.13
2	900	0.19
3	1,841	0.39
5	3,528	0.75
7.5	5,438	1.15
10	5,952	1.26
15	7,848	1.66
20	7,246	1.54

Engineered Nozzles (Time of Sale, Retrofit - Early Replacement)

	Measure Details
Official Measure Code	CI-Proc-CANozzle-1
Measure Unit	Per nozzle
Measure Category	Process
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by size
Peak Demand Reduction (kW)	Varies by size
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by size
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	$14.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Engineered nozzles use compressed air to entrain and amplify atmospheric air into a stream, thus increasing pressure with minimal compressed air use. They are able to induce a large airflow entrainment while still using a smaller volume of air than open jets. The velocity of the resulting airflow is reduced, but the mass flow of the air is increased, thus increasing the cooling and drying effect. Energy savings result due to the decrease in compressor work required to provide the nozzles with compressed air. Engineered nozzles have the added benefits of noise reduction and improved safety in systems with greater than 30 psig.

Definition of Efficient Equipment

The efficient condition is an engineered nozzle equipped to the end of a pneumatic tool.

Definition of Baseline Equipment

The baseline condition is an open copper tube or an air gun with an open end.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 15 years.[391]

[391] PA Consulting Group. *Business Programs: Measure Life Study.* Prepared for State of Wisconsin Public Service Commission. 2009.

Deemed Measure Cost

The deemed cost for this measure is $14.00.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = (FLOW_{BASE} - FLOW_{ENG}) * kW_{SCFM} * \%USE * HOURS$$

Where:

kW_{SCFM} = Average electrical demand needed to produce one cubic foot of air at 100 psi (= 0.29)

$FLOW_{BASE}$ = Flow rate of compressed air from an open end in SCFM[392]

$FLOW_{ENG}$ = Flow rate of compressed air from an engineered nozzle in SCFM (= depending on size of nozzle, see table below)

Flow Rate by Nozzle Size

	Open Flow (SCFM)* $FLOW_{BASELINE}$	Engineered Nozzle (SCFM)** $FLOW_{ENG}$	ΔSCFM
1/8" Nozzle	21	6	15
1/4" Nozzle	58	11	47

* Machinery's Handbook 25th Edition.

** Survey of Engineered Nozzle Suppliers.

%USE = Percentage of the compressor total operating hours that nozzle is in use (= 3 seconds of use per minute, or 0.05)[393]

HOURS = Annual operating hours of the compressed air system (= actual; otherwise based on number of facility shifts as shown in table below)

392 SCFM is the flowrate (cfm) at standard conditions of temperature, pressure, and humidity.

393 This value assumes 50% handheld air guns and 50% stationary air nozzles. Manual air guns tend to be used less than stationary air nozzles, and a conservative estimate of 1 second of blow-off per minute of compressor run time is assumed. Stationary air nozzles are commonly more wasteful, as they are often mounted on machine tools and can be manually operated (resulting in the possibility of a long-term open blow situation).

Annual Operating Hours by Number of Shifts

No. of Shifts	HOURS	Description
Single Shift (8:00 a.m. to 5:00 p.m.)	1,976	7:00 a.m. to 3:00 p.m. weekdays, minus holidays and scheduled downtime
Two Shifts	3,952	7:00 a.m. to 11:00 p.m. weekdays, minus holidays and scheduled downtime
Three Shifts	5,928	24 hours per weekday, minus holidays and scheduled downtime
Four Shifts	8,320	24 hours per day, minus holidays and scheduled downtime

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = \frac{\Delta\, kWh}{HOURS} * CF$$

Where:

ΔkWh = Energy savings as calculated above

HOURS = Annual operating hours

CF = Summer peak coincidence factor (= 0.75)[394]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

394 *Pacific Gas and Electric, and San Diego Gas and Electric Time of Use Surveys*. 1996. Values based on 4:00 p.m. to 5:00 p.m. as peak hour of use.

Insulated Pellet Dryers (Retrofit)

	Measure Details
Official Measure Code	CI-Proc-InsulPellet-1
Measure Unit	Per heat duct area
Measure Category	Process
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by load
Peak Demand Reduction (kW)	Varies by load
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by load
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Resin pellets used in injection molders and extruders are typically dried using electrically heated and desiccant dried air. Flexible ducts in the 3-inch to 8-inch diameter size range circulate the drying air. Air temperatures usually range from 160°F to 200°F. Un-insulated duct heat loss must be replaced by electric resistance heaters. Most facilities have pellet dryers running constantly to maintain pellet dryness at all times.

Definition of Efficient Equipment

The efficient condition is a pellet dryer with insulation on the heat ducts.

Definition of Baseline Equipment

The baseline condition is a pellet dryer with un-insulated heat ducts.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 5 years.[395]

Deemed Measure Cost

Incremental costs are based on the linear feet and diameter of heating ducts.

[395] This lifetime is based on engineering judgment.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = L * (kW_{BASE} - kW_{EFF}) * HOURS$$

Where:

L	=	Length of pipe to be insulated in feet
kW_{BASE}	=	Maximum hourly demand at technology level without insulation (= see table in Reference Table section)
kW_{EFF}	=	Maximum hourly demand at technology level with pipe insulation (= see table in Reference Table section)
HOURS	=	Annual operating hours (= 4,962)[396]

Summer Peak Coincident Demand Reduction

$$\Delta \text{kW} = L * (kW_{BASE} - kW_{EFF}) * CF$$

Where:

CF = Summer peak coincident factor (= 0.75)[397]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

Reference Table

Electric Demand by Load Temperature and Duct Diameter

Temperature (°F)	Duct Diameter (inches)	kW Baseline	kW Energy Efficient	ΔkW
160	3	0.03/ft	0.01/ft	0.02/ft
	4	0.04/ft	0.01/ft	0.03/ft
	5	0.05/ft	0.01/ft	0.04/ft
	6	0.06/ft	0.01/ft	0.05/ft
	8	0.09/ft	0.01/ft	0.08/ft
170	3	0.03/ft	0.01/ft	0.03/ft
	4	0.05/ft	0.01/ft	0.04/ft

396 PA Consulting Group Inc. *State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs: Deemed Savings Parameter Development*. August 2009.

397 *Pacific Gas and Electric, San Diego Gas and Electric, and Time of Use Surveys*. 1996.

Temperature (°F)	Duct Diameter (inches)	kW Baseline	kW Energy Efficient	ΔkW
	5	0.06/ft	0.01/ft	0.05/ft
	6	0.07/ft	0.01/ft	0.06/ft
	8	0.10/ft	0.01/ft	0.09/ft
180	3	0.04/ft	0.01/ft	0.03/ft
	4	0.05/ft	0.01/ft	0.04/ft
	5	0.07/ft	0.01/ft	0.06/ft
	6	0.08/ft	0.01/ft	0.07/ft
	8	0.11/ft	0.01/ft	0.10/ft
190	3	0.04/ft	0.01/ft	0.04/ft
	4	0.06/ft	0.01/ft	0.05/ft
	5	0.07/ft	0.01/ft	0.06/ft
	6	0.09/ft	0.01/ft	0.08/ft
	8	0.13/ft	0.02/ft	0.11/ft
200	3	0.05/ft	0.01/ft	0.04/ft
	4	0.07/ft	0.01/ft	0.06/ft
	5	0.08/ft	0.01/ft	0.07/ft
	6	0.10/ft	0.01/ft	0.09/ft
	8	0.14/ft	0.02/ft	0.12/ft

Injecting Molding Barrel Wrap (Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-Proc-IMMWrap-1
Measure Unit	Per blanket or vest
Measure Category	Process
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by operating temperature
Peak Demand Reduction (kW)	Varies by operating temperature
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by operating temperature
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Removable insulated blankets enclose the cylindrical barrels of an injection molding machine. Surface temperatures of the barrels range from 300°F to 600°F, depending on the resins processed. Barrels are heated either with electric resistance band heaters or by friction from the mechanical screw (which shears plastic material in the barrel, generating frictional heat). Insulated blankets minimize the use of resistance heating without affecting the temperature control of the resin. Barrel wraps are held in place by straps. Blankets are available either standard sizes or can be custom manufactured.

Definition of Efficient Equipment

The efficient condition is an injection molding machine with an insulating blanket or vest wrapped around the barrel.

Definition of Baseline Equipment

The baseline condition is an injection molding machine with no added insulation.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 5 years.

Deemed Measure Cost

The actual measure installation cost should be used (including material and labor).

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{\Delta E_{LOSS} * LEN_{BARREL} * D_{BARREL} * \pi}{1{,}000} * HOURS$$

Where:

ΔE_{LOSS} = Difference in heat loss (measured in watts per square foot needed to replace lost heat) between an injection molding barrel with insulation and an injection molding barrel without insulation (= dependent on operating temperature and thickness of insulation; see table below)

Difference in Heat Loss (W/sqft) by Operating Temperature and Insulation Thickness

Calculating Barrel Heat Loss*	Amount of Insulation		
Operating Temperature (°F)	No Insulation	1-Inch	1.5-Inches
300	180	18.6	12.4
325	210	20.9	14
350	243	23.4	15.6
375	275	26	17.3
400	313	29	19
425	350	31.5	21
450	387	34.3	22.9
475	425	37.2	24.8
500	465	40.1	25.8
525	505	43.2	26.9
550	550	46.5	28.3
575	605	49.9	29.9
600	660	54.1	32.1

* Industrial Modeling Supplies. *Reference/Conversion Chart*. 2009. Available online: http://www.imscompany.com/pdf/Tech%20Tips%20&%20Conversion%20and%20Reference%20Charts.pdf

LEN_{BARREL} = Length of barrel (= actual)

D_{BARREL} = Diameter of barrel (= actual)

π = Pi is used to calculate the surface area of the insulated barrel

1,000 = Conversion factor from watts to kilowatts

HOURS = Annual operating hours (= actual; otherwise assume 3,952)[398]

[398] The default annual operating hours assume that equipment operates continuously on a typical 2-shift operation (7:00 a.m. to 11:00 p.m. weekdays, minus some holidays and scheduled down time).

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta E_{LOSS} * LEN_{BARREL} * D_{BARREL} * \pi}{1,000} * CF$$

Where:

CF = Summer peak coincidence factor (= 0.75)[399]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

399 AUTHOR. *Pacific Gas and Electric, RLW Schools, RLW CF, and San Diego Gas and Electric Time of Use Surveys*. 1996. Pending verification based on information to be provided by the utilities.

Efficient Air Compressors (Time of Sale)

	Measure Details
Official Measure Code	CI-Proc-AirComp-1
Measure Unit	Per compressor
Measure Category	Process
Sector(s)	Industrial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	15
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing an air compressor with a variable frequency drive, load/no load controls, or variable displacement controls. Baseline compressors choke off the inlet air to modulate the compressor output, which is not efficient. Efficient compressors use less energy at part load conditions. Demand curves are per U.S. Department of Energy data for a variable speed compressor versus a modulating compressor. This measure could relate to replacing an existing unit at the end of its useful life, or installing a new system in a new building (i.e., time of sale).

Definition of Efficient Equipment

The efficient equipment is an air compressor with a variable frequency drive, load/no load controls,[400] or variable displacement controls.

Definition of Baseline Equipment

The baseline equipment is a modulating air compressor with blow down.

Deemed Lifetime of Efficient Equipment

The expected measure life is 15 years.[401]

---

400 For analysis purposes, it is assumed that the compressed air system with load/no load controls uses an air receiver with a storage capacity of 5 gallons per cubic foot per minute of compressor capacity.

401 Based on a review of TRM assumptions from Vermont, New Hampshire, Massachusetts, and Wisconsin. Estimates range from 10 to 15 years.

Deemed Measure Cost

The incremental capital costs for this measure should be determined on a case-by-case basis. For analysis purposes, assume the incremental costs specified in the table below.

Incremental Measure Cost by Compressor Type

Compressor Type	Incremental Cost*
Load/No Load	$200.00/hp
Variable Displacement	$250.00/hp
Variable Frequency Drive	$300.00/hp

* VEIC. *Technical Reference Manual (TRM) for Ohio Senate Bill 221 Energy Efficiency and Conservation Program and 09-512-GE-UNC*. October 15, 2009. Future study of these estimates is recommended, as published estimates of incremental costs for efficient air compressors are scarce. Costs do not include adding a receiver tank; it is assumed that a receiver tank of adequate size is an existing part of the system.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = Bhp * \frac{0.746}{\eta_{MOTOR}} * HOURS * ESF$$

Where:

Bhp = Compressor motor full load brake horsepower (= actual)

0.746 = Conversion factor from horsepower to kilowatts

η_{MOTOR} = Compressor motor nameplate efficiency (= actual; otherwise assume 90%)[402]

HOURS = Total hours of compressor operation (= actual)

ESF = Energy savings factor (= dependent on compressor control type as shown in table below)

[402] Improving Compressed Air System Performance: A Sourcebook for Industry, U.S. Department of Energy, November 2003.

Energy Saving Factor by Control Type

Control Type	Energy Savings Factor*
Load/No Load	10%
Variable Displacement	17%
Variable Frequency Drive	26%

* Developed using U.S. Department of Energy part load data for different compressor control types, as well as load profiles from 50 facilities employing air compressors.

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{HOURS} * CF$$

Where:

CF = Summer peak coincidence factor (= 0.38)[403]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

403 *Technical Reference Manual (TRM) for Ohio Senate Bill 221 Energy Efficiency and Conservation Program and 09-512-GE-UNC*. October 15, 2009. This is likely a conservative estimate, but is recommended for further study.

Commercial Clothes Washer (Time of Sale)

	Measure Details
Official Measure Code	CI-Proc-CloWash-1
Measure Unit	Per washer
Measure Category	Process
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by water heater
Peak Demand Reduction (kW)	Varies by water heater
Annual Fossil Fuel Savings (MMBtu)	Varies by water heater
Lifetime Energy Savings (kWh)	Varies by water heater
Lifetime Fossil Fuel Savings (MMBtu)	Varies by water heater
Water Savings (gal/yr)	15,854 gallons per year
Effective Useful Life (years)	10
Incremental Cost	Varies by CEE Tier
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

High-efficiency commercial washers are intended for purchase and installation in laundromats, multifamily buildings, and institutions. These high-efficiency washers are nearly identical to residential models available in retail outlets, with minor engineering changes, such as the addition of a coin box. High-efficiency commercial washers typically save up to 50% of the energy costs and use 30% less water.

Definition of Efficient Equipment

The efficient equipment is a commercial-grade clothes washer meeting the minimum efficiency standards for ENERGY STAR (MEF ≥ 2.0). Also, the facility where the equipment is installed must have an electric water heater.

Definition of Baseline Equipment

The baseline equipment is a commercial-grade clothes washer that meets federal manufacturing standards (MEF ≥1.26).

Deemed Lifetime of Efficient Equipment

The effective measure life for commercial-grade clothes washers is 10 years.[404]

---

404 *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values."

Deemed Measure Cost

The deemed measure cost is \$347.00 per unit ENERGY STAR/CEE Tier1, \$475.00 per unit CEE Tier 2, and \$604.00 per unit CEE Tier 3.[405]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = \Delta kWh_{LOAD} * Loads_{YEAR}$$

Where:

ΔkWh_{LOAD} = Difference in electricity consumption per load of laundry between baseline equipment and efficient equipment (= dependent on energy source for washer, see table below)[406]

Assumptions for Electricity and Natural Gas Consumption for Commercial Clothes Washers

Fuel Source	ΔkWh per Load	MMBtu per Load
Electric Hot Water, Electric Dryer	0.57	0
Natural Gas Hot Water, Electric Dryer	0.25	0.002

$Load_{YEAR}$ = Number of loads per year (= 950)[407]

For example, the energy savings from installing a commercial clothes washer in a facility with electric water heating and electric drying would be:

$$\Delta \text{kWh} = 0.57 * 950 = 541.5 \text{ kWh}$$

Summer Peak Coincident Demand Reduction

No demand reduction is claimed for this measure since there is insufficient peak coincident data.

405 *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. “Cost Values and Summary Documentation.”

406 ENERGY STAR. *Calculator for Commercial Clothes Washers.* July 2009. Values based on the difference between the average of all qualified models and the average of all unqualified models.

407 Multi-Family Laundry Association. *ENERGY STAR Calculator for Commercial Clothes Washers.* 2002.

Fossil Fuel Impact Descriptions and Calculation

Commercial clothes washers will only have fossil fuel impacts when either the washer, dryer, or both are powered by natural gas.

$$\Delta MMBtu = \Delta MMBtu_{LOAD} * Loads_{YEAR}$$

Where:

$\Delta MMBtu_{LOAD}$ = Difference in natural gas consumption per load of laundry between baseline equipment and efficient equipment (= dependent on energy source for washer and dryer, see table above)

$Loads_{YEAR}$ = Number of loads per year (= 950)

Water Impact Descriptions and Calculation

The water savings from a commercial clothes washer is 15,854 gallons per year.[408]

[408] ENERGY STAR. *Calculator for Commercial Clothes Washers.* July 2009. Average water consumption based on all qualified models.

Refrigeration

LED Case Lighting with/without Motion Sensors (New Construction; Retrofit – Early Replacement

	Measure Details
Official Measure Code	CI-Refrig-LEDCase-1
Measure Unit	Per fixture
Measure Category	Refrigeration
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by lamp type
Peak Demand Reduction (kW)	Varies by lamp type
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by lamp type
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	8
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing LED lamps with or without motion sensors in vertical display refrigerators, coolers, and freezers to replace T8 or T12 linear fluorescent lamp technology. LED lamps should be intended for this application. LED lamps not only provide the same light output with lower connected wattages, but produce less waste heat (which decreases the cooling load on the refrigeration system and the amount of energy needed by the refrigerator compressor). Additional savings can be achieved from installing a motion sensor that automatically dims the lighting system when the space is unoccupied. Retrofit projects must completely remove the existing fluorescent fixture end connectors and ballasts to qualify, though wiring may be reused. Eligible fixtures include new, replacement, and retrofit. Savings and assumptions are based on a per-door basis.

Definition of Efficient Equipment

The efficient equipment is LED case lighting with or without motion sensors on refrigerators, coolers, and freezers (specifically on vertical displays).

Definition of Baseline Equipment

The baseline equipment is T8 or T12 linear fluorescent lamps.

Deemed Lifetime of Efficient Equipment

The expected measure life is 8 years.[409]

Deemed Measure Cost

The incremental capital cost for this measure is $250.00 per door retrofit, or $150.00 for time of sale, new construction.[410]

If a motion sensor is installed, there is an additional cost of $130.00 per every 25 feet of case.[411]

Deemed O&M Cost Adjustments

The stream of baseline lamp replacement costs over the lifetime of the measure results in a net present value of $22.96.[412] This computes to a levelized annual baseline replacement cost assumption of $4.07.

- Baseline Lamp Cost: $4.00
- Baseline Lamp Life: 12,000 hours
- Baseline Lamp Labor Cost: $5.00 (15 min @ $20 per hour labor)

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{WATTS_{BASE} - WATTS_{EE}}{1{,}000} * (N + 1) * HOURS * (1 + WHF_E) * ESF_{MC}$$

Where:

$WATTS_{BASE}$ = Connected wattage per door of baseline fixtures (= see table below)

$WATTS_{EE}$ = Connected wattage per door of high-efficiency fixtures (= actual; otherwise see table below)

[409] Theobald, M. A., Pacific Gas and Electric Company. *Emerging Technologies Program: Application Assessment Report #0608, LED Supermarket Case Lighting Grocery Store, Northern California*. January 2006. Available online: http://www.etcc-ca.com/images/stories/pdf/ETCC_Report_204.pdf. Assumes 6,205 annual operating hours, and that the lifetime of the motion sensors is equal to the lifetime of the LED lighting.

[410] Based on a review of TRM incremental cost assumptions from Oregon and Vermont, supplemented with completed project information from New York.

[411] Michele Friedrich, Portland Energy Conservation. "LED Case Lighting With and Without Motion Sensors." Presentation. January 2010.

[412] This value is based on using a discount rate of 5.7% (as is used for Efficiency Vermont), and assumes the baseline ballast life exceeds the life of the LED assembly.

Baseline and Efficient Wattage by Measure Type*

Type of Measure	Efficient Lamp	Efficient Fixture Wattage ($WATTS_{EE}$)	Baseline Fixture Wattage ($WATTS_{BASE}$)	Fixture Savings (Watts)
Refrigerated Case Lighting (per door)	5' LED Case Lighting System	30	55	25
	6' LED Case Lighting System	36	66	20

* Based on Wisconsin TRM V4.0 (2015) assumption of 11 W/ft of baseline fluorescent case lighting and 6 W/ft of LED case lighting.

1,000 = Conversion factor from watts to kilowatts

N = Number of doors (= actual; note: N+1 accounts for the additional fixture that is present in a row of case lighting doors)

HOURS = Annual operating hours (= actual; otherwise assume 6,205)[413]

ESF_{MC} = Energy savings factor; additional savings percentage achieved with a motion sensor (= 1.0 if no motion sensor is installed; = 1.43 if motion sensor installed)[414]

WHF_E= Waste heat factor for energy to account for cooling savings from efficient lighting (= 0.41 for refrigerated space; = 0.52 for freezer space)[415]

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{WATTS_{BASE} - WATTS_{EE}}{1{,}000} * (N+1) * CF * (1 + WHF_D) * DSF_{MC}$$

[413] Theobald, M. A., Pacific Gas and Electric Company. *Emerging Technologies Program: Application Assessment Report #0608, LED Supermarket Case Lighting Grocery Store, Northern California*. January 2006. Available online: http://www.etcc-ca.com/images/stories/pdf/ETCC_Report_204.pdf. Assumes refrigerated case lighting typically operates 17 hours per day, 365 days per year.

[414] D. Bisbee, Sacramento Municipal Utility District. *Customer Advanced Technologies Program Technology Evaluation Report: LED Freezer Case Lighting Systems.* July 2008.

[415] Hall, N. et al., TecMarket Works. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Measures in Commercial and Industrial Programs.* September 1, 2009. This factor is a candidate for future adjustments due to climatic differences between Indiana and New York.

Where:

WHF_D = Waste heat factor for energy to account for cooling savings from efficient lighting (= 0.41 for prescriptive refrigerated lighting measures; = 0.52 for freezer space)[416]

DSF_{MC} = Demand savings factor; additional savings percentage achieved with a motion sensor (= 1.0 if no motion sensor is installed; = 1.43 if motion sensor installed)[417]

CF = Summer peak coincidence factor (= 0.92)[418]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts associated with this measure.

416 Ibid.

417 D. Bisbee, Sacramento Municipal Utility District. *Customer Advanced Technologies Program Technology Evaluation Report: LED Freezer Case Lighting Systems.* July 2008.

418 Kuiken et al., KEMA. *State of Wisconsin Public Service Commission of Wisconsin Focus on Energy Evaluation Business Programs: Deemed Savings Parameter Development.* November 13, 2009. Summer peak coincident period is defined as June through August on weekdays between 3:00 p.m. and 6:00 p.m., unless otherwise noted.

Refrigerated Case Covers (Time of Sale, New Construction, Retrofit – New Equipment)

	Measure Details
Official Measure Code	CI-Refrig-CaseCover-1
Measure Unit	Per cover
Measure Category	Refrigeration
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by linear foot
Peak Demand Reduction (kW)	Varies by linear foot
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by linear foot
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	5
Incremental Cost	$42.00 per linear foot
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

By covering refrigerated cases, the heat gain from spilling refrigerated air and convective mixing with room air is reduced at the case opening. Continuous curtains can be pulled down overnight while the store is closed, yielding significant energy savings.

Definition of Efficient Equipment

The efficient equipment is a refrigerated case with a continuous cover deployed during overnight periods. The savings are based on covers being deployed for six hours daily.

Definition of Baseline Equipment

The baseline equipment is a refrigerated case without a cover.

Deemed Lifetime of Efficient Equipment

The expected measure life is 5 years.[419]

419 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008.

Deemed Measure Cost

The incremental capital cost is $42.00 per linear foot of cover installed, including material and labor.[420]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta \text{kWh} = \frac{LOAD}{12{,}000} * FEET * \frac{3.516}{COP} * ESF * 8{,}760$$

Where:

LOAD	=	Average refrigeration load per linear foot of refrigerated case without night covers deployed (= 1,500 Btu/hr)[421]
12,000	=	Conversion factor of Btu per ton of cooling
FEET	=	Linear (horizontal) feet of covered refrigerated case (= actual)
3.516	=	Conversion factor from coefficient of performance to kilowatts per ton
COP	=	Coefficient of performance for refrigerated case (= actual; otherwise assume 2.2)[422]
ESF	=	Energy savings factor; reflects the percentage reduction in refrigeration load due to the deployment of night covers (= 9%)[423]
8,760	=	Assumed annual operating hours of refrigerated case

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.[424]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

420 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05.* "Cost Values and Summary Documentation." December 16, 2008.

421 Davis Energy Group. *Analysis of Standard Options for Open Case Refrigerators and Freezers.* May 11, 2004.

422 Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0.* March 22, 2010.

423 Southern California Edison. *Effects of the Low Emissivity Shields on Performance and Power Use of a Refrigerated Display Case*. August 8, 1997. Available online: http://www.sce.com/NR/rdonlyres/2AAEFF0B-4CE5-49A5-8E2C-3CE23B81F266/0/AluminumShield_Report.pdf

424 Because continuous covers are deployed at night, no demand reduction occurs during the peak period.

Door Heater Controls for Cooler or Freezer (Time of Sale)

	Measure Details
Official Measure Code	CI-Refrig-ASHCtrl-1
Measure Unit	Per heater
Measure Category	Refrigeration
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by connected load
Peak Demand Reduction (kW)	Varies by connected load
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by connected load
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	$200.00
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

Significant energy savings can be realized by installing a control device to turn off door heaters when there is little or no risk of condensation. There are two commercially available "on-off" control strategies for door heaters:

1. The first is based on the relative humidity of the air in the store. The system activates door heaters when the relative humidity in the store rises above a specific setpoint, and turns them off when the relative humidity falls below that setpoint.
2. The second is based on the conductivity of the door (which drops when condensation appears). The sensor activates door heaters when the door conductivity falls below a certain setpoint, and turns them off when the conductivity rises above that setpoint.

Definition of Efficient Equipment

The efficient equipment is a door heater control on a commercial glass door cooler or refrigerator with humidity or conductivity control.

Definition of Baseline Equipment

The baseline condition is a commercial glass door cooler or refrigerator with a standard heated door with no controls installed.

Deemed Lifetime of Efficient Equipment

The expected measure life is 12 years.[425]

Deemed Measure Cost

The incremental capital cost for a humidity based control is $300.00 per circuit, regardless of the number of doors controlled. The incremental cost for conductivity based controls is $200.00.[426]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = kW_{BASE} * NUM_{DOORS} * ESF * BF * 8{,}760$$

Where:

kW_{BASE}	=	Connected load kilowatts for typical reach-in refrigerator or freezer door and frame with a heater (= actual; otherwise assume 0.195 kW for freezers and 0.092 kW for coolers)[427]
NUM_{DOORS}	=	Number of reach-in refrigerator or freezer doors controlled by sensor (= actual)
ESF	=	Energy savings factor; represents the percentage of hours annually that the door heater is powered off due to the controls (= 55% for humidity based controls, = 70% for conductivity based controls)[428]
BF	=	Bonus factor; represents the increased savings due to the reduced cooling load inside the cases (=1.36 for low-temperature applications, =

[425] California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05.* "Effective/Remaining Useful Life Values." December 16, 2008.

[426] Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions.* February, 19, 2010.

[427] A review of TRM methodologies from Connecticut, New York, Vermont, and Wisconsin reveals several different sources for this factor. Connecticut requires site-specific information, whereas New York's characterization does not explicitly identify the kW_{BASE}. Connecticut and Vermont provide very consistent values, and the simple average of these two values was used.

[428] A review of TRM methodologies from Connecticut, New York, Vermont, and Wisconsin reveals several different estimates of the energy savings factor. Vermont has the only TRM that provides savings estimates dependent on the control type, and these estimates are the most conservative of all TRMs reviewed. The Vermont TRM values were adopted.

1.22 for medium-temperature applications, = 1.15 for high-temperature applications)[429]

Summer Peak Coincident Demand Reduction

There is no expected peak demand reduction associated with this measure.[430]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

---

[429] Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February, 19, 2010.

[430] This is based on the assumption that humidity levels will most likely be relatively high during the peak period, reducing the likelihood of demand reduction from door heater controls.

ENERGY STAR Ice Machine (Time of Sale, New Construction)

	Measure Details
Official Measure Code	CI-Refrig-IceMach-1
Measure Unit	Per machine
Measure Category	Refrigeration
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	9
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a new ENERGY STAR-qualified, air-cooled, cube-type commercial ice machine, including ice-making head, self-contained, and remote-condensing units. This measure could relate to replacing an existing unit at the end of its useful life, or installing a new system in a new or existing building.

Definition of Efficient Equipment

The efficient equipment is a commercial ice machine meeting the minimum ENERGY STAR efficiency standards.

Definition of Baseline Equipment

The baseline equipment is a commercial ice machine meeting the federal equipment standards established January 1, 2010.

Deemed Lifetime of Efficient Equipment

The expected measure life is 9 years.[431]

Deemed Measure Cost

The incremental capital cost for this measure is provided in the table below.

---

[431] The following report estimates the life of a commercial ice-maker at 7-10 years: Arthur D. Little, Inc. *Energy Savings Potential for Commercial Refrigeration Equipment*. 1996.

Incremental Capital Cost by Size of Machine

Harvest Rate (H)	Incremental Cost*
100-200 lb. ice machine	$296.00
201-300 lb. ice machine	$312.00
301-400 lb. ice machine	$559.00
401-500 lb. ice machine	$981.00
501-1,000 lb. ice machine	$1,485.00
1,001-1,500 lb. ice machine	$1,821.00
>1,500 lb. ice machine	$2,194.00

* These values are from electronic work papers prepared in support of the following report: San Diego Gas & Electric. *Application for Approval of Electric and Gas Energy Efficiency Programs and Budgets for Years 2009-2011*. March 2, 2009.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{kWh_{BASE} - kWh_{EE}}{100} * DC * H * 365$$

Where:

kWh_{BASE} = Maximum kilowatt-hour consumption per 100 pounds of ice for the baseline equipment (= dependent on machine type; see table below using the actual harvest rate (H) of efficient equipment)

kWh_{EE} = Maximum kilowatt-hour consumption per 100 pounds of ice for the efficient equipment (=dependent on machine type; see table below using the actual harvest rate (H) of efficient equipment)

Ice Machine Type	kWh_{BASE}*	kWh_{EE}**
Ice Making Head (H < 450)	10.26 - 0.0086*H	9.23 - 0.0077*H
Ice Making Head (H ≥ 450)	6.89 – 0.0011*H	6.20 - 0.0010*H
Remote Condensing Unit, without remote compressor (H < 1,000)	8.85 – 0.0038*H	8.05 - 0.0035*H
Remote Condensing Unit, without remote compressor (H ≥ 1,000)	5.1	4.64
Remote Condensing Unit, with remote compressor (H < 934)	8.85 – 0.0038*H	8.05 - 0.0035*H
Remote Condensing Unit, with remote compressor (H ≥ 934)	5.3	4.82
Self-Contained Unit (H < 175)	18 - 0.0469*H	16.7 - 0.0436*H
Self-Contained Unit (H ≥ 175)	9.8	9.11

* Baseline reflects federal standards that apply to units manufactured on or after January 1, 2010 (http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:3.0.1.4.17.8&idno=10).
** U.S. Environmental Protection Agency. *ENERGY STAR Program Requirements for Commercial Ice Machines, Partner Commitments*.

100 = Conversion factor from kWh_{BASE} and kWh_{EE} into maximum kilowatt-hour consumption per pound of ice

DC = Duty cycle of ice machine (= 0.57)[432]

H = Harvest rate of pounds of ice made per day (= actual)

365 = Days per year

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{HOURS * DC} * CF$$

[432] The duty cycle varies considerably from one installation to the next. TRM assumptions from New York Vermont, and Wisconsin vary from 40% to 57%, while the ENERGY STAR *Commercial Ice Machine Savings Calculator* assumes a value of 75% (http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Ice_Machines.xls). A field study of eight ice machines in California revealed an average duty cycle of 57% (Food Service Technology Center. *A Field Study to Characterize Water and Energy Use of Commercial Ice-Cube Machines and Quantify Saving Potential*. December 2007.). Furthermore, another report assumed a value of 40% (Nadel, S., American Council for an Energy-Efficient Economy. *Packaged Commercial Refrigeration Equipment: A Briefing Report for Program Planners and Implementers*. December 2002.). These savings are based on the average value of 57% from the California study.

Where:

HOURS = Annual operating hours (= 8,760)[433]

CF = Summer peak coincidence factor (= 0.772)[434]

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

Water Impact Descriptions and Calculation

While the ENERGY STAR labeling criteria have certain "maximum potable water use per 100 pounds of ice made" requirements for certified commercial ice machines, such requirements are intended to prevent equipment manufacturers from gaining energy efficiency at the cost of water consumptions. The AHRI *Certification Directory*[435] indicates that approximately 81% of air-cooled, cube-type machines meet the ENERGY STAR potable water use requirement. Therefore, there are no assumed water impacts for this measure.

433 A unit is assumed to be connected to power 24 hours per day, 365 days per year.

434 This value is based on the summer peak coincidence factor for commercial ice machines being consistent with that of general commercial refrigeration equipment. The savings use a value of 77.2% from: Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February 19, 2010.

435 Available online: http://www.ahridirectory.org/ahridirectory/pages/home.aspx

Commercial Solid Door Refrigerators & Freezers (Time of Sale, New Construction)

	Measure Details
Official Measure Code	CI-Refrig-Ref/Freez-1
Measure Unit	Per door
Measure Category	Refrigeration
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by equipment type
Peak Demand Reduction (kW)	Varies by equipment type
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	Varies by equipment type
Lifetime Fossil Fuel Savings (MMBtu)	0
Water Savings (gal/yr)	0
Effective Useful Life (years)	12
Incremental Cost	Varies by project
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This measure is installing a reach-in commercial refrigerator or freezer meeting ENERGY STAR efficiency standards. ENERGY STAR-labeled commercial refrigerators and freezers are more energy efficient because they are designed with components such as ECM evaporator and condenser fan motors, hot natural gas anti-sweat heaters, or high-efficiency compressors, which significantly reduce energy consumption. This measure could relate to replacing an existing unit at the end of its useful life, or installing a new system in a new or existing building.

Definition of Efficient Equipment

The efficient equipment is a solid or glass door refrigerator or freezer meeting the minimum ENERGY STAR efficiency standards.

Definition of Baseline Equipment

The baseline equipment is a solid or glass door refrigerator or freezer meeting the minimum federal manufacturing standards as specified by the Energy Policy Act of 2005.

Deemed Lifetime of Efficient Equipment

The expected measure life is 12 years.[436]

Deemed Measure Cost

The incremental capital cost for this measure is provided in the table below.

Incremental Cost by Refrigerator or Freezer Volume

Type	Refrigerator Incremental Cost*	Freezer Incremental Cost*
Solid or Glass Door		
Volume ≤ 15	$143.00	$142.00
15 ≤ Volume < 30	$164.00	$166.00
30 ≤ Volume < 50	$164.00	$166.00
Volume ≥ 50	$249.00	$407.00

* Estimates of the incremental cost for commercial refrigerators and freezers varies widely by source. One report indicates that the incremental cost is approximately $0.00 (Nadel, S., American Council for an Energy-Efficient Economy. *Packaged Commercial Refrigeration Equipment: A Briefing Report for Program Planners and Implementers*. December 2002.). Another report assumes incremental cost range from $75.00 to $125.00 depending on equipment volume (Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions.* February 19, 2010.). The American Council for an Energy-Efficient Economy notes that incremental cost ranges from 0% to 10% of the baseline unit cost (http://www.aceee.org/ogeece/ch5_reach.htm). These values use a 5% incremental cost adder on the full unit costs (as presented in: Goldberg et al., KEMA. *State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs: Incremental Cost Study*. October 28, 2009.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = (kWh_{BASE} - kWh_{EE}) * 365$$

Where:

kWh_{BASE} = Baseline maximum daily energy consumption in kilowatt hours (= dependent on chilled or frozen compartment volume (V) of efficient unit, see table below)

[436] California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Effective/Remaining Useful Life Values." December 16, 2008. Available online: http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

Baseline Daily Energy Consumption by Refrigerator or Freezer Volume

Type	kWh_{BASE}*
Solid Door Refrigerator	0.10 * V + 2.04
Glass Door Refrigerator	0.12 * V + 3.34
Solid Door Freezer	0.40 * V + 1.38
Glass Door Freezer	0.75 * V + 4.10

* U.S. Environmental Protection Agency. Energy Policy Act of 2005.

kWh_{EE} = Efficient maximum daily energy consumption in kilowatt hours (= dependent on chilled or frozen compartment volume of efficient unit, see table below)[437]

Efficient Daily Energy Consumption by Refrigerator or Freezer Volume

Type	Refrigerator kWh_{EE}	Freezer kWh_{EE}
Solid Door		
Volume ≤ 15	≤ 0.089V + 1.411	≤ 0.250V + 1.250
15 ≤ Volume < 30	≤ 0.037V + 2.200	≤ 0.400V – 1.000
30 ≤ Volume < 50	≤ 0.056V + 1.635	≤ 0.163V + 6.125
Volume ≥ 50	≤ 0.060V + 1.416	≤ 0.158V + 6.333
Glass Door		
Volume ≤ 15	≤ 0.118V + 1.382	≤ 0.607V + 0.893
15 ≤ Volume < 30	≤ 0.140V + 1.050	≤ 0.733V – 1.000
30 ≤ Volume < 50	≤ 0.088V + 2.625	≤ 0.250V + 13.500
Volume ≥ 50	≤ 0.110V + 1.500	≤ 0.450V + 3.500

V = Chilled or frozen compartment volume in square feet as defined in the Association of Home Appliance Manufacturers Standard HRF1–1979 (= actual)

365 = Days per year

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{HOURS} * CF$$

Where:

HOURS = Number of hours equipment is operating (= 8,760)

CF = Summer peak coincidence factor (= 1.0)

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

437 U.S. Environmental Protection Agency. *ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers Partner Commitments Version 2.0*.

Strip Curtain for Walk-in Coolers and Freezers (New Construction, Retrofit – New Equipment, Retrofit –Early Replacement)

	Measure Details
Official Measure Code	CI-Refrig-StripCurt-1
Measure Unit	Per curtain
Measure Category	Refrigeration
Sector(s)	Commercial
Annual Energy Savings (kWh)	2,974 (freezer), 422 (refrigerator)
Peak Demand Reduction (kW)	0.34 (freezer), 0.05 (refrigerator)
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	
Lifetime Fossil Fuel Savings (MMBtu)	
Water Savings (gal/yr)	0
Effective Useful Life (years)	6
Incremental Cost	$10.22 per square foot
Important Comments	
Effective Date	January 10, 2013
End Date	TBD

Description

This commercial measure is installing infiltration barriers (strip curtains) on walk-in coolers or freezers. Strip curtains impede heat transfer from adjacent warm and humid spaces into walk-ins when the main door is opened, thereby reducing the cooling load. As a result, the compressor run time and energy consumption are reduced. The savings values are based on the walk-in door being open 2.5 hours per day every day, and the strip curtain covering the entire door frame. Eligible applications include new construction and retrofit.

Definition of Efficient Equipment

The efficient equipment is a polyethylene strip curtain added to a walk-in cooler or freezer.

Definition of Baseline Equipment

The baseline assumption is a walk-in cooler or freezer with either no strip curtain installed or an old, ineffective strip curtain installed.

Deemed Lifetime of Efficient Equipment

The expected measure life is 6 years.[438]

[438] M. Goldberg, J.R. Barry, B. Dunn, M. Ackley, J. Robinson, and D. Deangelo-Woolsey, KEMA. *Focus on Energy: Business Programs – Measure Life Study*. August 2009.

Deemed Measure Cost

The incremental capital cost for this measure is $10.22 per square foot of door opening (includes material and labor).[439]

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

ΔkWh[440] = 2,974 for freezers

= 422 for coolers

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{8{,}760} * CF$$

Where:

8,760	=	Hours per year
CF	=	Summer peak coincidence factor (= 1.0)

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

439 California Public Utilities Commission. *2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05*. "Cost Values and Summary Documentation." December 16, 2008.

440 Values based on analysis prepared by ADM for FirstEnergy utilities in Pennsylvania, provided via personal communication with Diane Rapp of FirstEnergy on June 4, 2010. Based on a review of deemed savings assumptions and methodologies from Oregon and California, the values from Pennsylvania appear reasonable and are the most applicable to the Indiana climate.

Door Gaskets for Refrigerated Cases

	Measure Details
Official Measure Code	CI-Refrig-Gasket-1
Measure Unit	Per installation
Measure Category	Refrigeration
Sector(s)	Commercial
Annual Energy Savings (kWh)	Varies by project
Peak Demand Reduction (kW)	Varies by project
Annual Fossil Fuel Savings (MMBtu)	0
Lifetime Energy Savings (kWh)	
Lifetime Fossil Fuel Savings (MMBtu)	
Water Savings (gal/yr)	0
Effective Useful Life (years)	4
Incremental Cost	$2.25 per linear foot
Important Comments	
Effective Date	January 2013
End Date	TBD

Description

This measure is replacing worn-out gaskets with new, better fitting gaskets on glass or solid door reach-in coolers and freezers. Tight-fitting gaskets inhibit the infiltration of warm and moist air from the surrounding environment into the cold refrigerated space, thereby reducing the cooling load. They also prevent moisture from entering the refrigerated space and becoming frost on the cooling coils, reducing heat transfer effectiveness. As a result of these two factors, the compressor run time and energy consumption are reduced.

Definition of Efficient Equipment

The efficient condition is replacement door gaskets being applied to a reach-in cooler or freezer.

Definition of Baseline Equipment

The baseline condition is a reach-in cooler or freezer with worn gaskets.

Deemed Lifetime of Efficient Equipment

The expected lifetime of the measure is 4 years.

Deemed Measure Cost

The incremental cost for this measure is $2.25 per linear foot.

Deemed O&M Cost Adjustments

There are no expected O&M cost adjustments for this measure.

Savings Algorithm

Energy Savings

$$\Delta kWh = \frac{\Delta kWh}{LF} * LF$$

Where:

ΔkWh/LF = Kilowatt-hour savings per linear foot of gasket installed (= 3.3 for reach-in freezers; = 0.5 for reach-in coolers)[441]

LF = Linear feet of installed gasket (= actual)

Summer Peak Coincident Demand Reduction

$$\Delta kW = \frac{\Delta kWh}{8{,}760} * CF$$

Where:

ΔkWh = Annual kilowatt-hour savings from gasket replacement

CF = Summer peak coincidence factor (= 0.9)

Fossil Fuel Impact Descriptions and Calculation

There are no fossil fuel impacts from this measure.

441 ADM Associates. *Commercial Facilities Contract Group 2006-2008 Direct Impact Evaluation*. Study ID PUC0016.01. Prepared for California Public Utilities Commission. 2010.

Appendices

Appendix A – Prototypical Building Energy Simulation Model Development

Many of the savings values from the TRM are derived from DOE-2.2 simulations of typical commercial buildings. They are based on building prototypes originally developed to calculate savings for the California DEER, with certain parameters adjusted to Indiana building practice based on a review of the U.S. Energy Information Administration's *Commercial Buildings Energy Consumption Survey*. The following sections describe prototypical buildings and summarize key modeling assumptions.

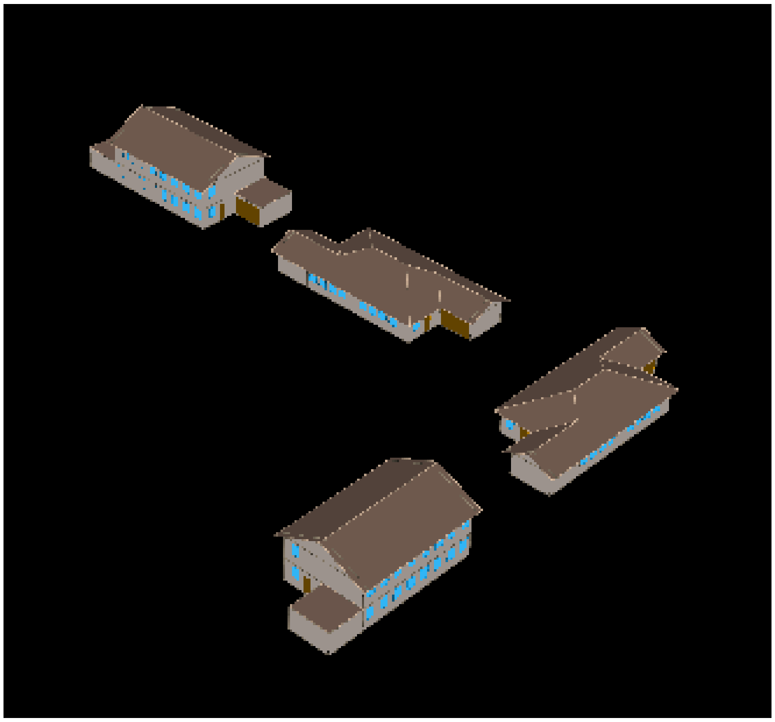
Residential Building Prototypes

The analysis used to develop parameters for the energy savings and demand savings calculations are based on DOE-2.2 simulations of a set of prototypical residential buildings. The prototypical simulation models were derived from the residential building prototypes used in the California DEER[442] study, with adjustments made for local building practices and climate. The single family model contains four residential buildings: two are one-story and two are two-story. Both versions of the one-story and 2-story buildings are identical except for the orientation, which is shifted by 90 degrees. The selection of four buildings provides a reasonable average of the impacts from energy efficiency measures for buildings of different design and orientation.

A sketch of the single-family residential prototype buildings is shown below.

[442] Itron, Inc. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report.* December 2005. Available online: http://www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf

Computer Rendering of Single-Family Residential Building Prototypical DOE-2 Model



The general characteristics of the single-family residential building prototype model are summarized below.

Single Family Residential Building Prototype Description

Characteristic	Value
Conditioned floor area	1-story house: 1,465 square feet (not including basement) 2-story house: 2,930 square feet (not including basement)
Wall construction	Wood frame with siding
Roof construction	Wood frame with asphalt shingles
Glazing type	Double pane clear
Lighting and appliance power density	0.51 watts per square foot average
HVAC system type	Packaged single zone air conditioner or heat pump
HVAC system size	Based on peak load with 20% over-sizing
HVAC system efficiency	Baseline SEER = 13
Thermostat setpoints	Heating: 70°F with setback to 67°F Cooling: 75°F with setup to 78°F
Duct location	Buildings without basement: attic Buildings with basement: basement
Duct surface area	Single-story house: 390 square foot supply, 72 square foot return Two-story house: 505 square foot supply, 290 square foot return

Characteristic	Value
Duct insulation	Uninsulated
Duct leakage	20% of fan flow total leakage, evenly split between supply and return
Natural ventilation	Allowed during cooling season when cooling setpoint exceeded and outdoor temperature < 65°F, with three air changes per hour

Commercial Building Prototype Model Development

Commercial sector prototype building models were developed for a series of small commercial buildings with packaged rooftop HVAC systems, including assembly, big-box retail, fast food restaurant, full service restaurant, grocery, light industrial, primary school, small office, and small retail buildings. Large office, hotel, and hospital prototypes were also included to analyze measures associated with built-up HVAC systems. The following sections describe the prototypical simulation models used in this analysis.

Assembly

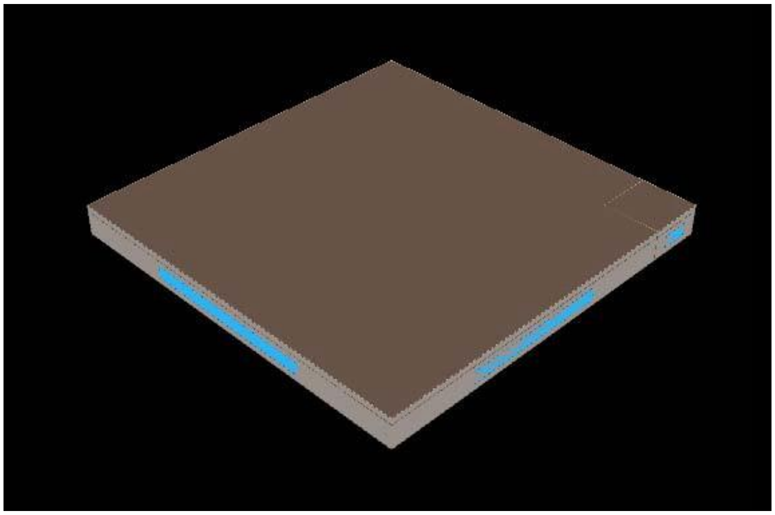
A prototypical building energy simulation model for an assembly building was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in the table below.

Assembly Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	34,000 square feet Auditorium: 33,240 square feet Office: 760 square feet
Number of floors	1
Wall construction and R-value	Concrete block, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Auditorium: 1.9 watts per square foot Office: 1.55 watts per square foot
Plug load density	Auditorium: 1.2 watts per square foot Office: 1.7 watts per square foot
Operating hours	Monday through Sunday, 8:00 a.m. to 9:00 p.m.
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

A computer-generated sketch of the prototype is shown below.

Assembly 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 the table below.

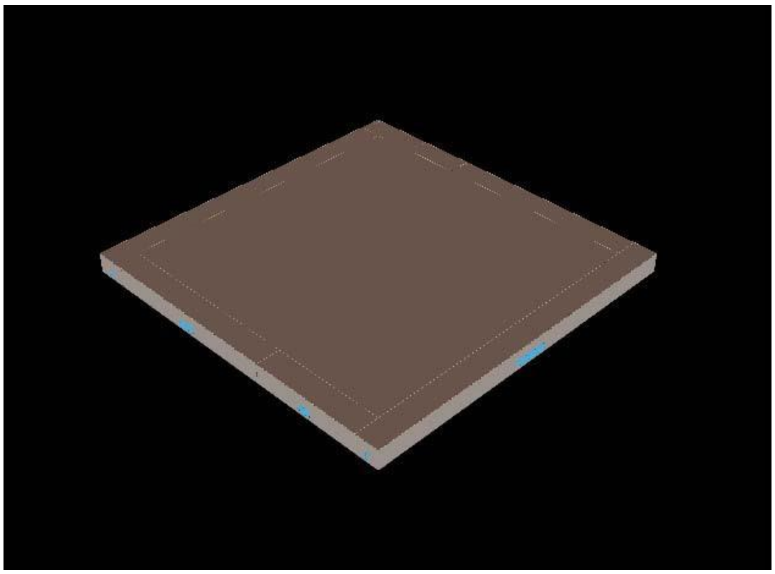
Big-Box Retail Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	130,500 square feet Sales: 107,339 square feet Storage: 11,870 square feet Office: 4,683 square feet Auto repair: 5,151 square feet Kitchen: 1,459 square feet
Number of floors	1
Wall construction and R-value	Concrete block with insulation, R-7.5
Roof construction and R-value	Metal frame with built-up roof, R-13.5
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Sales: 2.15 watts per square foot Storage: 0.85 watts per square foot (active), 0.45 watts per square foot (inactive) Office: 1.55 watts per square foot Auto repair: 1.7 watts per square foot Kitchen: 2.2 watts per square foot
Plug load density	Sales: 1.15 watts per square foot Storage: 0.23 watts per square foot

Characteristic	Value
	Office: 1.73 watts per square foot Auto repair: 1.15 watts per square foot Kitchen: 3.23 watts per square foot
Operating hours	Monday through Sunday, 10:00 a.m. to 9:00 p.m.
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

A computer-generated sketch of the prototype is shown below.

Big-Box Retail Building Rendering



Fast Food Restaurant

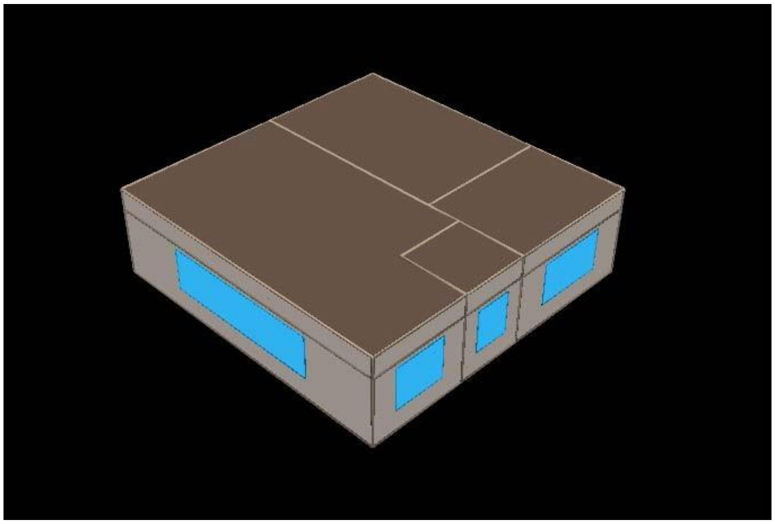
A prototypical building energy simulation model for a fast food restaurant was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in the table below.

Fast Food Restaurant Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2,000 square feet Dining: 1,000 square feet Entry/lobby: 600 square feet Kitchen: 300 square feet Restroom: 100 square feet
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-7.5
Roof construction and R-value	Concrete deck with built-up roof, R-13.5
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Dining: 1.7 watts per square foot Entry area: 1.7 watts per square foot Kitchen: 2.2 watts per square foot Restroom: 0.9 watts per square foot
Plug load density	Dining: 0.6 watts per square foot Entry/lobby: 0.6 watts per square foot Kitchen: 4.3 watts per square foot Restroom: 0.2 watts per square foot
Operating hours	Monday through Sunday, 6:00 a.m. to 11:00 p.m.
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

A computer-generated sketch of the prototype is shown below.

Fast Food Restaurant 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 the table below.

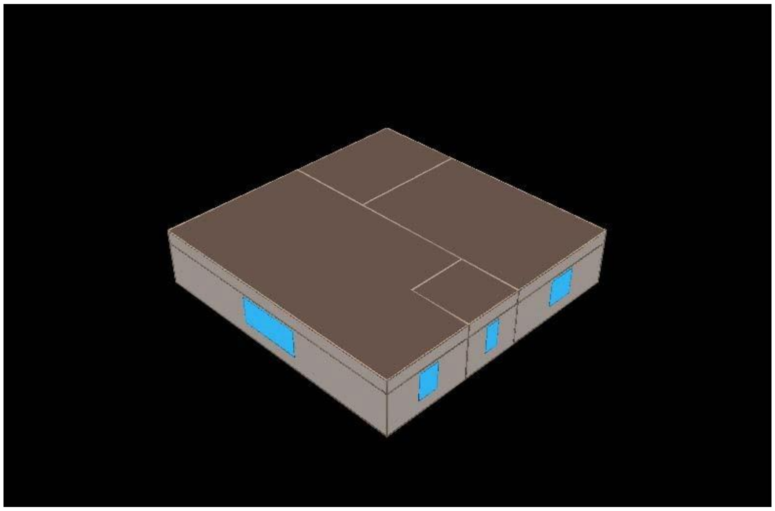
Full Service Restaurant Prototype Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	Dining: 2,000 square feet Entry/reception: 600 square feet Kitchen: 1,200 square feet Restrooms: 200 square feet
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13.5
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Dining: 1.7 watts per square foot Entry: 1.7 watts per square foot Kitchen: 2.2 watts per square foot Restrooms: 1.5 watts per square foot
Plug load density	Dining: 0.6 watts per square foot Entry: 0.6 watts per square foot Kitchen: 3.1 watts per square foot Restrooms: 0.2 watts per square foot
Operating hours	9:00 a.m. to 12:00 a.m.

Characteristic	Value
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

A computer-generated sketch of the full-service restaurant prototype is shown in **Error! Reference ource not found.**.

Full Service Restaurant Prototype Rendering



Grocery

A prototypical building energy simulation model for a grocery building was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in the table below.

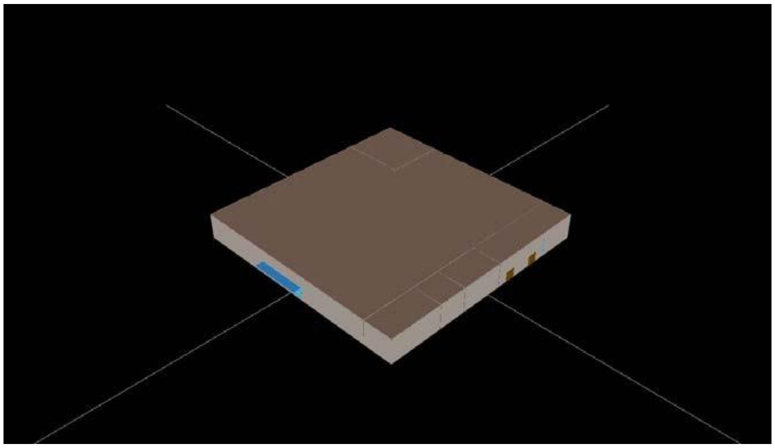
Grocery Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	50,000 square feet Sales: 40,000 square feet Office and employee lounge: 3,500 square feet Dry storage: 2,860 square feet 50°F prep area: 1,268 square feet 35°F walk-in cooler: 1,560 square feet - 5°F walk-in freezer: 812 square feet
Number of floors	1
Wall construction and R-value	Concrete block with insulation, R-5
Roof construction and R-value	Metal frame with built-up roof, R-12

Characteristic	Value
Glazing type	Single pane clear
Lighting power density	Sales: 3.36 watts per square foot Office: 2.2 watts per square foot Storage: 1.82 watts per square foot 50°F prep area: 4.3 watts per square foot 35°F walk-in cooler: 0.9 watts per square foot - 5°F walk-in freezer: 0.9 watts per square foot
Equipment power density	Sales: 1.15 watts per square foot Office: 1.73 watts per square foot Storage: 0.23 watts per square foot 50°F prep area: 0.23 watts per square foot+ 36 kBtu/hr process load 35°F walk-in cooler: 0.23 watts per square foot+ 17 kBtu/hr process load - 5°F walk-in freezer: 0.23 watts per square foot+ 29 kBtu/hr process load
Operating hours	Monday through Sunday, 6:00 a.m. to 10:00 p.m.
HVAC system type	Packaged single zone, no economizer
Refrigeration system type	Air cooled multiplex
Refrigeration system size	-20°F suction temperature: 23 compressor ton 18°F suction temperature: 45 compressor ton
Refrigeration condenser size	-20°F suction temperature: 535 kBtu/hr THR 18°F suction temperature: 756 kBtu/hr THR
Thermostat setpoints	Occupied hours: 74°F cooling, 70°F heating Unoccupied hours: 79°F cooling, 65°F heating

A computer-generated sketch of the prototype is shown in the figure below.

Grocery Building Rendering



Hospital

A prototypical building energy simulation model for a large hospital building was developed using the DOE-2.2 building energy simulation program and TMY3 long-term average weather data. The characteristics of the prototype are summarized in the table below.

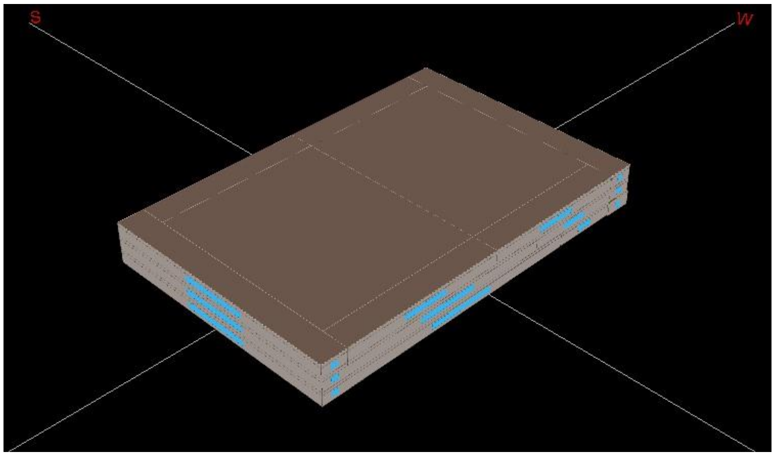
Large Hospital Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	250,000 square feet
Number of floors	3
Wall construction and R-value	Brick and CMU, R=7.5
Roof construction and R-value	Built-up roof, R=13.5
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Patient rooms: 2.3 watts per square foot Office: 2.2 watts per square foot Lab: 4.4 watts per square foot Dining: 1.7 watts per square foot Kitchen and food prep: 4.3 watts per square foot
Plug load density	Patient rooms: 1.7 watts per square foot Office: 1.7 watts per square foot Lab: 1.7 watts per square foot Dining: 0.6 watts per square foot Kitchen and food prep: 4.6 watts per square foot
Operating hours	24/7, 365
HVAC system types	Patient Rooms: 4 pipe fan coil Kitchen: Rooftop DX Remaining space: 1. Central constant volume system with hydronic reheat, without economizer 2. Central constant volume system with hydronic reheat, with economizer 3. Central VAV system with hydronic reheat, with economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Chiller type	Water cooled and air cooled
Chilled water system type	Constant volume with 3-way control valves
Chilled water system control	Constant CHW temperature, 45°F setpoint
Boiler type	Hot water, 80% efficiency
Hot water system type	Constant volume with 3-way control valves
Hot water system control	Constant hot water temperature, 180°F setpoint
Thermostat setpoints	Occupied hours: 76°F cooling, 72°F heating Unoccupied hours: 79°F cooling, 69°F heating

Each set of measures was run with three different HVAC system configurations: (1) a constant volume reheat system without economizer, (2) a constant volume reheat system with economizer, and (3) a VAV system with economizer. The constant volume reheat system without economizer represents a system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. This presents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the prototype is shown below.

Hospital Building Rendering



Hotel

A prototypical building energy simulation model for a hotel building was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in the table below.

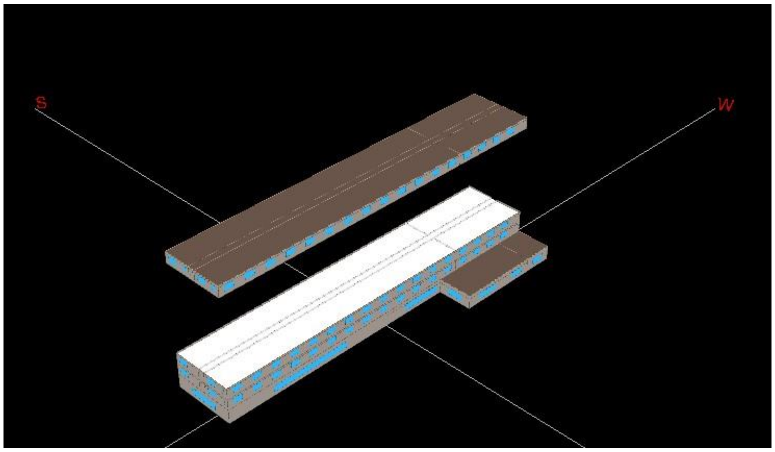
Hotel Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	200,000 square feet total Bar/cocktail lounge: 800 square feet Corridor: 20,100 square feet Dining: 1,250 square feet Guest rooms: 160,680 square feet Kitchen: 750 square feet Laundry: 4,100 square feet Lobby: 8,220 square feet Office: 4,100 square feet
Number of floors	11
Wall construction and R-value	Block construction, R-7.5
Roof construction and R-value	Wood deck with built-up roof, R-13.5

Characteristic	Value
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Bar/cocktail lounge: 1.7 watts per square foot Corridor: 1.0 watts per square foot Dining: 1.7 watts per square foot Guest: 0.6 watts per square foot Kitchen: 4.3 watts per square foot Laundry: 1.8 watts per square foot Lobby: 3.1 watts per square foot Office: 2.2 watts per square foot
Plug load density	Bar/cocktail lounge: 1.2 watts per square foot Corridor: 0.2 watts per square foot Dining: 0.6 watts per square foot Guest rooms: 0.6 watts per square foot Kitchen: 3.0 watts per square foot Laundry: 3.5 watts per square foot Lobby: 0.6 watts per square foot Office: 1.7 watts per square foot
Operating hours	Rooms: 60% occupied 40% unoccupied All others: 24 hr/day
HVAC system type	Guest rooms: PTAC Corridors: PSZ Everywhere else: central built-up system: 1. Central constant volume system with perimeter hydronic reheat, without economizer 2. Central constant volume system with perimeter hydronic reheat, with economizer 3. Central VAV system with perimeter hydronic reheat, with economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Chiller type	Water cooled and air cooled
Chilled water system type	Constant volume with 3-way control valves
Chilled water system control	Constant CHW temperature, 45°F setpoint
Boiler type	Hot water, 80% efficiency
Hot water system type	Constant volume with 3-way control valves
Hot water system control	Constant hot water temperature, 180°F setpoint
Thermostat setpoints	Occupied hours: 76°F cooling, 72°F heating Unoccupied hours: 81°F cooling, 67°F heating

A computer-generated sketch of the prototype is shown below.

Hotel Building Rendering



Large Office

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

Large Office Prototype Building Description

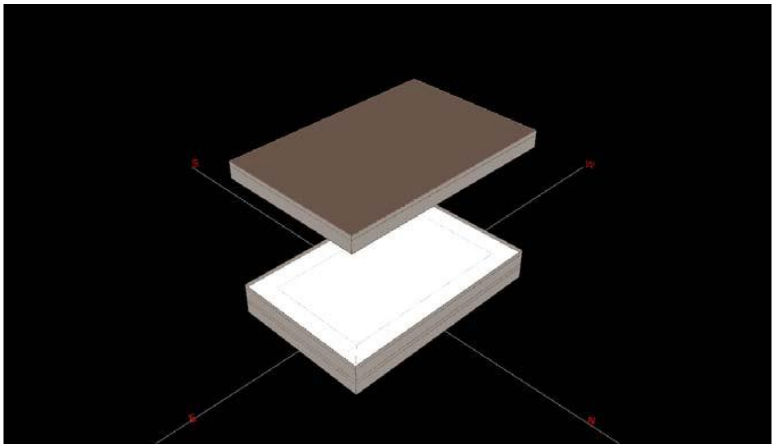
Characteristic	Value
Vintage	Existing (1970s) vintage
Size	350,000 square feet
Number of floors	10
Wall construction and R-value	Glass curtain wall, R-7.5
Roof construction and R-value	Built-up roof, R-13.5
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Perimeter offices: 1.55 watts per square foot Core offices: 1.45 watts per square foot
Plug load density	Perimeter offices: 1.6 watts per square foot Core offices: 0.7 watts per square foot
Operating hours	Monday through Saturday, 9:00 a.m. to 6:00 p.m. Sunday unoccupied
HVAC system types	1. Central constant volume system with perimeter hydronic reheat, without economizer 2. Central constant volume system with perimeter hydronic reheat, with economizer 3. Central VAV system with perimeter hydronic reheat, with economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Chiller type	Water cooled and air cooled
Chilled water system type	Constant volume with 3-way control valves

Chilled water system control	Constant CHW temperature, 45°F setpoint
Boiler type	Hot water, 80% efficiency
Hot water system type	Constant volume with 3-way control valves
Hot water system control	Constant hot water temperature, 180°F setpoint
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

Each set of measures was run using three different HVAC system configurations: (1) a constant volume reheat system without economizer, (2) a constant volume reheat system with economizer, and (3) a VAV system with economizer. The constant volume reheat system without economizer represents the system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. This presents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the prototype is shown below. Note that middle floors are thermally equivalent, therefore were simulated as a single floor with the results multiplied by the number of floors.

Large Office Building Rendering



Light Industrial

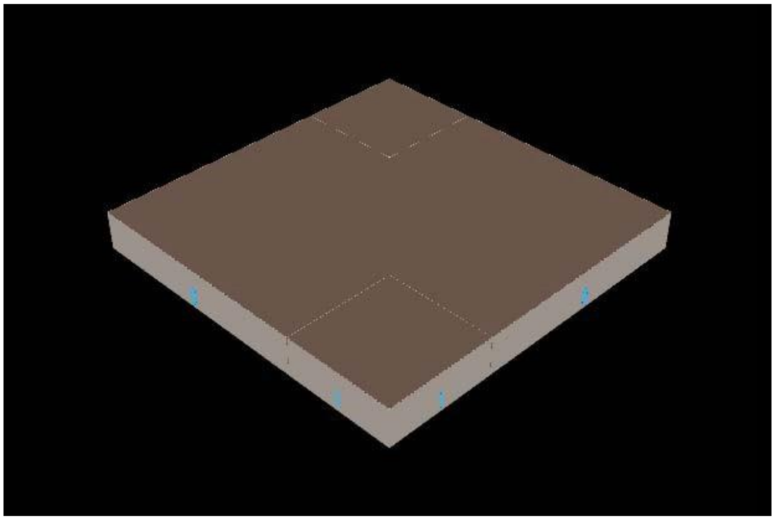
A prototypical building energy simulation model for a light industrial building was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in the table below.

Light Industrial Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	100,000 square feet total Factory: 80,000 square feet Warehouse: 20,000 square feet
Number of floors	1
Wall construction and R-value	Concrete block with brick, no insulation, R-5
Roof construction and R-value	Concrete deck with built-up roof, R-12
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Factory: 2.25 watts per square foot Warehouse: 0.7 watts per square foot
Plug load density	Factory: 1.2 watts per square foot Warehouse: 0.2 watts per square foot
Operating hours	Monday through Friday, 6:00 a.m. to 6:00 p.m. Saturday and Sunday, u noccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

A computer-generated sketch of the prototype is shown below.

Light Industrial Building Rendering



Primary School

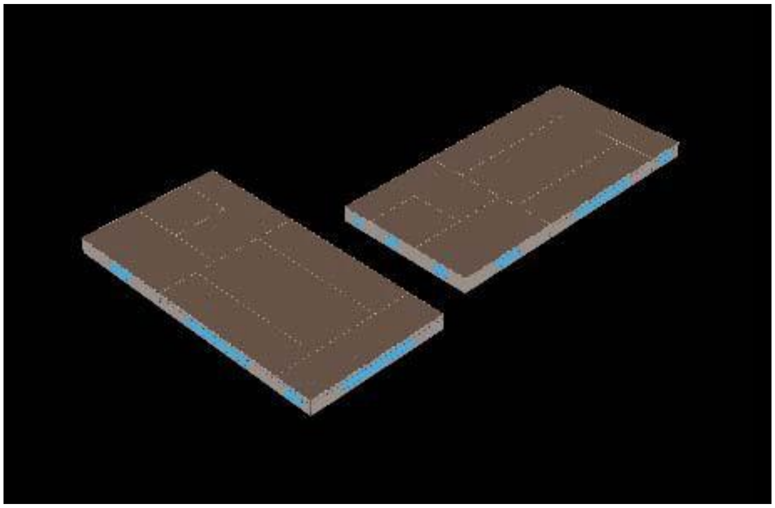
A prototypical building energy simulation model for an elementary school was developed using the DOE-2.2 building energy simulation program. The model is of two identical buildings oriented in different directions. The characteristics of the prototype are summarized in the table below.

Elementary School Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2 buildings, 25,000 square feet each, oriented 90 degrees from each other Classroom: 15,750 square feet Cafeteria: 3,750 square feet Gymnasium: 3,750 square feet Kitchen: 1,750 square feet
Number of floors	1
Wall construction and R-value	Concrete with brick veneer, R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13.5
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Classroom: 1.8 watts per square foot Cafeteria: 1.3 watts per square foot Gymnasium: 1.7 watts per square foot Kitchen: 2.2 watts per square foot
Plug load density	Classroom: 1.2 watts per square foot Cafeteria: 0.6 watts per square foot Gymnasium: 0.6 watts per square foot Kitchen: 4.2 watts per square foot
Operating hours	Monday through Friday, 8:00 a.m. to 6:00 p.m. Sunday, 8:00 a.m. to 4:00 p.m. Saturday, unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

A computer-generated sketch of the prototype is shown below.

School Building Rendering



Small Office

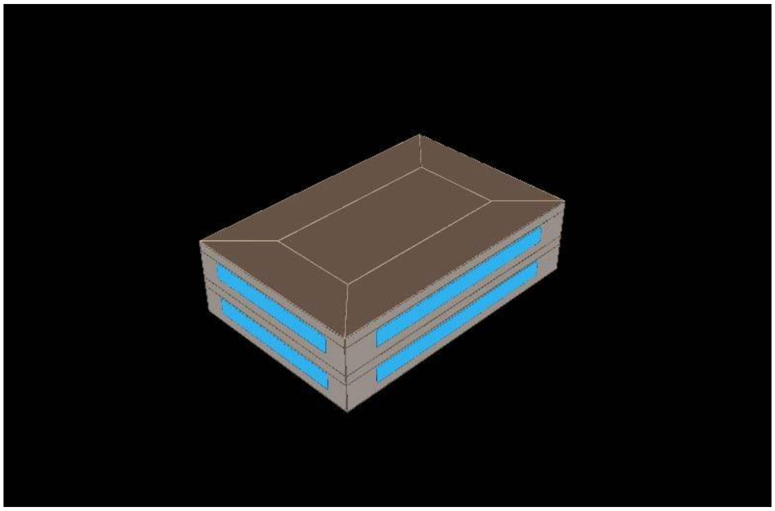
A prototypical building energy simulation model for a small office was developed using the DOE-2.2 building energy simulation program. The characteristics of the small office prototype are summarized in the table below.

Small Office Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	10,000 square feet
Number of floors	2
Wall construction and R-value	Wood frame with brick veneer, R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13.5
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Perimeter offices: 1.55 watts per square foot Core offices: 1.45 watts per square foot
Plug load density	Perimeter offices: 1.6 watts per square foot Core offices: 0.7 watts per square foot
Operating hours	Monday through Saturday, 9:00 a.m. to 6:00 p.m. Sunday, unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

A computer-generated sketch of the small office prototype is shown below.

Small Office Prototype Building Rendering



Small Retail

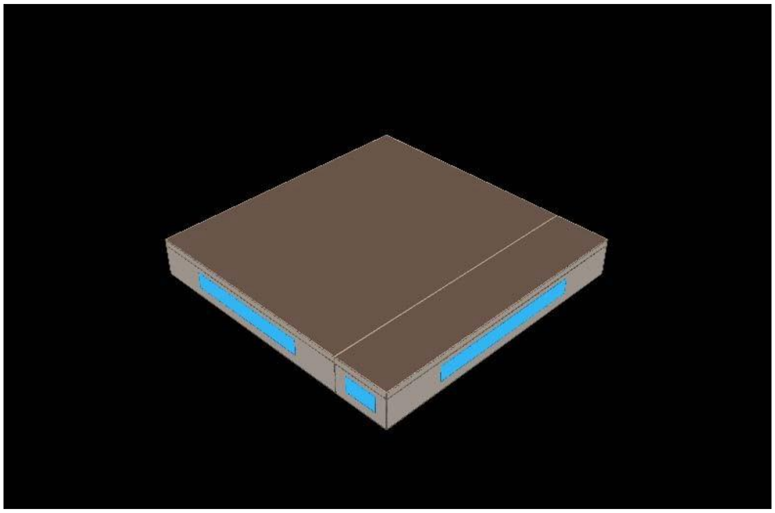
A prototypical building energy simulation model for a small retail building was developed using the DOE-2.2 building energy simulation program. The characteristics of the small retail building prototype are summarized in the table below.

Table 1. Small Retail Prototype Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	8,000 square feet total Sales area: 6,400 square feet Storage: 1,600 square feet
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13.5
Glazing type	Multipane shading coefficient = 0.84 U-value = 0.72
Lighting power density	Sales area: 2.15 watts per square foot Storage: 0.85 watts per square foot (active); 0.45 watts per square foot (inactive)
Plug load density	Sales area: 1.2 watts per square foot Storage: 0.2 watts per square foot
Operating hours	Monday through Saturday, 10:00 a.m. to 10:00 p.m. Sunday, 10:00 a.m. to 8:00 p.m.
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Thermostat setpoints	Occupied hours: 75°F cooling, 70°F heating Unoccupied hours: 80°F cooling, 65°F heating

A computer-generated sketch of the small retail building prototype is shown below.

Small Retail Prototype Building Rendering



Appendix B – HVAC Interactive Effects Multipliers

Residential Buildings

HVAC Interactive Effects Multipliers for Residential Buildings

City	AC with Natural Gas Heat			Heat Pump			AC with Electric Heat			Electric Heat Only			Natural Gas Heat Only		
	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G
Indianapolis	0.06	0.07	-0.0024	-0.17	0.03	0.00	-0.45	0.07	0.00	-0.52	0.00	0.00	0.00	0.00	-0.0024
South Bend	0.05	0.05	-0.0025	-0.18	0.00	0.00	-0.47	0.05	0.00	-0.54	0.00	0.00	0.00	0.00	-0.0025
Evansville	0.07	0.11	-0.0022	-0.11	0.10	0.00	-0.37	0.11	0.00	-0.45	0.00	0.00	0.00	0.00	-0.0022
Ft Wayne	0.05	0.05	-0.0026	-0.22	0.00	1.00	-0.50	0.05	1.00	-0.56	0.00	0.00	0.00	0.00	-0.0026
Terre Haute	0.07	0.08	-0.0024	-0.15	0.00	2.00	-0.42	0.08	2.00	-0.50	0.00	0.00	0.00	0.00	-0.0024

Data to calculated weights for each HVAC system type in residential buildings were obtained from the *Residential Energy Consumption Survey* for the East North Central census region (including Indiana and Ohio). These data are summarized in the table below.

Waste Heat Factor Weights by HVAC System Type

HVAC System Type	Number of Homes (millions)	Weight
AC Natural Gas Heat	4.22	0.63
Heat Pump	0.30	0.04
AC Electric Heat	1.18	0.18
Electric Heat Only	0.15	0.02
Natural Gas Heat Only	0.85	0.13

Applying these weights to the waste heat factor from the table above gives the following weighted averages by city, along with a statewide value assuming equal weights across cities.

Weighted Average Waste Heat Factors by City

City	Weighted		
	WHF_E	WHF_D	WHF_G
Indianapolis	-0.061	0.055	-0.0018
South Bend	-0.070	0.038	-0.0019
Evansville	-0.034	0.092	-0.0017
Ft Wayne	-0.082	0.038	-0.0019
Terre Haute	-0.048	0.061	-0.0018
Statewide	**-0.059**	**0.057**	**-0.0018**

Commercial Buildings

HVAC Interactive Effects Multipliers for Commercial Buildings

Building	City	AC with Natural Gas Heat			Heat Pump			AC with Electric Heat			Electric Heat Only			Natural Gas Heat Only		
		WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G
Assembly	Indianapolis	0.155	0.2	-0.0029	-0.174	0.2	0	-0.434	0.2	0	-0.591	0	0	0	0	-0.0029
	South Bend	0.133	0.2	-0.0023	-0.221	0.2	0	-0.349	0.2	0	-0.483	0	0	0	0	-0.0024
	Evansville	0.2	0.2	-0.0017	-0.042	0.2	0	-0.143	0.2	0	-0.318	0	0	0	0	-0.0017
	Ft Wayne	0.123	0.2	-0.003	-0.571	0.2	0	-0.485	0.2	0	-0.607	0	0	0	0	-0.0029
	Terre Haute	0.165	0.2	-0.0031	-0.184	0.2	0	-0.459	0.2	0	-0.604	0	0	0	0	-0.003
Big Box	Indianapolis	0.146	0.2	-0.0017	-0.086	0.2	0	-0.193	0.2	0	-0.318	0	0	0	0	-0.0017
	South Bend	0.133	0.2	-0.0019	-0.099	0.2	0	-0.242	0.2	0	-0.365	0	0	0	0	-0.0019
	Evansville	0.177	0.2	-0.0012	0.049	0.2	0	-0.043	0.2	0	-0.186	0	0	0	0	-0.0011
	Ft Wayne	0.126	0.2	-0.002	-0.16	0.2	0	-0.266	0.2	0	-0.371	0	0	0	0	-0.002
	Terre Haute	0.17	0.2	-0.0015	-0.028	0.2	0	-0.116	0.2	0	-0.28	0	0	0	0	-0.0015
Elementary School	Indianapolis	0.096	0.2	-0.0033	-0.278	0.2	0	-0.605	0.2	0	-0.743	0	0	0	0	-0.0033
	South Bend	0.073	0.2	-0.0036	-0.318	0.2	0	-0.701	0.2	0	-0.839	0	0	0	0	-0.0036
	Evansville	0.126	0.2	-0.0029	-0.148	0.2	0	-0.465	0.2	0	-0.606	0	0	0	0	-0.0029
	Ft Wayne	0.069	0.2	-0.0037	-0.356	0.2	0	-0.736	0.2	0	-0.869	0	0	0	0	-0.0037
	Terre Haute	0.101	0.2	-0.0034	-0.274	0.2	0	-0.605	0.2	0	-0.784	0	0	0	0	-0.0034

Building	City	AC with Natural Gas Heat			Heat Pump			AC with Electric Heat			Electric Heat Only			Natural Gas Heat Only		
		WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G
Fast Food	Indianapolis	0.109	0.2	-0.0029	-0.023	0.2	0	-0.53	0.2	0	-0.661	0	0	0	0	-0.0032
	South Bend	0.09	0.2	-0.0032	-0.024	0.2	0	-0.586	0.2	0	-0.664	0	0	0	0	-0.0032
	Evansville	0.131	0.2	-0.0025	-0.016	0.2	0	-0.404	0.2	0	-0.677	0	0	0	0	-0.0033
	Ft Wayne	0.088	0.2	-0.0032	-0.026	0.2	0	-0.618	0.2	0	-0.66	0	0	0	0	-0.0032
	Terre Haute	0.112	0.2	-0.0029	-0.02	0.2	0	-0.505	0.2	0	-0.689	0	0	0	0	-0.0034
Full Service Restaurant	Indianapolis	0.108	0.2	-0.0033	-0.023	0.2	0	-0.556	0	0	-0.872	0	0	0	0	-0.0042
	South Bend	0.091	0.2	-0.0034	-0.024	0.2	0	-0.602	0	0	-0.746	0	0	0	0	-0.0036
	Evansville	0.135	0.2	-0.0026	-0.016	0.2	0	-0.372	0	0	-0.546	0	0	0	0	-0.0028
	Ft Wayne	0.088	0.2	-0.0036	-0.026	0.2	0	-0.638	0	0	-0.758	0	0	0	0	-0.0036
	Terre Haute	0.124	0.2	-0.0029	-0.02	0.2	0	-0.458	0	0	-0.628	0	0	0	0	-0.0031
Grocery	Indianapolis	0.146	0.2	-0.0017	-0.086	0.2	0	-0.193	0.2	0	-0.318	0	0	0	0	-0.0017
	South Bend	0.133	0.2	-0.0019	-0.099	0.2	0	-0.242	0.2	0	-0.365	0	0	0	0	-0.0019
	Evansville	0.177	0.2	-0.0012	0.049	0.2	0	-0.043	0.2	0	-0.186	0	0	0	0	-0.0011
	Ft Wayne	0.126	0.2	-0.002	-0.16	0.2	0	-0.266	0.2	0	-0.371	0	0	0	0	-0.002
	Terre Haute	0.17	0.2	-0.0015	-0.028	0.2	0	-0.116	0.2	0	-0.28	0	0	0	0	-0.0015
Light Industrial	Indianapolis	0.096	0.2	-0.0022	-0.145	0.2	0	-0.332	0.2	0	-0.433	0	0	0	0	-0.0021
	South Bend	0.08	0.2	-0.0024	-0.173	0.2	0	-0.397	0.2	0	-0.496	0	0	0	0	-0.0024
	Evansville	0.123	0.2	-0.0018	-0.048	0.2	0	-0.217	0.2	0	-0.308	0	0	0	0	-0.0017
	Ft Wayne	0.074	0.2	-0.0025	-0.188	0.2	0	-0.407	0.2	0	-0.499	0	0	0	0	-0.0024
	Terre Haute	0.103	0.2	-0.0021	-0.099	0.2	0	-0.306	0.2	0	-0.394	0	0	0	0	-0.0021
Small Office	Indianapolis	0.119	0.2	-0.0016	-0.027	0.2	0	-0.182	0.2	0	-0.182	0	0	0	0	-0.0015
	South Bend	0.122	0.2	-0.0015	-0.015	0.2	0	-0.169	0.2	0	-0.169	0	0	0	0	-0.0014
	Evansville	0.144	0.2	-0.0012	0.051	0.2	0	-0.072	0.2	0	-0.072	0	0	0	0	-0.009
	Ft Wayne	0.102	0.2	-0.0019	-0.112	0.2	0	-0.271	0.2	0	-0.271	0	0	0	0	-0.0018
	Terre Haute	0.124	0.2	-0.0016	-0.036	0.2	0	-0.184	0.2	0	-0.184	0	0	0	0	-0.0014
Small Retail	Indianapolis	0.124	0.2	-0.0023	-0.083	0.2	0	-0.315	0.2	0	-0.437	0	0	0	0	-0.0022
	South Bend	0.121	0.2	-0.0024	-0.088	0.2	0	-0.324	0.2	0	-0.445	0	0	0	0	-0.0022
	Evansville	0.157	0.2	-0.0016	0.023	0.2	0	-0.128	0.2	0	-0.264	0	0	0	0	-0.0015
	Ft Wayne	0.101	0.2	-0.0026	-0.168	0.2	0	-0.41	0.2	0	-0.51	0	0	0	0	-0.0025

Building	City	AC with Natural Gas Heat			Heat Pump			AC with Electric Heat			Electric Heat Only			Natural Gas Heat Only		
		WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G	WHF_E	WHF_D	WHF_G
	Terre Haute	0.145	0.2	-0.002	-0.076	0.2	0	-0.247	0.2	0	-0.381	0	0	0	0	-0.002
Warehouse	Indianapolis	0.096	0.2	-0.0022	-0.145	0.2	0	-0.332	0.2	0	-0.433	0	0	0	0	-0.0021
	South Bend	0.08	0.2	-0.0024	-0.173	0.2	0	-0.397	0.2	0	-0.496	0	0	0	0	-0.0024
	Evansville	0.123	0.2	-0.0018	-0.048	0.2	0	-0.217	0.2	0	-0.308	0	0	0	0	-0.0017
	Ft Wayne	0.074	0.2	-0.0025	-0.188	0.2	0	-0.407	0.2	0	-0.499	0	0	0	0	-0.0024
	Terre Haute	0.103	0.2	-0.0021	-0.099	0.2	0	-0.306	0.2	0	-0.394	0	0	0	0	-0.0021
Other	Indianapolis	0.115	0.2	-0.0023	-0.15	0.2	0	-0.357	0.185	0	-0.487	0	0	0	0	-0.0022
	South Bend	0.103	0.2	-0.0024	-0.159	0.2	0	-0.38	0.185	0	-0.488	0	0	0	0	-0.0021
	Evansville	0.142	0.2	-0.0019	-0.047	0.2	0	-0.24	0.185	0	-0.375	0	0	0	0	-0.0017
	Ft Wayne	0.095	0.2	-0.0026	-0.247	0.2	0	-0.448	0.185	0	-0.544	0	0	0	0	-0.0023
	Terre Haute	0.126	0.2	-0.0023	-0.129	0.2	0	-0.345	0.185	0	-0.476	0	0	0	0	-0.0021

Appendix C – Insulation Measures in Single Family Buildings

Roof Insulation Measure Tables by City and HVAC Type

City: Indianapolis
HVAC: AC with Natural Gas Heat

Measure R-Value	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	416.2	0.154	30.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	467.6	0.205	33.8	51.4	0.051	3.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	496.6	0.222	36.0	80.4	0.068	5.8	29.0	0.017	2.2	N/A	N/A	N/A	N/A	N/A	N/A
38	505.3	0.239	36.8	89.1	0.085	6.6	37.7	0.034	3.0	8.7	0.017	0.8	N/A	N/A	N/A
49	514.3	0.239	37.5	98.1	0.085	7.4	46.8	0.034	3.7	17.7	0.017	1.6	9.0	0.00	0.7
60	522.9	0.239	38.0	106.7	0.085	7.8	55.3	0.034	4.2	26.3	0.017	2.0	17.6	0.00	1.2

City: Indianapolis
HVAC: Heat Pump

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	5,043.2	0.410	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	5,588.4	0.495	545.2	0.085	N/A	N/A	N/A	N/A	N/A	N/A
30	5,902.4	0.546	859.2	0.137	314.0	0.051	N/A	N/A	N/A	N/A
38	6,022.0	0.563	978.8	0.154	433.6	0.068	119.6	0.017	N/A	N/A
49	6,128.3	0.580	1,085.2	0.171	539.9	0.085	225.9	0.034	106.3	0.017
60	6,194.0	0.580	1,150.9	0.171	605.6	0.085	291.6	0.034	172.0	0.017

City: Indianapolis
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	7,280.0	0.375	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	8,141.3	0.444	861.3	0.068	N/A	N/A	N/A	N/A	N/A	N/A
30	8,644.2	0.495	1,364.2	0.119	502.9	0.051	N/A	N/A	N/A	N/A
38	8,837.4	0.512	1,557.3	0.137	696.1	0.068	193.2	0.017	N/A	N/A
49	9,011.4	0.529	1,731.4	0.154	870.1	0.085	367.2	0.034	174.1	0.017
60	9,118.9	0.529	1,838.9	0.154	977.6	0.085	474.7	0.034	281.6	0.017

City: Indianapolis
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	6942.2	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	7766.6	0.00	824.4	0.00	N/A	N/A	N/A	N/A	N/A	N/A
30	8247.6	0.00	1305.5	0.00	481.1	0.00	N/A	N/A	N/A	N/A
38	8434.0	0.00	1491.8	0.00	667.4	0.00	186.3	0.00	N/A	N/A
49	8596.1	0.00	1653.9	0.00	829.5	0.00	348.5	0.00	162.1	0.00
60	8701.9	0.00	1759.7	0.00	935.3	0.00	454.3	0.00	267.9	0.00

City: Indianapolis
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	149.1	0.00	30.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	166.7	0.00	34.4	17.6	0.00	3.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	177.0	0.00	36.5	27.8	0.00	5.9	10.2	0.00	2.2	N/A	N/A	N/A	N/A	N/A	N/A
38	180.9	0.00	37.4	31.7	0.00	6.7	14.2	0.00	3.0	3.9	0.00	0.9	N/A	N/A	N/A
49	184.1	0.00	38.1	35.0	0.00	7.5	17.4	0.00	3.8	7.2	0.00	1.6	3.2	0.00	0.7
60	186.3	0.00	38.6	37.2	0.00	8.0	19.6	0.00	4.2	9.4	0.00	2.1	5.5	0.00	1.2

City: South Bend
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	351.2	0.137	30.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	394.5	0.171	34.1	43.3	0.034	3.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	417.2	0.188	36.2	66.0	0.051	5.9	22.7	0.017	2.2	N/A	N/A	N/A	N/A	N/A	N/A
38	424.4	0.188	37.1	73.2	0.051	6.7	29.9	0.017	3.0	7.2	0.00	0.8	N/A	N/A	N/A
49	433.1	0.188	37.8	81.9	0.051	7.4	38.6	0.017	3.7	15.9	0.00	1.6	8.7	0.00	0.8
60	437.9	0.188	38.3	86.7	0.051	7.9	43.3	0.017	4.2	20.6	0.00	2.1	13.5	0.00	1.2

City: South Bend
HVAC: Heat Pump

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	5,171.8	0.119	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	5,730.0	0.154	558.2	0.034	N/A	N/A	N/A	N/A	N/A	N/A
30	6,044.9	0.171	873.0	0.051	314.8	0.017	N/A	N/A	N/A	N/A
38	6,166.4	0.188	994.5	0.068	436.3	0.034	121.5	0.017	N/A	N/A
49	6,271.7	0.188	1,099.8	0.068	541.6	0.034	226.8	0.017	105.3	0.00
60	6,343.0	0.188	1,171.2	0.068	613.0	0.034	298.1	0.017	176.6	0.00

City: South Bend
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	7,316.2	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	8,190.4	0.034	874.2	0.034	N/A	N/A	N/A	N/A	N/A	N/A
30	8,694.2	0.068	1,378.0	0.068	503.8	0.034	N/A	N/A	N/A	N/A
38	8,892.2	0.068	1,575.9	0.068	701.7	0.034	198.0	0.00	N/A	N/A
49	9,063.7	0.085	1,747.4	0.085	873.2	0.051	369.5	0.017	171.5	0.017
60	9,177.8	0.085	1,861.6	0.085	987.4	0.051	483.6	0.017	285.7	0.017

City: South Bend
HVAC: Electric Heat Only

Measure	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	7,061.6	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	7,905.5	0.00	843.9	0.00	N/A	N/A	N/A	N/A	N/A	N/A
30	8,393.2	0.00	1,331.6	0.00	487.7	0.00	N/A	N/A	N/A	N/A
38	8,584.3	0.00	1,522.7	0.00	678.8	0.00	191.1	0.00	N/A	N/A
49	8,750.3	0.00	1,688.7	0.00	844.9	0.00	357.2	0.00	166.0	0.00
60	8,859.0	0.00	1,797.4	0.00	953.6	0.00	465.9	0.00	274.7	0.00

City: South Bend
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			19			30			38		
	kWh/kSF	kW/kSF	MMBtu/kSF	kWh/kSF	kW/kSF	MMBtu/kSF	kWh/kSF	kW/kSF	MMBtu/kSF	kWh/kSF	kW/kSF	MMBtu/kSF	kWh/kSF	kW/kSF	MMBtu/kSF
11	151.9	0.00	30.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	170.0	0.00	34.6	18.1	0.00	3.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	180.2	0.00	36.8	28.3	0.00	6.0	10.2	0.00	2.2	N/A	N/A	N/A	N/A	N/A	N/A
38	184.1	0.00	37.6	32.3	0.00	6.8	14.2	0.00	3.1	3.9	0.00	0.9	N/A	N/A	N/A
49	187.7	0.00	38.4	35.8	0.00	7.6	17.7	0.00	3.8	7.5	0.00	1.6	3.6	0.00	0.8
60	189.9	0.00	38.9	38.1	0.00	8.0	20.0	0.00	4.3	9.7	0.00	2.1	5.8	0.00	1.2

City: Evansville
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	475.3	0.392	24.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	530.7	0.461	27.3	55.5	0.068	3.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	562.1	0.512	29.0	86.9	0.119	4.8	31.4	0.051	1.8	N/A	N/A	N/A	N/A	N/A	N/A
38	573.5	0.529	29.7	98.3	0.137	5.5	42.8	0.068	2.5	11.4	0.017	0.7	N/A	N/A	N/A
49	582.4	0.546	30.3	107.2	0.154	6.1	51.7	0.085	3.1	20.3	0.034	1.3	8.9	0.017	0.6
60	588.6	0.563	30.7	113.3	0.171	6.5	57.8	0.102	3.5	26.5	0.051	1.7	15.0	0.034	1.0

City: Evansville
HVAC: Heat Pump

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	3,299.0	0.631	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	3,673.2	0.717	374.2	0.085	N/A	N/A	N/A	N/A	N/A	N/A
30	3,886.9	0.751	587.9	0.119	213.7	0.034	N/A	N/A	N/A	N/A
38	3,968.4	0.768	669.5	0.137	295.2	0.051	81.6	0.017	N/A	N/A
49	4,042.0	0.785	743.0	0.154	368.8	0.068	155.1	0.034	73.5	0.017
60	4,089.2	0.785	790.3	0.154	416.0	0.068	202.4	0.034	120.8	0.017

City: Evansville
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	5,831.6	0.580	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	6,547.1	0.648	715.5	0.068	N/A	N/A	N/A	N/A	N/A	N/A
30	6,959.0	0.683	1,127.5	0.102	411.9	0.034	N/A	N/A	N/A	N/A
38	7,118.8	0.700	1,287.2	0.119	571.7	0.051	159.7	0.017	N/A	N/A
49	7,260.1	0.700	1,428.5	0.119	713.0	0.051	301.0	0.017	141.3	0.00
60	7,351.2	0.717	1,519.6	0.137	804.1	0.068	392.2	0.034	232.4	0.017

City: Evansville
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	5,398.6	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	6,057.8	0.00	659.2	0.00	N/A	N/A	N/A	N/A	N/A	N/A
30	6,441.1	0.00	1,042.5	0.00	383.3	0.00	N/A	N/A	N/A	N/A
38	6,591.1	0.00	1,192.5	0.00	533.3	0.00	150.0	0.00	N/A	N/A
49	6,721.3	0.00	1,322.7	0.00	663.5	0.00	280.2	0.00	130.2	0.00
60	6,806.8	0.00	1,408.2	0.00	749.0	0.00	365.7	0.00	215.7	0.00

City: Evansville
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	115.5	0.00	24.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	129.7	0.00	27.7	14.2	0.00	3.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	137.7	0.00	29.5	22.2	0.00	4.9	8.0	0.00	1.8	N/A	N/A	N/A	N/A	N/A	N/A
38	141.0	0.00	30.2	25.4	0.00	5.6	11.3	0.00	2.5	3.2	0.00	0.7	N/A	N/A	N/A
49	143.7	0.00	30.8	28.2	0.00	6.2	14.0	0.00	3.1	6.0	0.00	1.3	2.7	0.00	0.6
60	145.4	0.00	31.2	29.9	0.00	6.6	15.7	0.00	3.5	7.7	0.00	1.7	4.4	0.00	1.0

City: Ft Wayne
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	339.2	0.171	32.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	378.7	0.205	35.9	39.4	0.034	3.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	399.7	0.239	38.1	60.4	0.068	6.1	21.0	0.034	2.3	N/A	N/A	N/A	N/A	N/A	N/A
38	409.2	0.239	39.0	70.0	0.068	7.0	30.5	0.034	3.2	9.6	0.00	0.9	N/A	N/A	N/A
49	417.4	0.256	39.8	78.2	0.085	7.8	38.7	0.051	3.9	17.7	0.017	1.7	8.2	0.017	0.8
60	421.7	0.256	40.3	82.4	0.085	8.3	43.0	0.051	4.4	22.0	0.017	2.2	12.5	0.017	1.3

City: Ft Wayne
HVAC: Heat Pump

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	5,507.3	0.051	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	6,091.0	0.085	583.6	0.034	N/A	N/A	N/A	N/A	N/A	N/A
30	6,427.1	0.102	919.8	0.051	336.2	0.017	N/A	N/A	N/A	N/A
38	6,555.6	0.102	1,048.3	0.051	464.7	0.017	128.5	0.00	N/A	N/A
49	6,667.2	0.102	1,159.9	0.051	576.3	0.017	240.1	0.00	111.6	0.00
60	6,739.8	0.119	1,232.4	0.068	648.8	0.034	312.6	0.017	184.1	0.017

City: Ft Wayne
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	7,528.7	0.171	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	8,421.0	0.205	892.3	0.034	N/A	N/A	N/A	N/A	N/A	N/A
30	8,941.0	0.239	1,412.3	0.068	520.0	0.034	N/A	N/A	N/A	N/A
38	9,146.8	0.239	1,618.1	0.068	725.8	0.034	205.8	0.00	N/A	N/A
49	9,326.1	0.256	1,797.4	0.085	905.1	0.051	385.2	0.017	179.4	0.017
60	9,441.8	0.256	1,913.1	0.085	1,020.8	0.051	500.9	0.017	295.1	0.017

City: Ft Wayne
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	7,338.6	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	8,208.0	0.00	869.5	0.00	N/A	N/A	N/A	N/A	N/A	N/A
30	8,718.1	0.00	1,379.5	0.00	510.1	0.00	N/A	N/A	N/A	N/A
38	8,917.9	0.00	1,579.4	0.00	709.9	0.00	199.8	0.00	N/A	N/A
49	9,092.5	0.00	1,753.9	0.00	884.5	0.00	374.4	0.00	174.6	0.00
60	9,206.7	0.00	1,868.1	0.00	998.6	0.00	488.6	0.00	288.7	0.00

City: Ft Wayne
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	149.0	0.00	32.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	166.4	0.00	35.8	17.4	0.00	3.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	176.6	0.00	38.1	27.6	0.00	6.1	10.2	0.00	2.3	N/A	N/A	N/A	N/A	N/A	N/A
38	180.5	0.00	39.0	31.6	0.00	7.0	14.2	0.00	3.2	3.9	0.00	0.9	N/A	N/A	N/A
49	184.1	0.00	39.8	35.2	0.00	7.8	17.7	0.00	4.0	7.5	0.00	1.7	3.6	0.00	0.8
60	186.3	0.00	40.3	37.4	0.00	8.3	20.0	0.00	4.5	9.7	0.00	2.2	5.8	0.00	1.3

City: Terre Haute
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	344.0	0.188	31.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	384.3	0.205	35.8	40.3	0.017	3.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	406.0	0.222	38.1	61.9	0.034	6.2	21.7	0.017	2.3	N/A	N/A	N/A	N/A	N/A	N/A
38	416.4	0.239	39.0	72.4	0.051	7.1	32.1	0.034	3.2	10.4	0.017	0.9	N/A	N/A	N/A
49	420.6	0.239	39.8	76.6	0.051	7.9	36.3	0.034	4.0	14.7	0.017	1.7	4.3	0.00	0.8
60	426.3	0.239	40.3	82.3	0.051	8.4	42.0	0.034	4.5	20.3	0.017	2.2	9.9	0.00	1.3

City: Terre Haute
HVAC: Heat Pump

Measure	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	5,539.8	0.188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	6,144.0	0.205	604.3	0.017	N/A	N/A	N/A	N/A	N/A	N/A
30	6,488.6	0.222	948.8	0.034	344.5	0.017	N/A	N/A	N/A	N/A
38	6,621.2	0.239	1,081.4	0.051	477.1	0.034	132.6	0.017	N/A	N/A
49	6,737.4	0.239	1,197.6	0.051	593.3	0.034	248.8	0.017	116.2	0.00
60	6,813.0	0.256	1,273.2	0.068	668.9	0.051	324.4	0.034	191.8	0.017

City: Terre Haute
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	7,544.0	0.188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	8,444.2	0.205	900.2	0.017	N/A	N/A	N/A	N/A	N/A	N/A
30	8,970.3	0.222	1,426.3	0.034	526.1	0.017	N/A	N/A	N/A	N/A
38	9,178.5	0.239	1,634.5	0.051	734.3	0.034	208.2	0.017	N/A	N/A
49	9,355.3	0.239	1,811.3	0.051	911.1	0.034	385.0	0.017	176.8	0.00
60	9,473.7	0.239	1,929.7	0.051	1,029.5	0.034	503.4	0.017	295.2	0.00

City: Terre Haute
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		19		30		38	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	7,354.6	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	8,232.6	0.00	878.0	0.00	N/A	N/A	N/A	N/A	N/A	N/A
30	8,747.6	0.00	1,393.0	0.00	515.0	0.00	N/A	N/A	N/A	N/A
38	8,949.5	0.00	1,594.9	0.00	716.9	0.00	201.9	0.00	N/A	N/A
49	9,125.8	0.00	1,771.2	0.00	893.2	0.00	378.2	0.00	176.3	0.00
60	9,241.0	0.00	1,886.3	0.00	1,008.4	0.00	493.3	0.00	291.5	0.00

City: Terre Haute
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			19			30			38		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	154.4	0.00	31.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	172.7	0.00	35.8	18.3	0.00	3.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	183.3	0.00	38.1	28.8	0.00	6.2	10.6	0.00	2.3	N/A	N/A	N/A	N/A	N/A	N/A
38	187.4	0.00	39.0	32.9	0.00	7.1	14.7	0.00	3.2	4.1	0.00	0.9	N/A	N/A	N/A
49	191.1	0.00	39.8	36.7	0.00	7.9	18.4	0.00	4.0	7.8	0.00	1.7	3.8	0.00	0.8
60	193.5	0.00	40.3	39.1	0.00	8.4	20.8	0.00	4.5	10.2	0.00	2.2	6.1	0.00	1.3

Wall Insulation Measure Tables by City and HVAC Type

City: Indianapolis
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	96.0	0.073	8.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	108.4	0.073	9.3	12.4	0.00	1.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	128.2	0.091	11.1	32.2	0.018	3.0	19.8	0.018	1.8	N/A	N/A	N/A	N/A	N/A	N/A
19	135.6	0.091	11.8	39.6	0.018	3.7	27.3	0.018	2.5	7.5	0.00	0.7	N/A	N/A	N/A
21	140.5	0.109	12.4	44.5	0.036	4.3	32.2	0.036	3.1	12.4	0.018	1.2	4.9	0.018	0.6
25	152.2	0.109	13.2	56.2	0.036	5.1	43.8	0.036	3.9	24.0	0.018	2.1	16.5	0.018	1.4
27	156.0	0.109	13.6	60.0	0.036	5.5	47.6	0.036	4.3	27.8	0.018	2.5	20.4	0.018	1.8

City: Indianapolis
HVAC: Heat Pump

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,150.4	0.145	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	1,312.9	0.164	162.5	0.018	N/A	N/A	N/A	N/A	N/A	N/A
17	1,567.1	0.200	416.7	0.055	254.2	0.036	N/A	N/A	N/A	N/A
19	1,658.7	0.218	508.4	0.073	345.8	0.055	91.6	0.018	N/A	N/A
21	1,735.8	0.218	585.5	0.073	422.9	0.055	168.7	0.018	77.1	0.00
25	1,855.1	0.236	704.7	0.091	542.2	0.073	288.0	0.036	196.4	0.018
27	1,902.4	0.255	752.0	0.109	589.5	0.091	335.3	0.055	243.6	0.036

City: Indianapolis
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,866.2	0.127	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	2,135.5	0.145	269.3	0.018	N/A	N/A	N/A	N/A	N/A	N/A
17	2,556.2	0.182	690.0	0.055	420.7	0.036	N/A	N/A	N/A	N/A
19	2,709.3	0.182	843.1	0.055	573.8	0.036	153.1	0.00	N/A	N/A
21	2,837.8	0.200	971.6	0.073	702.4	0.055	281.6	0.018	128.5	0.018
25	3,036.7	0.200	1,170.5	0.073	901.3	0.055	480.5	0.018	327.5	0.018
27	3,116.5	0.218	1,250.4	0.091	981.1	0.073	560.4	0.036	407.3	0.036

City: Indianapolis
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,794.2	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	2,054.2	0.00	260.0	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	2,458.9	0.00	664.7	0.00	404.7	0.00	N/A	N/A	N/A	N/A
19	2,606.0	0.00	811.8	0.00	551.8	0.00	147.1	0.00	N/A	N/A
21	2,730.0	0.00	935.8	0.00	675.8	0.00	271.1	0.00	124.0	0.00
25	2,920.2	0.00	1,126.0	0.00	866.0	0.00	461.3	0.00	314.2	0.00
27	2,998.4	0.00	1,204.2	0.00	944.2	0.00	539.5	0.00	392.4	0.00

City: Indianapolis
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	39.3	0.00	8.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	44.7	0.00	9.3	5.5	0.00	1.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	53.6	0.00	11.2	14.4	0.00	3.0	8.9	0.00	1.8	N/A	N/A	N/A	N/A	N/A	N/A
19	56.9	0.00	11.9	17.6	0.00	3.7	12.2	0.00	2.5	3.3	0.00	0.7	N/A	N/A	N/A
21	59.6	0.00	12.4	20.4	0.00	4.3	14.9	0.00	3.1	6.0	0.00	1.2	2.7	0.00	0.6
25	63.8	0.00	13.3	24.5	0.00	5.2	19.1	0.00	4.0	10.2	0.00	2.1	6.9	0.00	1.5
27	65.5	0.00	13.7	26.2	0.00	5.5	20.7	0.00	4.3	11.8	0.00	2.5	8.5	0.00	1.8

City: South Bend
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	81.5	0.055	8.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	91.6	0.055	9.5	10.2	0.00	1.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	111.8	0.073	11.3	30.4	0.018	3.1	20.2	0.018	1.8	N/A	N/A	N/A	N/A	N/A	N/A
19	117.6	0.073	12.0	36.2	0.018	3.8	26.0	0.018	2.5	5.8	0.00	0.7	N/A	N/A	N/A
21	121.3	0.073	12.5	39.8	0.018	4.4	29.6	0.018	3.1	9.5	0.00	1.2	3.6	0.00	0.6
25	131.1	0.073	13.4	49.6	0.018	5.3	39.5	0.018	3.9	19.3	0.00	2.1	13.5	0.00	1.4
27	135.3	0.073	13.8	53.8	0.018	5.6	43.6	0.018	4.3	23.5	0.00	2.5	17.6	0.00	1.8

City: South Bend
HVAC: Heat Pump

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,160.0	0.055	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	1,338.5	0.073	178.5	0.018	N/A	N/A	N/A	N/A	N/A	N/A
17	1,591.3	0.091	431.3	0.036	252.7	0.018	N/A	N/A	N/A	N/A
19	1,682.0	0.091	522.0	0.036	343.5	0.018	90.7	0.00	N/A	N/A
21	1,756.2	0.091	596.2	0.036	417.6	0.018	164.9	0.00	74.2	0.00
25	1,876.4	0.091	716.4	0.036	537.8	0.018	285.1	0.00	194.4	0.00
27	1,924.5	0.109	764.5	0.055	586.0	0.036	333.3	0.018	242.5	0.018

City: South Bend
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,885.5	0.073	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	2,184.2	0.073	298.7	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	2,606.5	0.091	721.1	0.018	422.4	0.018	N/A	N/A	N/A	N/A
19	2,758.9	0.091	873.5	0.018	574.7	0.018	152.4	0.00	N/A	N/A
21	2,886.5	0.091	1,001.1	0.018	702.4	0.018	280.0	0.00	127.6	0.00
25	3,090.5	0.109	1,205.1	0.036	906.4	0.036	484.0	0.018	331.6	0.018
27	3,171.3	0.109	1,285.8	0.036	987.1	0.036	564.7	0.018	412.4	0.018

City: South Bend
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,826.5	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	2,117.6	0.00	291.1	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	2,526.2	0.00	699.6	0.00	408.5	0.00	N/A	N/A	N/A	N/A
19	2,675.3	0.00	848.7	0.00	557.6	0.00	149.1	0.00	N/A	N/A
21	2,799.6	0.00	973.1	0.00	682.0	0.00	273.5	0.00	124.4	0.00
25	2,995.8	0.00	1,169.3	0.00	878.2	0.00	469.6	0.00	320.5	0.00
27	3,074.2	0.00	1,247.6	0.00	956.5	0.00	548.0	0.00	398.9	0.00

City: South Bend
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	40.0	0.00	8.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	46.4	0.00	9.5	6.4	0.00	1.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	55.5	0.00	11.4	15.5	0.00	3.2	9.1	0.00	1.9	N/A	N/A	N/A	N/A	N/A	N/A
19	58.7	0.00	12.1	18.7	0.00	3.8	12.4	0.00	2.5	3.3	0.00	0.7	N/A	N/A	N/A
21	61.5	0.00	12.6	21.5	0.00	4.4	15.1	0.00	3.1	6.0	0.00	1.2	2.7	0.00	0.6
25	65.6	0.00	13.5	25.6	0.00	5.3	19.3	0.00	4.0	10.2	0.00	2.1	6.9	0.00	1.5
27	67.5	0.00	13.9	27.5	0.00	5.7	21.1	0.00	4.3	12.0	0.00	2.5	8.7	0.00	1.8

City: Evansville
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	100.5	0.109	6.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	118.4	0.127	7.6	17.8	0.018	1.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	144.2	0.164	9.1	43.6	0.055	2.6	25.8	0.036	1.5	N/A	N/A	N/A	N/A	N/A	N/A
19	151.8	0.164	9.7	51.3	0.055	3.1	33.5	0.036	2.1	7.6	0.00	0.5	N/A	N/A	N/A
21	158.7	0.182	10.1	58.2	0.073	3.6	40.4	0.055	2.5	14.5	0.018	1.0	6.9	0.018	0.5
25	169.6	0.182	10.9	69.1	0.073	4.3	51.3	0.055	3.2	25.5	0.018	1.7	17.8	0.018	1.2
27	175.1	0.200	11.1	74.5	0.091	4.6	56.7	0.073	3.5	30.9	0.036	2.0	23.3	0.036	1.5

City: Evansville
HVAC: Heat Pump

Measure	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	760.9	0.127	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	882.2	0.145	121.3	0.018	N/A	N/A	N/A	N/A	N/A	N/A
17	1,062.9	0.182	302.0	0.055	180.7	0.036	N/A	N/A	N/A	N/A
19	1,124.2	0.200	363.3	0.073	242.0	0.055	61.3	0.018	N/A	N/A
21	1,174.4	0.200	413.5	0.073	292.2	0.055	111.5	0.018	50.2	0.00
25	1,255.3	0.218	494.4	0.091	373.1	0.073	192.4	0.036	131.1	0.018
27	1,287.6	0.218	526.7	0.091	405.5	0.073	224.7	0.036	163.5	0.018

City: Evansville
HVAC: AC with Electric Heat

Measure	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,479.6	0.109	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	1,716.7	0.127	237.1	0.018	N/A	N/A	N/A	N/A	N/A	N/A
17	2,062.5	0.145	582.9	0.036	345.8	0.018	N/A	N/A	N/A	N/A
19	2,184.0	0.164	704.4	0.055	467.3	0.036	121.5	0.018	N/A	N/A
21	2,286.4	0.164	806.7	0.055	569.6	0.036	223.8	0.018	102.4	0.00
25	2,444.4	0.182	964.7	0.073	727.6	0.055	381.8	0.036	260.4	0.018
27	2,507.8	0.182	1,028.2	0.073	791.1	0.055	445.3	0.036	323.8	0.018

City: Evansville
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,381.1	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	1,602.4	0.00	221.3	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	1,925.3	0.00	544.2	0.00	322.9	0.00	N/A	N/A	N/A	N/A
19	2,038.9	0.00	657.8	0.00	436.5	0.00	113.6	0.00	N/A	N/A
21	2,133.8	0.00	752.7	0.00	531.5	0.00	208.5	0.00	94.9	0.00
25	2,282.5	0.00	901.5	0.00	680.2	0.00	357.3	0.00	243.6	0.00
27	2,342.4	0.00	961.3	0.00	740.0	0.00	417.1	0.00	303.5	0.00

City: Evansville
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	30.0	0.00	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	34.9	0.00	7.6	4.9	0.00	1.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	42.0	0.00	9.1	12.0	0.00	2.6	7.1	0.00	1.5	N/A	N/A	N/A	N/A	N/A	N/A
19	44.4	0.00	9.7	14.4	0.00	3.1	9.5	0.00	2.1	2.4	0.00	0.5	N/A	N/A	N/A
21	46.5	0.00	10.1	16.5	0.00	3.6	11.6	0.00	2.5	4.5	0.00	1.0	2.2	0.00	0.5
25	49.6	0.00	10.8	19.6	0.00	4.3	14.7	0.00	3.2	7.6	0.00	1.7	5.3	0.00	1.2
27	51.1	0.00	11.1	21.1	0.00	4.6	16.2	0.00	3.5	9.1	0.00	2.0	6.7	0.00	1.5

City: Ft. Wayne
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	50.8	0.033	5.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	58.5	0.043	6.1	7.7	0.011	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	69.4	0.054	7.3	18.5	0.022	2.0	10.8	0.011	1.2	N/A	N/A	N/A	N/A	N/A	N/A
19	73.4	0.054	7.8	22.5	0.022	2.4	14.8	0.011	1.6	4.0	0.00	0.4	N/A	N/A	N/A
21	76.5	0.054	8.1	25.7	0.022	2.8	18.0	0.011	2.0	7.2	0.00	0.8	3.1	0.00	0.4
25	82.9	0.054	8.7	32.1	0.022	3.4	24.4	0.011	2.5	13.5	0.00	1.4	9.5	0.00	0.9
27	84.5	0.054	8.9	33.7	0.022	3.6	26.0	0.011	2.8	15.2	0.00	1.6	11.2	0.00	1.1

City: Ft Wayne
HVAC: Heat Pump

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	778.7	0.022	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	897.9	0.022	119.2	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	1,062.4	0.033	283.8	0.011	164.5	0.011	N/A	N/A	N/A	N/A
19	1,122.6	0.033	343.9	0.011	224.7	0.011	60.2	0.00	N/A	N/A
21	1,172.0	0.033	393.3	0.011	274.1	0.011	109.6	0.00	49.4	0.00
25	1,251.8	0.033	473.1	0.011	353.9	0.011	189.4	0.00	129.2	0.00
27	1,282.0	0.043	503.4	0.022	384.1	0.022	219.6	0.011	159.4	0.011

City: Ft Wayne
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,218.4	0.033	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	1,409.0	0.043	190.5	0.011	N/A	N/A	N/A	N/A	N/A	N/A
17	1,677.1	0.054	458.7	0.022	268.2	0.011	N/A	N/A	N/A	N/A
19	1,775.1	0.054	556.7	0.022	366.1	0.011	98.0	0.00	N/A	N/A
21	1,856.7	0.054	638.3	0.022	447.8	0.011	179.6	0.00	81.6	0.00
25	1,986.3	0.054	767.9	0.022	577.4	0.011	309.2	0.00	211.3	0.00
27	2,037.4	0.054	819.0	0.022	628.4	0.011	360.3	0.00	262.3	0.00

City: Ft Wayne
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,193.0	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	1,380.2	0.00	187.2	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	1,643.4	0.00	450.4	0.00	263.2	0.00	N/A	N/A	N/A	N/A
19	1,739.4	0.00	546.4	0.00	359.2	0.00	96.0	0.00	N/A	N/A
21	1,819.4	0.00	626.4	0.00	439.2	0.00	176.0	0.00	80.0	0.00
25	1,945.5	0.00	752.4	0.00	565.3	0.00	302.1	0.00	206.0	0.00
27	1,996.0	0.00	802.9	0.00	615.8	0.00	352.6	0.00	256.6	0.00

City: Ft. Wayne
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	25.9	0.00	5.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	29.9	0.00	6.1	4.0	0.00	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	35.7	0.00	7.3	9.8	0.00	2.0	5.7	0.00	1.2	N/A	N/A	N/A	N/A	N/A	N/A
19	37.7	0.00	7.8	11.8	0.00	2.4	7.8	0.00	1.6	2.1	0.00	0.4	N/A	N/A	N/A
21	39.5	0.00	8.1	13.5	0.00	2.8	9.5	0.00	2.0	3.8	0.00	0.8	1.7	0.00	0.4
25	42.2	0.00	8.7	16.3	0.00	3.4	12.2	0.00	2.5	6.5	0.00	1.4	4.4	0.00	0.9
27	43.2	0.00	8.9	17.3	0.00	3.6	13.3	0.00	2.8	7.6	0.00	1.6	5.5	0.00	1.2

City: Terre Haute
HVAC: AC with Natural Gas Heat

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	49.2	0.033	5.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	57.2	0.033	6.0	8.0	0.00	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	72.6	0.043	7.1	23.4	0.011	2.0	15.4	0.011	1.2	N/A	N/A	N/A	N/A	N/A	N/A
19	74.9	0.043	7.5	25.7	0.011	2.4	17.7	0.011	1.6	2.3	0.00	0.4	N/A	N/A	N/A
21	79.4	0.043	7.9	30.2	0.011	2.8	22.2	0.011	1.9	6.8	0.00	0.8	4.6	0.00	0.4
25	84.5	0.054	8.5	35.3	0.022	3.3	27.3	0.022	2.5	11.9	0.011	1.3	9.6	0.011	0.9
27	88.0	0.054	8.7	38.8	0.022	3.5	30.8	0.022	2.7	15.4	0.011	1.6	13.1	0.011	1.1

City: Terre Haute
HVAC: Heat Pump

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	760.8	0.033	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	878.8	0.033	118.0	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	1,046.2	0.043	285.4	0.011	167.4	0.011	N/A	N/A	N/A	N/A
19	1,105.9	0.043	345.1	0.011	227.1	0.011	59.7	0.00	N/A	N/A
21	1,154.8	0.043	394.0	0.011	276.0	0.011	108.6	0.00	48.9	0.00
25	1,233.0	0.054	472.3	0.022	354.2	0.022	186.9	0.011	127.1	0.011
27	1,265.8	0.054	505.0	0.022	386.9	0.022	219.6	0.011	159.9	0.011

City: Terre Haute
HVAC: AC with Electric Heat

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,175.9	0.033	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	1,363.4	0.033	187.5	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	1,631.7	0.043	455.8	0.011	268.3	0.011	N/A	N/A	N/A	N/A
19	1,726.3	0.043	550.4	0.011	362.9	0.011	94.6	0.00	N/A	N/A
21	1,807.7	0.043	631.8	0.011	444.3	0.011	176.0	0.00	81.4	0.00
25	1,933.8	0.054	757.9	0.022	570.3	0.022	302.1	0.011	207.5	0.011
27	1,985.6	0.054	809.7	0.022	622.2	0.022	353.9	0.011	259.3	0.011

City: Terre Haute
HVAC: Electric Heat Only

Measure R-Value	Base									
	0		11		13		17		19	
	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF	kWh/kSF	kW/kSF
11	1,151.6	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	1,335.1	0.00	183.5	0.00	N/A	N/A	N/A	N/A	N/A	N/A
17	1,593.5	0.00	441.9	0.00	258.4	0.00	N/A	N/A	N/A	N/A
19	1,688.1	0.00	536.4	0.00	352.9	0.00	94.5	0.00	N/A	N/A
21	1,766.6	0.00	615.0	0.00	431.5	0.00	173.1	0.00	78.6	0.00
25	1,890.3	0.00	738.7	0.00	555.2	0.00	296.8	0.00	202.3	0.00
27	1,939.7	0.00	788.1	0.00	604.6	0.00	346.2	0.00	251.7	0.00

City: Terre Haute
HVAC: Natural Gas Heat Only

Measure	Base														
	0			11			13			17			19		
	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF	kWh/ kSF	kW/ kSF	MMBtu/ kSF
11	25.0	0.00	5.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	29.0	0.00	6.0	4.0	0.00	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	34.7	0.00	7.1	9.6	0.00	2.0	5.6	0.00	1.2	N/A	N/A	N/A	N/A	N/A	N/A
19	36.7	0.00	7.6	11.7	0.00	2.4	7.7	0.00	1.6	2.1	0.00	0.4	N/A	N/A	N/A
21	38.4	0.00	7.9	13.3	0.00	2.8	9.3	0.00	2.0	3.7	0.00	0.8	1.6	0.00	0.4
25	41.1	0.00	8.5	16.0	0.00	3.3	12.0	0.00	2.5	6.4	0.00	1.3	4.3	0.00	0.9
27	42.2	0.00	8.7	17.1	0.00	3.5	13.1	0.00	2.7	7.5	0.00	1.5	5.4	0.00	1.1

Appendix D – Standard Wattage Tables

High Bay Fixture Baseline and Efficient Wattages

Efficient Lamp	Efficient Fixture Ballast Type	Baseline Lamp	Baseline Fixture Ballast Type	Efficient Fixture Wattage ($WATTS_{EE}$)	Efficient Fixture Wattage Source	Baseline Fixture Wattage ($WATTS_{BASE}$)	Baseline Fixture Wattage Source	Fixture Savings (Watts)
High Bay Fixtures								
T-5 46" Two Lamp High Output	Electronic - PRS	150 Watt Pulse Start Metal Halide	Magnetic-CWA	117	4	183	4	66
T-5 46" Three Lamp High Output	Electronic - PRS	200 Watt Pulse Start Metal Halide	Magnetic-CWA	181	4	232	3	51
T-5 46" Four Lamp High Output	Electronic – IS	320 Watt Pulse Start Metal Halide	Magnetic-CWA	234	3	365	3	131
T-5 46" Six Lamp High Output	Electronic – IS	350 Watt Pulse Start Metal Halide	Magnetic-CWA	351	3	400	3	49
T-5 46" Eight Lamp High Output	Electronic – IS	1,000 Watt Pulse Start Metal Halide	Magnetic-CWA	468	3	1,080	3	612
T-5 46" Six Lamp High Output (2 Fixtures)	Electronic – IS	1,000 Watt Pulse Start Metal Halide	Magnetic-CWA	702	3	1,080	3	378
T-8 48" Two Lamp Very High Output	Electronic – IS	150 Watt Pulse Start Metal Halide	Magnetic-CWA	77	4	183	4	106
T-8 48" Three Lamp Very High Output	Electronic – IS	150 Watt Pulse Start Metal Halide	Magnetic-CWA	112	3	183	4	71
T-8 48" Four Lamp Very High Output	Electronic – IS	200 Watt Pulse Start Metal Halide	Magnetic-CWA	151	3	232	3	81
T-8 48" Six Lamp Very High Output	Electronic – IS	320 Watt Pulse Start Metal Halide	Magnetic-CWA	226	3	365	3	139
T-8 48" Eight Lamp Very High Output	Electronic - PRS	350 Watt Pulse Start Metal Halide	Magnetic-CWA	288	4	400	3	112

Efficient Lamp	Efficient Fixture Ballast Type	Baseline Lamp	Baseline Fixture Ballast Type	Efficient Fixture Wattage ($WATTS_{EE}$)	Efficient Fixture Wattage Source	Baseline Fixture Wattage ($WATTS_{BASE}$)	Baseline Fixture Wattage Source	Fixture Savings (Watts)
T-8 48" Eight Lamp Very High Output (2 Fixtures)	Electronic – PRS	1,000 Watt Pulse Start Metal Halide	Magnetic-CWA	576	4	1,080	3	504
High Efficiency Fluorescent (HEF) Fixtures								
T-8 24" One Lamp	Electronic	T-12 24" One Lamp	Magnetic-STD	18	3	24	3	6
T-8 24" Two Lamp	Electronic	T-12 24" Two Lamp	Magnetic-STD	32	3	56	3	24
T-8 24" Three Lamp	Electronic	T-12 24" Three Lamp	Magnetic-STD	50	3	62	3	12
T-8 24" Four Lamp	Electronic	T-12 24" Four Lamp	Magnetic-STD	65	3	112	3	47
T-8 36" One Lamp	Electronic	T-12 36" One Lamp	Magnetic-STD	25	3	46	3	21
T-8 36" Two Lamp	Electronic	T-12 36" Two Lamp	Magnetic-STD	46	3	81	3	35
T-8 36" Three Lamp	Electronic	T-12 36" Three Lamp	Magnetic-STD	70	3	127	3	57
T-8 36" Four Lamp	Electronic	T-12 36" Four Lamp	Magnetic-STD	88	3	162	3	74
Reduced Wattage T-8 48" One Lamp-28 Watts	Electronic – IS	T-8 48" One Lamp	Electronic - IS	23	2	31	3	7.7
Reduced Wattage T-8 48" Two Lamp-28 Watts	Electronic – IS	T-8 48" Two Lamp	Electronic - IS	47	2	59	3	12
Reduced Wattage T-8 48" Three Lamp-28 Watts	Electronic – IS	T-8 48" Three Lamp	Electronic - IS	69.9	2	89	3	19.1
Reduced Wattage T-8 48" Four Lamp-28 Watts	Electronic – IS	T-8 48" Four Lamp	Electronic - IS	92.6	2	112	3	19.4
Reduced Wattage T-8 48" One Lamp-25 Watts	Electronic – IS	T-8 48" One Lamp	Electronic - IS	22	2	31	3	9
Reduced Wattage T-8 48" Two Lamp-25 Watts	Electronic – IS	T-8 48" Two Lamp	Electronic - IS	41	2	59	3	18
Reduced Wattage T-8 48" Three Lamp-25 Watts	Electronic – IS	T-8 48" Three Lamp	Electronic - IS	61.3	2	89	3	27.7
Reduced Wattage T-8 48" Four Lamp-25 Watts	Electronic – IS	T-8 48" Four Lamp	Electronic - IS	80.5	2	112	3	31.5

Efficient Lamp	Efficient Fixture Ballast Type	Baseline Lamp	Baseline Fixture Ballast Type	Efficient Fixture Wattage ($WATTS_{EE}$)	Efficient Fixture Wattage Source	Baseline Fixture Wattage ($WATTS_{BASE}$)	Baseline Fixture Wattage Source	Fixture Savings (Watts)
T-8 96" One Lamp	Electronic – IS	T-12 96" One Lamp-ES	Magnetic-STD	58	3	75	3	17
T-8 96" Two Lamp	Electronic – IS	T-12 96" Two Lamp-ES	Magnetic-ES	109	3	123	3	14
T-8 96" Four Lamp	Electronic – IS	T-12 96" Four Lamp-ES	Magnetic-ES	219	3	246	3	27
High Performance T-8 48" One Lamp	Electronic	T-8 48" One Lamp	Electronic - IS	25	6	31	3	6
High Performance T-8 48" Two Lamp	Electronic	T-8 48" Two Lamp	Electronic - IS	48	6	59	3	10
High Performance T-8 48" Three Lamp	Electronic	T-8 48" Three Lamp	Electronic - IS	73	6	89	3	17
High Performance T-8 48" Four Lamp	Electronic	T-8 48" Four Lamp	Electronic - IS	96	6	112	3	18
Metal Halide Track (MHT) Fixtures								
Metal Halide 20 Watts		Two 50 Watt Halogen		23	1	100	1	77
Metal Halide 39 Watts		Two 75 Watt Halogen		43	1	150	1	107
Metal Halide 70 Watts		Three 75 Watt Halogen		77	1	225	1	148
Ceramic Metal Halide (CMH) Fixtures								
Ceramic Metal Halide 20 Watts		Two 50 Watt Halogen		26	1	100	1	74
Ceramic Metal Halide 39 Watts		Two 75 Watt Halogen		45	1	150	1	105
Ceramic Metal Halide 50 Watts		Three 65 Watt Halogen		55	1	195	1	140
Ceramic Metal Halide 70 Watts		Three 75 Watt Halogen		79	1	225	1	146
Ceramic Metal Halide 100 Watts		Three 90 Watt Halogen		110	1	270	1	160
Ceramic Metal Halide 150		Three 120 Watt Halogen		163	1	360	1	197

Efficient Lamp	Efficient Fixture Ballast Type	Baseline Lamp	Baseline Fixture Ballast Type	Efficient Fixture Wattage ($WATTS_{EE}$)	Efficient Fixture Wattage Source	Baseline Fixture Wattage ($WATTS_{BASE}$)	Baseline Fixture Wattage Source	Fixture Savings (Watts)
Watts								
Low and High Bay Fixtures								
Low Bay LED 85 Watts 3		Metal Halide 250 Watts		85		295		210
Low Bay LED 85 Watts 3		T-8 96" Two Lamp High Output	Electronic	85		160		75
High Bay LED 139 Watts		Metal Halide 200 Watts		139		232		93
High Bay LED 175 Watts		Metal Halide 250 Watts		175		295		120

Sources

1. Efficiency Vermont. *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*. February 19, 2010.
2. Kuiken et al., KEMA. *Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0*. March 22, 2010.
3. Southern California Edison. *2010 Standard Performance Contract Procedures Manual.* “Appendix B: 2010 Table of Standard Fixture Wattages. Ver. 1.1.” February 25, 2010. Available online: http://www.aesc-inc.com/download/SPC/2010SPCDocs/UnifiedManual/App%20B%20Standard%20Fixture%20Watts.pdf
4. El Paso Electric. “2009 EPE Program Downloads. Wattage Table 2009.” Accessed September 26, 2009. http://www.epelectricefficiency.com/downloads.asp?section=ci
5. *New Jersey Clean Energy Program: Protocols to Measure Resource Savings.* December 2007.
6. Thorne and Nadel. *Commercial Lighting Retrofits: A Briefing Report for Program Implementers.* Paper presented at the annual meeting for the American Council for an Energy-Efficient Economy, April 2003.

Appendix E – TRM Updates and Changes

Measure	Edit #	Major Edit Description	Date
Residential Sector			
Residential ENERGY STAR Compact Fluorescent Lamp (CFL) Lighting (CFL and LED)	1	Combined with LED lamps	June 2015
	2	Fully accepted EISA baselines (no more language about future changes)	June 2015
	3	Included annual hours-of-use for school programs	June 2015
	4	Included annual hours-of-use for multifamily and specialty bulbs (from Illinois TRM)	June 2015
	5	Changed algorithm from delta watts multiplier to base watts multiplier	June 2015
	6	Updated incremental cost for CFLs	June 2015
	7	Updated incremental cost for LEDs	June 2015
Residential Direct Install - ENERGY STAR Compact Fluorescent Lamp (CFL) (Early Replacement)	1	Removed from TRM (combined with CFL/LED section)	June 2015
Residential LED Lamps	1	Removed from TRM (combined with CFL/LED section)	June 2015
	2	Created baseline watt multiplier from ENERGY STAR-qualified list	June 2015
LED Night Lights	1	No edits made	June 2015
Refrigerator and/or Freezer Retirement (Early Retirement)	1	Corrected math in example equation	June 2015
Residential HVAC Maintenance/Tune Up (Retrofit)	1	Included typical existing cooling capacity in accordance with 2012 Baseline Study	June 2015
	2	Included typical existing SEER in accordance with 2012 Baseline Study	June 2015
Residential Boiler Tune-Up	1	Included typical existing heating input in accordance with 2012 Baseline Study	June 2015

Measure	Edit #	Major Edit Description	Date
Attic/Roof/Ceiling Insulation (Retrofit)	1	Removed from TRM (combined with Wall Insulation)	June 2015
	2	Corrected math in example equation	June 2015
ENERGY STAR Torchiere (Time of Sale)	1	Updated baseline watts to reflect EISA	June 2015
Dedicated Pin Based Compact Fluorescent Lamp (CFL) Table Lamp	1	Updated baseline watts to reflect EISA	June 2015
Ceiling Fan with ENERGY STAR Light Fixture (Time of Sale)	1	Updated baseline watts to reflect EISA	June 2015
Efficient Refrigerator – ENERGY STAR and CEE TIER 2 (Time of Sale)	1	Updated baseline UEC from ENERGY STAR website	June 2015
Refrigerator Replacement (Low Income, Early Replacement)	1	Updated baseline and efficient UEC from ENERGY STAR website	June 2015
Clothes Washer – ENERGY STAR and CEE TIER 3 (Time of Sale)	1	No edits made (could not follow methodology); future edits should update RECs data	June 2015
	2	Updated incremental cost	June 2015
ENERGY STAR Room Air Conditioner (Time of Sale)	1	Updated average size of rebated unit according to ENERGY STAR list	June 2015
	2	Updated baseline efficiency based on 2015 e-CFR (federal standard)	June 2015
	3	Updated ENERGY STAR efficiency to comply with standards	June 2015
ENERGY STAR Room Air Conditioner Replacement (Low Income, Early Replacement)	1	Updated average size of rebated unit according to ENERGY STAR list	June 2015
	2	Updated the baseline efficiency based on 2015 e-CFR (fed standard)	June 2015
	3	Updated ENERGY STAR efficiency to comply with standards	June 2015
ENERGY STAR Room Air Conditioner Recycling (Early Retirement)	1	Updated average size of rebated unit according to ENERGY STAR list	June 2015
Central Air Conditioning (Early Replacement)	1	Included typical existing cooling capacity in accordance with 2012 Baseline Study	June 2015

Measure	Edit #	Major Edit Description	Date
	2	Included typical existing SEER in accordance with 2012 Baseline Study	June 2015
Central Air Conditioning (Time of Sale	1	Included typical existing cooling capacity in accordance with 2012 Baseline Study	June 2015
Central Air Source Heat Pump (Early Replacement)	1	Corrected algorithm to distinguish between heating and cooling capacities	June 2015
Central Air-Source Heat Pump (Time of Sale)	1	Corrected algorithm to distinguish between heating and cooling capacities	June 2015
Ground-Source Heat Pumps (Time of Sale)	1	Corrected algorithm to distinguish between heating and cooling capacities	June 2015
Low-Flow Faucet Aerator (Time of Sale or Early Replacement)	1	Overhauled measure and algorithm to comply with Cadmus Michigan water study and Interstate Power & Light multifamily direct install study	June 2015
	2	Updated groundwater temperature table to comply with *DHW Event Generator* developed by NREL	June 2015
Low-Flow Showerhead (Time of Sale or Early Replacement)	1	Overhauled measure and algorithm to comply with Cadmus Michigan water study and Interstate Power & Light multifamily direct install study	June 2015
	2	Updated incremental cost	June 2015
	2	Updated groundwater temperature table to comply with *DHW Event Generator* developed by NREL	June 2015
Domestic Hot Water Pipe Insulation (Retrofit)	1	Updated incremental cost	June 2015
Wall Insulation (Retrofit)	1	Removed from TRM (combined with Attic/Roof/Ceiling Insulation)	June 2015
Air Sealing - Reduce Infiltration (Retrofit)	1	Updated N-factors in table to align properly with *Residential Energy Book*	June 2015

Measure	Edit #	Major Edit Description	Date
	2	Updated reference tables to incorporate the adjustment proxy for new modeling	June 2015
Duct Sealing and Insulation (Retrofit)	1	Included typical existing cooling capacity in accordance with 2012 Baseline Study	June 2015
	2	Included typical existing SEER in accordance with 2012 Baseline Study	June 2015
	3	Updated incremental cost	June 2015
ENERGY STAR Windows (Time of Sale)	1	Updated reference tables to incorporate the adjustment proxy for new modeling	June 2015
Natural Gas Water Heaters (Time of Sale)	1	Updated groundwater temperature table to comply with *DHW Event Generator* developed by NREL	June 2015
	2	Updated ENERGY STAR criteria table	June 2015
Programmable Thermostats (Time of Sale, Direct Install)	1	Updated ESFs based on NIPSCO smart Wi-Fi t-stat study	June 2015
	2	Updated heating algorithm (no efficiency term needed since FF equipment rating is already in input)	June 2015
Added Smart Thermostats	1	Based on published studies in Indiana.	July 2015
Condensing Furnaces-Residential (Time of Sale)	1	Updated incremental cost	June 2015
Residential New Construction	1	Updated based on IECC 2009 specifications	June 2015
Other Software	1	Removed	June 2015
Commercial Sector			
Chiller Tune-Up	1	Corrected math in example equation	June 2015
C&I Lighting Controls (Time of Sale, Retrofit)	1	Removed redundant ESF from demand reduction algorithm	June 2015
Lighting Systems (Non-Controls) (Time of Sale, New Construction	1	Reformatted to condense	June 2015

Measure	Edit #	Major Edit Description	Date
Lighting Systems (Non-Controls) (Early Replacement, Retrofit)	1	Reduced Delta Watts multiplier due to EISA	June 2015
LED Case Lighting with/without Motion Sensors (New Construction; Retrofit – Early Replacement	1	Updated wattage tables to align with Wisconsin TRM	June 2015
	1	Corrected algorithm to account for additional freezer fixture	June 2015
June 2015Traffic Signals (Retrofit)	1	Updated wattage tables and CFs to align with Pennsylvania TRM	June 2015
ENERGY STAR Room Air Conditioner (Time of Sale)	1	Updated baseline efficiency standards	June 2015
	2	Updated Tier 1 and ENERGY STAR efficiency standards	June 2015
ENERGY STAR Hot Food Holding Cabinet (Time of Sale)	1	Updated baseline and efficient wattage per cubic foot based on ENERGY STAR requirements and fishnick.com	June 2015
ENERGY STAR Griddle (Time of Sale)	1	Updated efficient model parameters based on fishnick.com	June 2015
Spray Nozzles for Food Service (Retrofit)	1	Updated groundwater temperature table to comply with *DHW Event Generator* developed by NREL	June 2015
Heat Pump Water Heaters (New Construction, Retrofit)	1	Updated groundwater temperature table to comply with *DHW Event Generator* developed by NREL	June 2015
	2	Updated EF algorithms based on federal baseline	June 2015
Commercial Clothes Washer (Time of Sale)	1	No edits made	June 2015
Commercial Plug Load – Smart Strip Plug Outlets (Time of Use, Retrofit – New Equipment)	1	Expanded standby power consumption table to include weighted values	June 2015
Energy Efficient Furnace (Time of Sale, Retrofit – Early Replacement)	1	Corrected algorithm to conform with citation	June 2015

Measure	Edit #	Major Edit Description	Date
High Efficiency Storage Tank Water Heater (Time of Sale, Retrofit – Early Replacement)	1	Updated groundwater temperature table to comply with *DHW Event Generator* developed by NREL	June 2015
	2	Updated EF algorithms based on federal baseline	June 2015
Tankless Water Heaters (Time of Sale, Retrofit – Early Replacement)	1	Updated groundwater temperature table to comply with *DHW Event Generator* developed by NREL	June 2015
	2	Updated EF algorithms based on federal baseline	June 2015

DATA REQUEST

JI 1_61 Please refer to Exhibits BLN-1, the 2023 MPS, and BLN-2 and BLN-3. Please provide a list of all programs that were considered for the portfolio and if programs were not chosen, please provide an explanation as to why not.

RESPONSE

Based on the recommendations made by GDS in the market potential study, the Company considered the HEIP, Commercial Energy Solutions Program, a Custom Commercial Program and an Online Marketplace Program.

However, Kentucky Power previously offered a version of the commercial customer and online marketplace programs that resulted in minimal participation. The commercial custom program was offered for approximately two years starting in 2016 and only had one customer participate during that time. These programs were discontinued by Commission order dated January 18, 2018 in Case No. 2017-00097.

Additionally, the online marketplace would require startup and maintenance costs with a third-party vendor to implement. Based on the Company's experience operating a similar program, the Residential Efficient Products program, which resulted in minimal customer participation for the online marketplace component, the decision was made not to pursue an RFP for this program.

Witness: Barrett L. Nolen

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_62 Please refer to Exhibit BLN-1, the 2023 MPS, p. 15 of 123.
a.: Please explain what type of heating equipment is included in "Other"?
b.: Does the Company have a breakdown of baseboard electric heating penetration in the service territory? If so, please provide that statistic.

RESPONSE

a. The large majority of the "other" is reflective of a combination of room, wall, unit heaters of varying fuel types. Pellet stoves and unknown (as answered by the survey respondent) are also reflected in "other".

b. Based on responses to the survey conducted for the market potential study, most electric heated homes consisted of either heat pumps or forced air electric furnaces (using ductwork). Only 5 respondents (out of 268) reported using Electric Resistance Heaters (without ductwork) and 1 additional respondent indicated using electric baseboard heating as part of an "Other" response.

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_63 Please refer to Exhibits BLN-2 and BLN-3. Please provide the following information concerning the proposed portfolio.
a.: Projected total net benefits, by year and over the three-year period, by program and overall portfolio;
b.: Projected lifetime savings;
c.: Non-electric benefits, such as water savings, gas savings, and any non-energy benefits; and
d.: Avoided cost assumptions.

RESPONSE

a.-d. Please see KPCO_R_KPSC_1_7_Attachment1, KPCO_R_KPSC_1_7_Attachment2, and KPCO_R_KPSC_1_7_Attachment3 for the requested information.

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_64 Please explain why the Company excluded the Marketplace Program from the proposed portfolio even though it was recommended in the portfolio identified in the MPS.

RESPONSE

Please see response to JI 1_61.

Witness: Barrett L. Nolen

Witness: Tanner S. Wolffram

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_65 Please explain whether the Company placed parameters on the MPS regarding the assessment of demand response programs as part of the portfolio.
a.: If demand response was not evaluated as part of the MPS, please explain why it was excluded.

RESPONSE

a. Please see response to JI 1_24.

Witness: Barrett L. Nolen

Witness: Tanner S. Wolffram

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_66 Please refer to Exhibit BLN-1, the 2023 MPS, p. 23 of 123 (Section 4.1.2.1). Please confirm that the MPS did not explore the potential to offer new construction programs for both residential and commercial customers.
a.: If confirmed, please explain why the study did not explore the potential to offer new construction programs to both residential and commercial customers.
b.: If not confirmed, please detail the ways in which the MPS considered the potential for new construction programs for commercial customers.

RESPONSE

a. Confirmed. Sales and the number of accounts was forecasted to decline over time in both sectors. With no net new growth evident in the forecast, the market potential study focused on the savings potential in existing homes and businesses.

b. N/A

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_67 Please refer to Exhibit BLN-1, the 2023 MPS. Did GDS consider AEP's experience implementing similar DSM programs in its sister utilities when determining the timeline for rollout of new measures?
a.: If so, please explain how that experience factored into GDS's analysis, and provide the basis for multi-year timelines given that relevant experience.
b.: If not, please explain why not.

RESPONSE

a. Chapter 4, starting on page 36, of the market potential study outlines the processes, guiding principles, and market research used for general program design and incentive structures. The market research included benchmarking of program and measure offerings, incentive levels, and non-incentive program expenditures, as well as program cost-effectiveness for AEP Appalachian Power (West Virginia and Virginia) and AEP Indiana & Michigan among others.

b. N/A

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_68 Please refer to Exhibit BLN-1, the 2023 MPS. Please explain why lighting is included in residential programs, especially in reference to EISA lighting standards.

RESPONSE

In the residential sector, the market potential study limited the assessment of lighting opportunities to some for EISA exempt bulbs and direct-install bulbs, as well as lighting controls. However, in the program potential analysis, the residential programs do not include any lighting measures.

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_69 For the Company's TEE Program and HEIP, please describe how multifamily homes are treated, as compared to single family homes.

RESPONSE

For the DOE's WAP and Company's TEE program, multifamily homes are eligible for weatherization assistance. The agencies in Kentucky Power's service territory refer multifamily units with greater than five residences to the state where they are handled by a specialized group through the Kentucky Housing Corporation.

For the proposed HEIP, each multifamily unit would be eligible for participation in the program and the full suite of incentives.

Witness: Barrett L. Nolen

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_70 Please refer to Exhibit BLN-1, the 2023 MPS. Does the MPS consider any dedicated strategies or programs to reach customers in manufactured housing?
a.: If yes, please detail how the MPS considers programs targeted to reach this subset of customers.
b.: If not, please explain why the study did not consider programs targeted to reach this subset of customers.

RESPONSE

The market potential study broke out manufactured housing in estimates of technical, economic, and achievable potential, but did not include specific programs or strategies as part of the recommended programs.

a. All residential customers, including those in manufactured housing, are eligible for the incentives under the HEIP.

b. N/A

Witness: Warren Hirons (GDS Associates)

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_71 Please refer to Exhibit BLN-1, the 2023 MPS. Does the MPS consider any dedicated strategies or programs to small business customers?
a.: If yes, please detail how the MPS considers programs targeted to reach this subset of customers.
b.: If not, please explain why the study did not consider programs targeted to reach this subset of customers.

RESPONSE

The market potential study considers the potential from all commercial customers, including small business, with varied incentive under the achievable potential scenarios. Any potential impact of a specific small business program strategy is expected to be captured in the range between Measure Achievable Potential (MAP) and Realistic Achievable Potential (RAP).

a. All commercial customers, including small business customers, are eligible for the incentives under the Commercial Energy Solutions Program.

b. N/A

Witness: Warren Hirons (GDS Associates)

DATA REQUEST

JI 1_72 Please refer to Exhibit BLN-2 and BLN-3. Please detail any financing options that may be available to assist with upfront costs to customers and extended payback periods.

RESPONSE

Please see the Company’s response to JI 1_50.

Witness: Tanner S. Wolffram

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_73 Please refer to the Company's Quick Reference Guides, Exhibits BLN-2 and BLN-3.
a.: Please provide the model, with workable cells, to support the calculations.
b.: Please provide a list of all eligible measures and projected savings by programs and/or customer class.
c.: Please provide a workable model for the calculation of benefit-cost test(s).

RESPONSE

a. and c. The requested information is confidential and proprietary information of GDS that the Company does not have full access to. The Company cannot provide this information to Joint Intervenors prior Joint Intervenors executing a non-disclosure agreement that would protect GDS' confidential and proprietary information. Upon execution of such non-disclosure agreements, the Company will supplement this response

b. Please see KPCO_R_JI_1_73_Attachment1 and KPCO_R_JI_1_73_Attachment2 for the requested information.

Witness: Barrett L. Nolen

Preparer: Counsel

AEP Operating Company	**Kentucky Power**
Program Name	**Home Energy Improvement Program**
Program Year	**2025 - 2027**
Implementation Contractor	**TRC Companies**

PROGRAM YEAR 1

Measure	Unit Gross kWh Savings	Unit Gross kW Savings (Summer)	Unit Gross kW Savings (Winter)	Total Gross Annual kWh Savings	Total Gross kW Savings (Summer)	Total Gross kW Savings (Winter)	Net-to-Gross Ratio	Net kWh	Net kW (Summer)	Net kW (Winter)
Weatherization										
Residential Attic Insulation	456.0	0.7862	0.0638	2,736.0	4.7	0.4	0.80	2,188.8	3.8	0.3
Residential Air Sealing	751.0	0.2227	0.1051	3,755.0	1.1	0.5	0.80	3,004.0	0.9	0.4
Residential Duct Sealing & Insulation	533.0	0.1313	0.0746	533.0	0.1	0.1	0.80	426.4	0.1	0.1
Residential Floor Insulation Above Crawlspace	1,093.0	0.7853	0.1531	6,558.0	4.7	0.9	0.80	5,246.4	3.8	0.7
HVAC										
Residential Air Source Heat Pump	3,325.0	0.4862	0.4657	226,100.0	33.1	31.7	0.80	180,880.0	26.5	25.3
Residential Central Air Conditioner	299.0	0.3914	0.0000	9,568.0	12.5	0.0	0.80	7,654.4	10.0	0.0
Residential Ductless AC	161.0	0.2033	0.0000	1,449.0	1.8	0.0	0.80	1,159.2	1.5	0.0
Residential Ductless Heat Pump	1,622.0	0.4767	0.2269	129,760.0	38.1	18.1	0.80	103,808.0	30.5	14.5
Residential ENERGY STAR Room Air Conditioner	72.6	0.0689	0.0000	16,698.0	15.8	0.0	0.80	13,358.4	12.7	0.0
Residential Heat Pump Water Heater	1,910.0	0.0953	0.6986	9,550.0	0.5	3.5	0.80	7,640.0	0.4	2.8
Residential Smart Thermostat	462.6	0.1346	0.8095	76,791.6	22.3	134.4	0.80	61,433.3	17.9	107.5
Home Audit										
Assessment Recommendations	21.6	0.0020	0.0020	1,144.8	0.1	0.1	0.80	915.8	0.1	0.1
Low-flow Showerhead	217.0	0.0221	0.0221	8,889.2	0.9	0.9	0.80	7,111.4	0.7	0.7
Low-flow Bathroom Faucet Aerator	35.5	0.0070	0.0070	1,454.2	0.3	0.3	0.80	1,163.4	0.2	0.2
Low-flow Kitchen Faucet Aerator	213.0	0.0420	0.0420	4,362.7	0.9	0.9	0.80	3,490.1	0.7	0.7
Domestic Hot Water Pipe Insulation	89.4	0.0100	0.0100	10,986.5	1.2	1.2	0.80	8,789.2	1.0	1.0
Water Heater Temperature Setback	120.7	0.0138	0.0138	1,367.9	0.2	0.2	0.80	1,094.4	0.1	0.1
Water Heater Wrap	246.0	0.0280	0.0280	2,091.0	0.2	0.2	0.80	1,672.8	0.2	0.2
Caulking, Sealing, Tape	12.6	0.0034	0.0034	441.7	0.1	0.1	0.80	353.4	0.1	0.1
Outlet and Switch Gaskets	21.0	0.0002	0.0002	3,686.8	0.0	0.0	0.80	2,949.4	0.0	0.0
Door Sweep	12.6	0.0034	0.0034	883.4	0.2	0.2	0.80	706.7	0.2	0.2
Window/Door Weatherstripping	12.6	0.0034	0.0034	441.7	0.1	0.1	0.80	353.4	0.1	0.1
Advanced Power Strip - Tier 1	80.0	0.0090	0.0090	2,128.0	0.2	0.2	0.80	1,702.4	0.2	0.2
				521,376.6	139.4	194.1		417,101.2	111.5	155.3

PROGRAM YEAR 2

Measure	Unit Gross kWh Savings	Unit Gross kW Savings (Summer)	Unit Gross kW Savings (Winter)	Total Gross Annual kWh Savings	Total Gross kW Savings (Summer)	Total Gross kW Savings (Winter)	Net-to-Gross Ratio	Net kWh	Net kW (Summer)	Net kW (Winter)
Weatherization										
Residential Attic Insulation	456.0	0.7862	0.0638	3,648.0	6.3	0.5	0.80	2,918.4	5.0	0.4
Residential Air Sealing	751.0	0.2227	0.1051	5,257.0	1.6	0.7	0.80	4,205.6	1.2	0.6
Residential Duct Sealing & Insulation	533.0	0.1313	0.0746	1,066.0	0.3	0.1	0.80	852.8	0.2	0.1
Residential Floor Insulation Above Crawlspace	1,093.0	0.7853	0.1531	8,744.0	6.3	1.2	0.80	6,995.2	5.0	1.0
HVAC										
Residential Air Source Heat Pump	3,325.0	0.4862	0.4657	315,875.0	46.2	44.2	0.80	252,700.0	37.0	35.4
Residential Central Air Conditioner	299.0	0.3914	0.0000	13,455.0	17.6	0.0	0.80	10,764.0	14.1	0.0
Residential Ductless AC	161.0	0.2033	0.0000	2,093.0	2.6	0.0	0.80	1,674.4	2.1	0.0
Residential Ductless Heat Pump	1,622.0	0.4767	0.2269	180,042.0	52.9	25.2	0.80	144,033.6	42.3	20.1
Residential ENERGY STAR Room Air Conditioner	72.6	0.0689	0.0000	23,377.2	22.2	0.0	0.80	18,701.8	17.7	0.0
Residential Heat Pump Water Heater	1,910.0	0.0953	0.6986	13,370.0	0.7	4.9	0.80	10,696.0	0.5	3.9
Residential Smart Thermostat	462.6	0.1346	0.8095	107,785.8	31.4	188.6	0.80	86,228.6	25.1	150.9
Home Audit										
Assessment Recommendations	21.6	0.0020	0.0020	2,311.2	0.2	0.2	0.80	1,849.0	0.2	0.2
Low-flow Showerhead	217.0	0.0221	0.0221	17,778.4	1.8	1.8	0.80	14,222.7	1.4	1.4
Low-flow Bathroom Faucet Aerator	35.5	0.0070	0.0070	2,908.4	0.6	0.6	0.80	2,326.8	0.5	0.5
Low-flow Kitchen Faucet Aerator	213.0	0.0420	0.0420	8,725.3	1.7	1.7	0.80	6,980.3	1.4	1.4
Domestic Hot Water Pipe Insulation	89.4	0.0100	0.0100	21,973.1	2.5	2.5	0.80	17,578.5	2.0	2.0
Water Heater Temperature Setback	120.7	0.0138	0.0138	2,735.9	0.3	0.3	0.80	2,188.7	0.3	0.3
Water Heater Wrap	246.0	0.0280	0.0280	4,182.0	0.5	0.5	0.80	3,345.6	0.4	0.4
Caulking, Sealing, Tape	12.6	0.0034	0.0034	883.4	0.2	0.2	0.80	706.7	0.2	0.2
Outlet and Switch Gaskets	21.0	0.0002	0.0002	7,373.5	0.1	0.1	0.80	5,898.8	0.1	0.1
Door Sweep	12.6	0.0034	0.0034	1,766.8	0.5	0.5	0.80	1,413.5	0.4	0.4
Window/Door Weatherstripping	12.6	0.0034	0.0034	883.4	0.2	0.2	0.80	706.7	0.2	0.2
Advanced Power Strip - Tier 1	80.0	0.0090	0.0090	4,256.0	0.5	0.5	0.80	3,404.8	0.4	0.4
				750,490.5	197.0	274.6		600,392.4	157.6	219.7

PROGRAM YEAR 3

Measure	Unit Gross kWh Savings	Unit Gross kW Savings (Summer)	Unit Gross kW Savings (Winter)	Total Gross Annual kWh Savings	Total Gross kW Savings (Summer)	Total Gross kW Savings (Winter)	Net-to-Gross Ratio	Net kWh	Net kW (Summer)	Net kW (Winter)
Weatherization										
Residential Attic Insulation	456.0	0.7862	0.0638	4,560.0	7.9	0.6	0.80	3,648.0	6.3	0.5
Residential Air Sealing	751.0	0.2227	0.1051	6,759.0	2.0	0.9	0.80	5,407.2	1.6	0.8
Residential Duct Sealing & Insulation	533.0	0.1313	0.0746	1,066.0	0.3	0.1	0.80	852.8	0.2	0.1

Residential Floor Insulation Above Crawlspace	1,093.0	0.7853	0.1531	10,930.0	7.9	1.5	0.80	8,744.0	6.3	1.2
HVAC										
Residential Air Source Heat Pump	3,325.0	0.4862	0.4657	405,650.0	59.3	56.8	0.80	324,520.0	47.5	45.5
Residential Central Air Conditioner	299.0	0.3914	0.0000	17,342.0	22.7	0.0	0.80	13,873.6	18.2	0.0
Residential Ductless AC	161.0	0.2033	0.0000	2,576.0	3.3	0.0	0.80	2,060.8	2.6	0.0
Residential Ductless Heat Pump	1,622.0	0.4767	0.2269	231,946.0	68.2	32.4	0.80	185,556.8	54.5	26.0
Residential ENERGY STAR Room Air Conditioner	72.6	0.0689	0.0000	30,056.4	28.5	0.0	0.80	24,045.1	22.8	0.0
Residential Heat Pump Water Heater	1,910.0	0.0953	0.6986	17,190.0	0.9	6.3	0.80	13,752.0	0.7	5.0
Residential Smart Thermostat	462.6	0.1346	0.8095	138,317.4	40.2	242.0	0.80	110,653.9	32.2	193.6
Home Audit										
Assessment Recommendations	21.6	0.0020	0.0020	2,311.2	0.2	0.2	0.80	1,849.0	0.2	0.2
Low-flow Showerhead	217.0	0.0221	0.0221	17,778.4	1.8	1.8	0.80	14,222.7	1.4	1.4
Low-flow Bathroom Faucet Aerator	35.5	0.0070	0.0070	2,908.4	0.6	0.6	0.80	2,326.8	0.5	0.5
Low-flow Kitchen Faucet Aerator	213.0	0.0420	0.0420	8,725.3	1.7	1.7	0.80	6,980.3	1.4	1.4
Domestic Hot Water Pipe Insulation	89.4	0.0100	0.0100	21,973.1	2.5	2.5	0.80	17,578.5	2.0	2.0
Water Heater Temperature Setback	120.7	0.0138	0.0138	2,735.9	0.3	0.3	0.80	2,188.7	0.3	0.3
Water Heater Wrap	246.0	0.0280	0.0280	4,182.0	0.5	0.5	0.80	3,345.6	0.4	0.4
Caulking, Sealing, Tape	12.6	0.0034	0.0034	883.4	0.2	0.2	0.80	706.7	0.2	0.2
Outlet and Switch Gaskets	21.0	0.0002	0.0002	7,373.5	0.1	0.1	0.80	5,898.8	0.1	0.1
Door Sweep	12.6	0.0034	0.0034	1,766.8	0.5	0.5	0.80	1,413.5	0.4	0.4
Window/Door Weatherstripping	12.6	0.0034	0.0034	883.4	0.2	0.2	0.80	706.7	0.2	0.2
Advanced Power Strip - Tier 1	80.0	0.0090	0.0090	4,256.0	0.5	0.5	0.80	3,404.8	0.4	0.4
				942,170.3	250.1	349.9		753,736.3	200.1	279.9

AEP Operating Company	**Kentucky Power**
Program Name	**Commercial Energy Solutions Program**
Program Year	**2025 - 2027**
Implementation Contractor	**TRC Companies**

PROGRAM YEAR 1

Measure	Unit Gross kWh Savings	Unit Gross kW Savings (Summer)	Unit Gross kW Savings (Winter)	Total Gross Annual kWh Savings	Total Gross kW Savings (Summer)	Total Gross kW Savings (Winter)	Net-to-Gross Ratio	Net kWh	Net kW (Summer)	Net kW (Winter)
Prescriptive Lighting										
LED Downlight Fixture	143.1	0.0182	0.0172	87,288.5	11.1	10.5	0.80	69,830.8	8.9	8.4
LED High Bay Fixture	1,929.7	0.2441	0.2319	152,445.8	19.3	18.3	0.80	121,956.7	15.4	14.7
LED Low Bay Fixture	369.1	0.0472	0.0444	183,819.4	23.5	22.1	0.80	147,055.5	18.8	17.7
LED Exterior Area Lighting	760.2	0.0000	0.0884	548,100.5	0.0	63.7	0.80	438,480.4	0.0	51.0
LED Refrigerated Display Case Lighting	84.5	0.0116	0.0095	220,738.7	30.3	24.7	0.80	176,591.0	24.3	19.8
LED Linear Tube Replacement	60.9	0.0076	0.0073	1,103,630.3	138.3	132.0	0.80	882,904.2	110.6	105.6
LED Troffer	154.9	0.0194	0.0186	91,837.7	11.5	11.0	0.80	73,470.1	9.2	8.8
LED Wallpack	566.7	0.0000	0.0659	273,718.6	0.0	31.8	0.80	218,974.9	0.0	25.5
Network Lighting Controls	1.2	0.0002	0.0001	220,701.1	27.7	26.3	0.80	176,560.9	22.2	21.1
Occupancy Sensors	143.4	0.0181	0.0175	125,055.5	15.8	15.3	0.80	100,044.4	12.6	12.2
Daylighting Controls	208.1	0.0260	0.0246	165,050.5	20.6	19.5	0.80	132,040.4	16.5	15.6
				3,172,386.5	298.2	375.3		2,537,909.2	238.5	300.2

PROGRAM YEAR 2

Measure	Unit Gross kWh Savings	Unit Gross kW Savings (Summer)	Unit Gross kW Savings (Winter)	Total Gross Annual kWh Savings	Total Gross kW Savings (Summer)	Total Gross kW Savings (Winter)	Net-to-Gross Ratio	Net kWh	Net kW (Summer)	Net kW (Winter)
Prescriptive Lighting										
LED Downlight Fixture	143.1	0.0182	0.0172	100,310.2	12.7	12.1	0.80	80,248.2	10.2	9.6
LED High Bay Fixture	1,929.7	0.2441	0.2319	173,672.5	22.0	20.9	0.80	138,938.0	17.6	16.7
LED Low Bay Fixture	369.1	0.0472	0.0444	211,503.1	27.1	25.4	0.80	169,202.5	21.7	20.3
LED Exterior Area Lighting	760.2	0.0000	0.0884	630,201.6	0.0	73.3	0.80	504,161.2	0.0	58.6
LED Refrigerated Display Case Lighting	84.5	0.0116	0.0095	253,853.7	34.9	28.4	0.80	203,083.0	27.9	22.7
LED Linear Tube Replacement	60.9	0.0076	0.0073	1,269,117.0	159.0	151.8	0.80	1,015,293.6	127.2	121.4
LED Troffer	154.9	0.0194	0.0186	105,466.2	13.2	12.7	0.80	84,372.9	10.6	10.1
LED Wallpack	566.7	0.0000	0.0659	314,521.3	0.0	36.6	0.80	251,617.1	0.0	29.2
Network Lighting Controls	1.2	0.0002	0.0001	253,806.1	31.9	30.3	0.80	203,044.9	25.5	24.2
Occupancy Sensors	143.4	0.0181	0.0175	143,699.1	18.1	17.6	0.80	114,959.3	14.5	14.1
Daylighting Controls	208.1	0.0260	0.0246	189,610.3	23.7	22.4	0.80	151,688.2	19.0	17.9

Prescriptive HVAC							0.80			
Commercial Air Conditioner	186.6	0.0520	0.0063	933.0	0.3	0.0	0.80	746.4	0.2	0.0
Commercial Smart Thermostat	399.4	0.2039	0.0033	17,571.5	9.0	0.1	0.80	14,057.2	7.2	0.1
Packaged Terminal Heat Pumps	220.7	0.0379	0.0488	662.1	0.1	0.1	0.80	529.7	0.1	0.1
Geothermal Heat Pump	112.3	0.0188	0.0259	224.5	0.0	0.1	0.80	179.6	0.0	0.0
Commercial Air Source Heat Pump	228.2	0.0386	0.0536	2,281.5	0.4	0.5	0.80	1,825.2	0.3	0.4
Commercial Heat Pump Water Heater	2,877.3	0.3789	0.4400	17,263.5	2.3	2.6	0.80	13,810.8	1.8	2.1
				3,684,697.2	354.7	434.8		2,947,757.8	283.7	347.9

PROGRAM YEAR 3

Measure	Unit Gross kWh Savings	Unit Gross kW Savings (Summer)	Unit Gross kW Savings (Winter)	Total Gross Annual kWh Savings	Total Gross kW Savings (Summer)	Total Gross kW Savings (Winter)	Net-to-Gross Ratio	Net kWh	Net kW (Summer)	Net kW (Winter)
Prescriptive Lighting										
LED Downlight Fixture	143.1	0.0182	0.0172	113,331.9	14.4	13.6	0.80	90,665.5	11.5	10.9
LED High Bay Fixture	1,929.7	0.2441	0.2319	196,828.8	24.9	23.7	0.80	157,463.0	19.9	18.9
LED Low Bay Fixture	369.1	0.0472	0.0444	238,817.6	30.6	28.7	0.80	191,054.1	24.4	23.0
LED Exterior Area Lighting	760.2	0.0000	0.0884	712,302.6	0.0	82.8	0.80	569,842.1	0.0	66.2
LED Refrigerated Display Case Lighting	84.5	0.0116	0.0095	286,968.8	39.4	32.1	0.80	229,575.0	31.5	25.7
LED Linear Tube Replacement	60.9	0.0076	0.0073	1,434,664.6	179.7	171.6	0.80	1,147,731.6	143.8	137.3
LED Troffer	154.9	0.0194	0.0186	119,249.6	15.0	14.3	0.80	95,399.7	12.0	11.4
LED Wallpack	566.7	0.0000	0.0659	355,890.8	0.0	41.4	0.80	284,712.6	0.0	33.1
Network Lighting Controls	1.2	0.0002	0.0001	286,911.2	36.1	34.2	0.80	229,528.9	28.8	27.4
Occupancy Sensors	143.4	0.0181	0.0175	162,486.1	20.5	19.9	0.80	129,988.9	16.4	15.9
Daylighting Controls	208.1	0.0260	0.0246	214,378.3	26.8	25.3	0.80	171,502.6	21.5	20.3
Prescriptive HVAC							0.80			
Commercial Air Conditioner	186.6	0.0520	0.0063	3,731.9	1.0	0.1	0.80	2,985.6	0.8	0.1
Commercial Smart Thermostat	399.4	0.2039	0.0033	19,967.6	10.2	0.2	0.80	15,974.1	8.2	0.1
Packaged Terminal Heat Pumps	220.7	0.0379	0.0488	662.1	0.1	0.1	0.80	529.7	0.1	0.1
Geothermal Heat Pump	112.3	0.0188	0.0259	336.8	0.1	0.1	0.80	269.4	0.0	0.1
Commercial Air Source Heat Pump	228.2	0.0386	0.0536	2,737.8	0.5	0.6	0.80	2,190.2	0.4	0.5
Commercial Heat Pump Water Heater	2,877.3	0.3789	0.4400	20,140.8	2.7	3.1	0.80	16,112.6	2.1	2.5
Prescriptive Food Service & Misc.							0.80			
Commercial Combination Ovens	9,057.8	1.7706	1.2956	18,115.5	3.5	2.6	0.80	14,492.4	2.8	2.1
Commercial Fryers	3,274.0	0.6400	0.4683	6,548.0	1.3	0.9	0.80	5,238.4	1.0	0.7
Commercial Steam Cookers	9,863.2	1.4039	1.6187	9,863.2	1.4	1.6	0.80	7,890.6	1.1	1.3
Commercial Dishwasher	17,369.0	2.9314	2.7237	17,369.0	2.9	2.7	0.80	13,895.2	2.3	2.2
				4,221,303.0	411.0	499.7		3,377,042.4	328.8	399.8

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_74 Please refer to Ranie K. Wohnhas's Rebuttal Testimony in Case No. 2017- 00097 at p. 12, lines 23-27.3 Does the Company agree that the maximum period for recovery of lost revenues is three years, absent an intervening rate case, and not to exceed the claimed savings life of measures? If anything but agreed, please explain in full.

RESPONSE

It has been the Company's historic practice in its previous DSM filings to limit recovery of its DSM lost revenues to three years absent an intervening rate case.

Witness: Tanner S. Wolffram

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_75 Please explain how the Company would propose to address potential under-recovery related to the proposed DSM plan while avoiding volatility in DSM rates. For example, please refer to Ranie K. Wohnhas's Rebuttal Testimony in Case No. 2017-00097 at p. 12, lines 3-17.

RESPONSE

The Company's proposal maintains the process laid out in the referenced testimony. Specifically, the DSM rate is calculated by adding any under- or over-recovery from the prior year plus the estimated expenses for the upcoming program year then dividing that sum by the forecasted sales for the upcoming year. The Company does not believe the previous under-recovery issue was a result of how the recovery mechanism was designed; instead, the previous under-recovery was largely due to an increase in DSM spend between annual filings that was agreed to as part of the settlement in Case No. 2012-00578.

Witness: Tanner S. Wolffram

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_76 Please state the $/kWh values that the Company proposes to apply to calculate net lost revenue recovery under the proposed DSM rates for all residential and commercial customer classes.

RESPONSE

Please see revised Exhibit SEB-2, "Input – Lost Revenue" tab, column F for the $/kWh values, which was filed July 8, 2024.

Witness: Tanner S. Wolffram

Kentucky Power Company
KPSC Case No. 2024-00115
Joint Intervenors' First Set of Data Requests
Dated June 21, 2024

DATA REQUEST

JI 1_77 Does the Company propose to recover net lost revenues based on savings confirmed in the eventual EM&V assessment? If not, please explain in full how the Company proposes to maintain DSM rates that accurately reflect verified actual savings.

RESPONSE

Confirmed. The Company will utilize the estimated energy savings provided by GDS in the market potential study to determine net lost revenues which will be subsequently trued up based on actual results from the eventual EM&V assessment.

Witness: Tanner S. Wolffram

DATA REQUEST

JI 1_78 Please answer the following questions regarding line loss assumptions.
a.: Please identify the line loss assumptions (both average and marginal) used in the estimation of DSM energy savings and peak load reduction for the purpose of determining the net lost revenue component of the DSM rate.
b.: Please refer to Exhibit SEB-6, p. 2 of 37.
i.: Do the line loss assumptions identified in response to subpart(a) match the 9.4% and 10.5% T&D losses for energy savings and peak demand reduction cited in this 2023 DSM Report? If not, please explain why not.
ii.: Please state whether the T&D loss figures provided in this exhibit are marginal or average.
c.: Please explain the empirical basis for each line loss assumption value identified above, including but not limited to, stating when the relevant study (or studies) of line losses took place, the specific geographic area(s) studied (e.g., KPC territory, all AEP affiliate territories, regional), methodology, and verification, if any.

RESPONSE

a. GDS used 10.5% as the line loss assumption for the market potential study. Recognizing the 9.4% for energy and 10.5% for demand are average line losses, GDS used the higher peak demand loss factor as a proxy for a marginal rate.

b.i. Please see the Company's response to subpart (a).

b.ii. The T&D loss figures provided in KPSC_R_JI_1_78_Attachment1 are average.

c. Please see KPSC_R_JI_1_78_Attachment1 for the requested information.

Witness: Tanner S. Wolffram

Witness: Warren Hirons (GDS Associates)

KENTUCKY POWER COMPANY

2020 Analysis of System Losses

June 2022

Prepared by:

Management Applications Consulting, Inc.
1103 Rocky Drive – Suite 201
Reading, PA 19609
Phone: (610) 670-9199 / Fax: (610) 670-9190

MANAGEMENT APPLICATIONS CONSULTING, INC.

1103 Rocky Drive • Suite 201 • Reading, PA 19609-1157 • 610/670-9199 • fax 610/670-9190 •www.manapp.com

June 2, 2022

Mr. David M. Roush
Director Regulatory Pricing & Analysis
American Electric Power
1 Riverside Plaza
Columbus, OH 43215

Mr. Chad Burnett
Director Economic Forecasting
American Electric Power
212 East 6th Street
Tulsa, OK 74119

RE: 2020 LOSS ANALYSIS

Dear Messrs. Roush and Burnett:

Transmitted herewith are the results of the 2020 Analysis of System Losses for the Kentucky Power Company's (KPCO) power system. Our analysis develops cumulative expansion factors (loss factors) for both demand (peak/kW) and energy (average/kWh) losses by discrete voltage levels applicable to metered sales data. Our analysis considers only technical losses in arriving at our final recommendations.

On behalf of MAC, we appreciate the opportunity to assist you in performing the loss analysis contained herein. The level of detailed load research and sales data by voltage level, coupled with a summary of power flow data and power system model, forms the foundation for determining reasonable and representative power losses on the KPCO system. Our review of these data and calculated loss results support the proposed loss factors as presented herein for your use in various cost of service, rate studies, and demand analyses.

Should you require any additional information, please let us know at your earliest convenience.

Sincerely,

Paul M. Normand
Principal

Enclosure
PMN/rjp

Kentucky Power Company
2020 Analysis of System Losses

TABLE OF CONTENTS

Kentucky Power Company
2020 Analysis of System Losses

1.0 EXECUTIVE SUMMARY

This report presents Kentucky Power Company's (KPCO) 2020 Analysis of System Losses for the power systems as performed by Management Applications Consulting, Inc. (MAC). The study developed separate demand (kW) and energy (kWh) loss factors for each voltage level of service in the power system for KPCO. The cumulative loss factor results by voltage level, as presented herein, can be used to adjust metered kW and kWh sales data for losses in performing cost of service studies, determining voltage discounts, and other analyses which may require a loss adjustment.

The procedures used in the overall loss study were similar to prior studies and emphasized the use of "in house" resources where possible. To this end, extensive use was made of the Company's peak hour power flow data and transformer plant investments in the model. In addition, measured and estimated load data provided a means of calculating reasonable estimates of losses by using a "top-down" and "bottom-up" procedure. In the "top-down" approach, losses from the high voltage system, through and including distribution substations, were calculated along with power flow data, conductor and transformer loss estimates, and metered sales.

At this point in the analysis, system loads and losses at the input into the distribution substation system are known with reasonable accuracy. However, it is the remaining loads and losses on the distribution substations, primary system, secondary circuits, and services which are generally difficult to estimate. Estimated and actual Company load data provided the starting point for performing a "bottom-up" approach for calculating the remaining distribution losses. Basically, this "bottom-up" approach develops line loadings by first determining loads and losses at each level beginning at a customer's meter service entrance and then going through secondary lines, line transformers, primary lines and finally distribution substation. These distribution system loads and associated losses are then compared to the initial calculated input into Distribution Substation loadings for reasonableness prior to finalizing the loss factors. An overview of the loss study is shown on Figure 1.

With the emergence of transmission as a stand-alone function throughout various regions of the country, a modification to the historical calculation of the transmission loss factors was required. Historic loss studies recognized the multipath approach to losses from high voltage to low voltage delivery. The current definition of transmission losses recognized in the industry is simply to sum all losses at transmission as an integrated system. This approach will typically increase the resulting composite transmission loss factors but better reflects the topology of the systems with dispersed supply resources and interconnections.

The load research data provided the starting point for performing a "bottom-up" approach for estimating the remaining distribution losses. Basically, this "bottom-up" approach develops line loadings by first determining loads and losses at each level beginning at a customer's meter and service entrance and then going through secondary lines, line transformers, primary lines and finally distribution substation. These distribution system loads and associated losses are then compared to the initial calculated input into Distribution Substation loadings for reasonableness prior to finalizing the loss factors. An overview of the loss study is shown on Figure 1 on the next page.

Table 1, below, provides the final results from Appendix A for the 2020 calendar year. Exhibits 8 and 9 of Appendix A present a more detailed analysis of the final calculated summary results of losses by voltage segments and delivery service level in the Company's power system. These Table 1 cumulative loss expansion factors are applicable only to metered sales at the point of receipt for adjustment to the power system's input level.

TABLE 1
Loss Factors at Sales Level, Calendar Year 2020

Voltage Level of Service	Total Company	Distribution Only
Demand (kW)		
Transmission[1]	1.04025	–
Subtransmission	1.05869	1.01773
Primary Lines	1.07522	1.03361
Secondary	1.10546	1.06269
Energy (kWh)		
Transmission[1]	1.02290	–
Subtransmission	1.03651	1.01330
Primary Lines	1.04930	1.02581
Secondary	1.09416	1.06966
Losses – Net System Input[2]	6.54%MWh	
	8.49 %MW	
Losses – Net System Output[3]	7.00 %MWh	
	9.27 %MW	
Composite Loss Factors at Metered Sales Level		
	MW	**MWH**
Retail	1.09345	1.07060
Wholesale	1.04583	1.02678

The loss factors presented in the Delivery Only column of Table 1 are the Total KPCO loss factors divided by the transmission loss factor in order to remove these losses from each service level loss factor. For example, the secondary distribution demand loss factor of 1.06269 includes

[1] Reflects results for 765 kV, 345 kV 161 kV, and 138 kV.
[2] Net system input equals firm sales plus losses, Company use less non-requirement sales and related losses. See Appendix A, Exhibit 1, for their calculations.
[3] Net system output uses losses divided by output or sales data as a reference.

the recovery of all distribution only losses from the distribution substation, primary lines, line transformers, secondary conductors and services.

The net system input shown in Table 1 represents the MWh losses of 6.54% for the total KPCO internal load using calculated losses divided by the associated input energy to the system. The 7.00% represents the same losses using system output instead of input as a reference. Similarly, the net system input reference shown in Table 1 for MW losses is 8.49%, and the MW loss referenced to output is 9.27%. These calculations are all based on the data and results shown on Exhibits 1, 7 and 9 of the study.

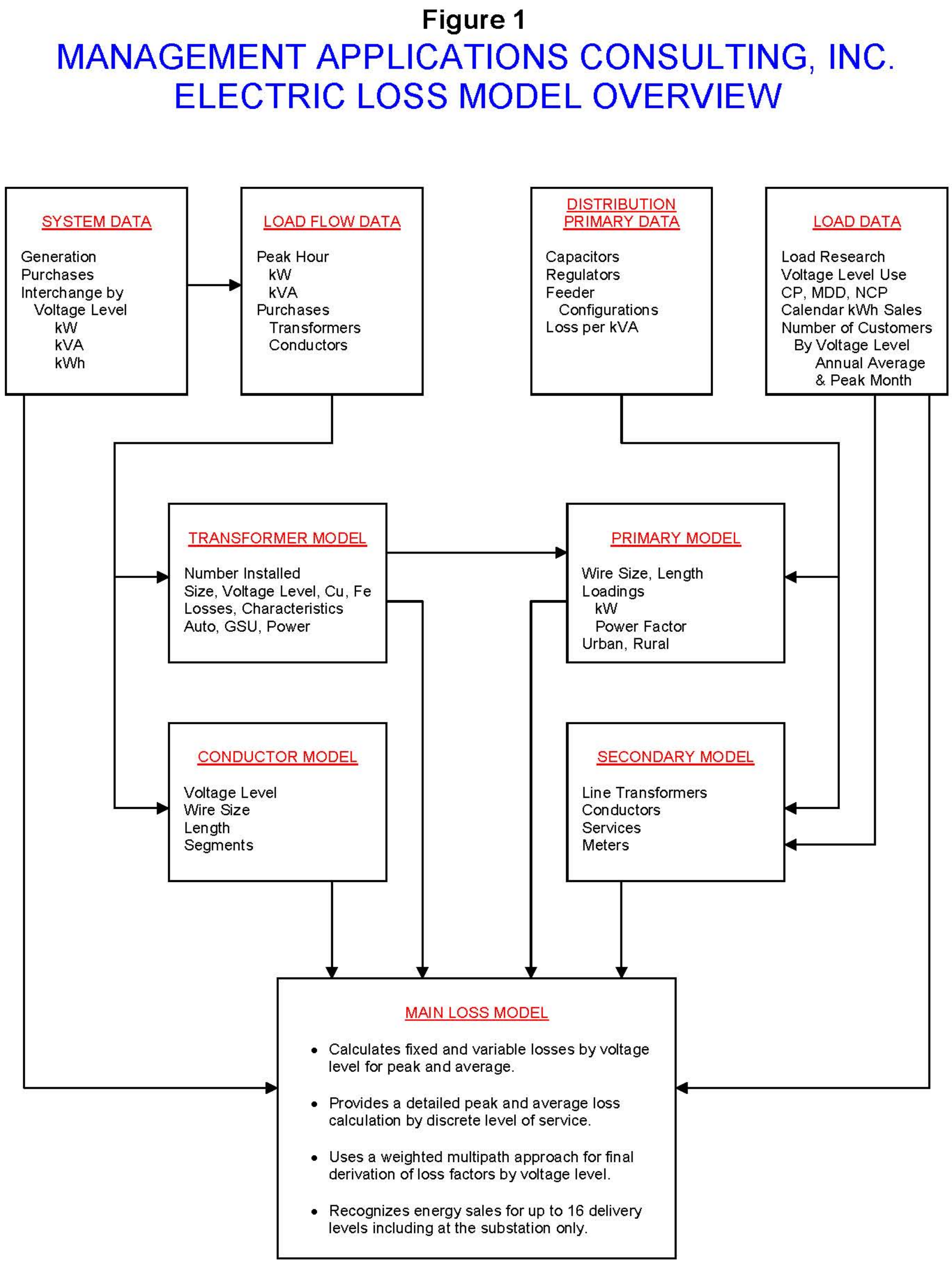
Due to the very nature of losses being primarily a function of equipment loading levels for a peak load hour, the loss factor derivations for any voltage level must consider both the load at that level plus the loads from lower voltages and their associated losses. As a result, cumulative losses on losses equates to additional load at higher levels along with future changes (+ or –) in loads throughout the power system. It is therefore important to recognize that losses are multiplicative in nature (future) and not additive (test year only) for all future years to ensure total recovery based on prospective fixed loss factors for each service voltage.

The derivation of the cumulative loss factors shown in Table 1 have been detailed for all electrical facilities in Exhibit 9, page 1 for demand and page 2 for energy. Beginning on line 1 of page 1 (demand) under the secondary column, metered sales are adjusted for service losses on lines 3 and 4. This new total load (with losses) becomes the load amount for the next higher facilities of secondary conductors and their loss calculations. This process is repeated for all the installed facilities until the secondary sales are at the input level (line 45). The final loss factor for all delivery voltages using this same process is shown on line 46 and Table 1 for demand. This procedure is repeated in Exhibit 9, page 2, for the energy loss factors.

The loss factor calculation is simply the input required (line 45) divided by the metered sales (line 43).

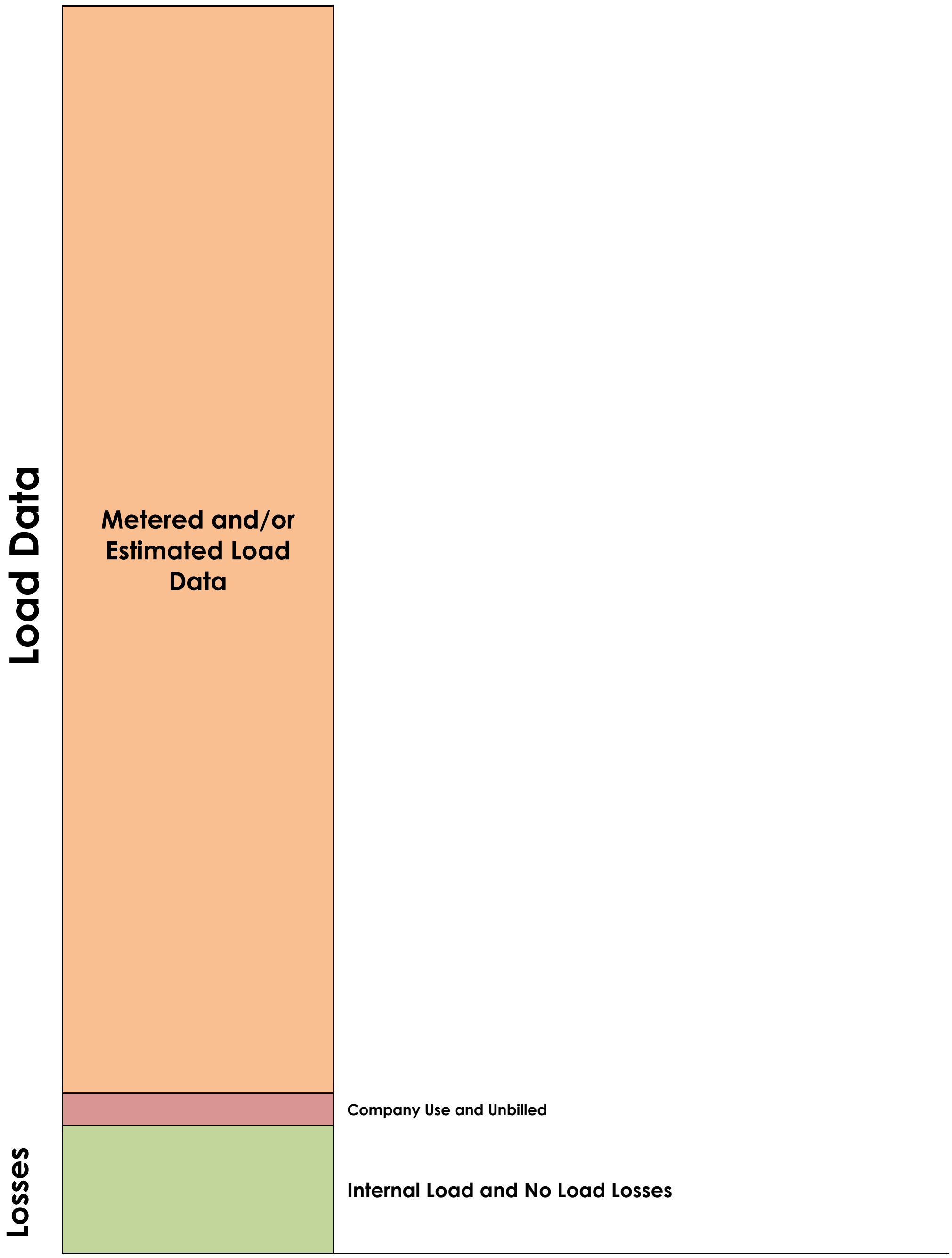
An overview of the loss study is shown on Figure 1 on the next page. Figure 2 simply illustrates the major components that must be considered in a loss analysis.

Kentucky Power Company
2020 Analysis of System Losses



Kentucky Power Company
2020 Analysis of System Losses

Figure 2
Generic Energy Loss Components



2.0 INTRODUCTION

This report of the 2020 Analysis of System Losses for the Company provides a summary of results, conceptual background or methodology, description of the analyses, and input information related to the study.

2.1 Conduct of Study

Typically, between five to ten percent of the total peak hour MW and annual MWH requirements of an electric utility is lost or unaccounted for in the delivery of power to customers. Investments must be made in facilities which support the total load which includes losses or unaccounted for load. Revenue requirements associated with load losses are an important concern to utilities and regulators in that customers must equitably share in all of these cost responsibilities. Loss expansion factors by voltage level are the mechanism by which customers' metered demand and energy data are mathematically adjusted to the generation or input level (point of reference) when performing cost and revenue calculations.

An acceptable accounting of losses can be determined for any given time period using available engineering, system, and customer data along with empirical relationships. This loss analysis for the delivery of demand and energy utilizes such an approach. A microcomputer loss model[4] is utilized as the vehicle to organize the available data, develop the relationships, calculate the losses, and provide an efficient and timely avenue for future updates and sensitivity analyses. Our procedures and calculations are similar with prior loss studies, and they rely on numerous databases that include customer statistics and power system investments at various voltage levels of service.

Company personnel performed most of the data gathering and data processing efforts and checked for reasonableness. MAC provided assistance as necessary to construct databases, transfer files, perform calculations, and check the reasonableness of results. Efforts in determining the data required to perform the loss analysis centered on information which was available from existing studies or reports within the Company. From an overall perspective, our efforts concentrated on five major areas:

1. System information concerning peak demand and annual energy requirements by voltage level,
2. High voltage power system power flow data and associated loss calculations,
3. Distribution system primary and secondary loss calculations,
4. Derivation of fixed and variable losses by voltage level, and
5. Development of final cumulative expansion factors at each voltage for peak demand (kW) and annual energy (kWh) requirements at the point of delivery (meter).

[4]Copyright by Management Applications Consulting, Inc.

2.2 Electric Power Losses

Losses in power systems consist of primarily technical losses with a much smaller level of non-technical losses.

Technical Losses

Electrical losses result from the transmission of energy over various electrical equipment. The largest component of total losses during peaking conditions is power dissipation as a result of varying loading conditions and are oftentimes called load losses which are mostly related to the square of the current (I^2R). These peak hour losses can be as high as 60-75% of all technical losses during peak loading conditions. The remaining losses are called no-load and represent essentially fixed (constant) energy losses throughout the year. These no-load losses represent energy required to energize various electrical equipment regardless of their loading levels over the entire year. The major portion of these no-load losses consists of core or magnetizing energy related to installed transformers throughout the power system and generates the major component of annual losses on any distribution system.

The following Table 2 summarizes the unadjusted fixed and variable losses by major functional categories from Exhibit 5 of Appendix A:

TABLE 2

	DEMAND (PEAK HOUR)			ENERGY (ANNUAL AVERAGE)		
	FIXED	VARIABLE	TOTAL	FIXED	VARIABLE	TOTAL
TRANS	2.64	41.66	44.31	22,182	96,384	118,566
(%)	5.96%	94.04%	100.00%	18.71%	81.29%	100.00%
SUBTRANS	2.11	14.07	16.18	18,508	40,502	59,010
(%)	13.03%	86.97%	100.00%	31.36%	68.64%	100.00%
DIST SUBS	2.69	2.41	5.11	23,663	6,721	30,383
(%)	52.77%	47.23%	100.00%	77.88%	22.12%	100.00%
PRIMARY	0.78	12.55	13.34	13,502	25,059	38,561
(%)	5.88%	94.12%	100.00%	35.01%	64.99%	100.00%
SECONDARY	11.10	9.81	20.91	97,455	21,669	119,125
(%)	53.10%	46.90%	100.00%	81.81%	18.19%	100.00%
TOTAL SYS.	19.33	80.50	99.83	175,310	190,335	365,646
(%)	19.36%	80.64%	100.00%	47.95%	52.05%	100.00%
TOTAL DIST	14.58	24.77	39.35	134,620	53,449	188,070
(%)	37.05%	62.95%	100.00%	71.58%	28.42%	100.00%

Non-Technical Losses

These are unaccounted for energy losses that are related to energy theft, metering, non-payment by customers, and accounting errors. Losses related to these areas are generally very small and can be extremely difficult and subjective to quantify. Our efforts generally do not develop any meaningful level because we assume that improving technology and utility practices have minimized these amounts.

2.3 Loss Impacts from Distributed Generation (DG)

The impacts of losses on a power system from the installation of various DG facilities will depend somewhat on the penetration level, type of installations and location on a circuit. Based on the results presented in Table 2 of this loss study, the impacts are significantly different from looking at any single peak load hour versus the potential impacts over all hours of an entire year. Use of a typical uniform loss factor(s) for each voltage level may require additional consideration to recognize that a reduced consumption level could have little or no impact due to the recovery requirements for the high level of fixed losses over the entire hourly electric grid condition for any DG location.

2.4 Description of Model

The loss model is a customized applications model, constructed using the Excel software program. Documentation consists primarily of the model equations at each cell location. A significant advantage of such a model is that the actual formulas and their corresponding computed values at each cell of the model are immediately available to the analyst.

A brief description of the three (3) major categories of effort for the preparation of each loss model is as follows:

- Main sheet which contains calculations for all primary and secondary losses, summaries of all conductor and transformer calculations from other sheets discussed below, output reports and supporting results.

- Transformer sheet which contains data input and loss calculations for each distribution substation and high voltage transformer. Separate iron and winding losses are calculated for each transformer by identified type.

- Conductor sheet containing summary data by major voltage level as to circuit miles, loading assumptions, and kW and kWh loss calculations. Separate loss calculations for each line segment were made using the Company's power flow data by line segment and summarized by voltage level in this model.

3.0 METHODOLOGY

3.1 Background

The objective of a Loss Study is to provide a reasonable set of energy (average) and demand (peak) loss expansion factors which account for system losses associated with the transmission and delivery of power to each voltage level over a designated period of time. The focus of this study is to identify the difference between total energy inputs and the associated sales with the difference being equitably allocated to all delivery levels. Several key elements are important in establishing the methodology for calculating and reporting the Company's losses. These elements are:

- Selection of voltage level of services,
- Recognition of losses associated with conductors, transformations, and other electrical equipment/components within voltage levels,
- Identification of customers and loads at various voltage levels of service,
- Review of generation or net power supply input at each level for the test period studied, and
- Analysis of kW and kWh sales by voltage levels within the test period.

The three major areas of data gathering and calculations in the loss analysis were as follows:

1. System Information (monthly and annual)
   - MWH generation and MWH sales.
   - Coincident peak estimates and net power supply input from all sources and voltage levels.
   - Customer load data estimates from available load research information, adjusted MWH sales, and number of customers in the customer groupings and voltage levels identified in the model.
   - System default values, such as power factor, loading factors, and load factors by voltage level.

2. High Voltage System

- Conductor information was summarized from a database by the Company which reflects the transmission system by voltage level. Extensive use was made of the Company's power flow data with the losses calculated and incorporated into the final loss calculations.

- Transformer information was developed in a database to model transformation at each voltage level. Substation power, step-up, and auto transformers were individually identified along with any operating data related to loads and losses.

- Power flow data of peak condition was the primary source of equipment loadings and derivation of load losses in the high voltage loss calculations.

3. Distribution System

- Distribution Substations – Data was developed for modeling each substation as to its size and loading. Loss calculations were performed from this data to determine load and no load losses separately for each transformer.

- Primary lines – Line loading and loss characteristics for several representative primary circuits were obtained from the Company. These loss results developed kW loss per MW of load and a composite average was calculated to derive the primary loss estimate.

- Line transformers – Losses in line transformers were based on each customer service group's size, as well as the number of customers per transformer. Accounting and load data provided the foundation with which to model the transformer loadings and to calculate load and no load losses.

- Secondary network – Typical secondary networks were estimated for conductor sizes, lengths, loadings, and customer penetration for residential and small general service customers.

- Services – Typical services were estimated for each secondary service class of customers identified in the study with respect to type, length, and loading.

The loss analysis was thus performed by constructing the model in segments and subsequently calculating the composite until the constraints of peak demand and energy were met:

- Information as to the physical characteristics and loading of each transformer and conductor segment was modeled.

- Conductors, transformers, and distribution were grouped by voltage level, and unadjusted losses were calculated.

- The loss factors calculated at each voltage level were determined by “compounding” the per-unit losses. Equivalent sales at the supply point were obtained by dividing sales at a specific level by the compounded loss factor to determine losses by voltage level.

- The resulting demand and energy loss expansion factors were then used to adjust all sales to the generation or input level in order to estimate the difference.

- Reconciliation of kW and kWh sales by voltage level using the reported system kW and kWh was accomplished by adjusting the initial loss factor estimates until the mismatch or difference was eliminated.

3.2 Calculations and Analysis

This section provides a discussion of the input data, assumptions, and calculations performed in the loss analysis. Specific appendices have been included in order to provide documentation of the input data utilized in the model.

3.2.1 Bulk, Transmission and Subtransmission Lines

The transmission and subtransmission line losses were calculated based on a modeling of unique voltage levels identified by the Company's power flow data and configuration for the entire integrated KPCO Power System. Specific information as to length of line, type of conductor, voltage level, peak load, maximum load, etc., were provided based on Company records and utilized as data input in the loss model.

Actual MW and MVA line loadings were based on KPCO’s peak loading conditions. Calculations of line losses were performed for each line segment separately and combined by voltage levels for reporting purposes as shown in the Discussion of Results (Section 4.0) of this report. The loss calculations consisted of determining a circuit current value based on MVA line loadings and evaluating the I^2R results for each line segment.

After system coincident peak hour losses were identified for each voltage level, a separate calculation was then made to develop annual average energy losses based on a loss factor approach. Load factors were determined for each voltage level based on system and customer load information. An estimate of the Hoebel coefficient (see Appendix B) was then used to calculate energy losses for the entire period being analyzed. The results are presented in Section 4.0 of this report.

3.2.2 Transformers

The transformer loss analysis required several steps in order to properly consider the characteristics associated with various transformer types; such as, step-up, auto transformers, distribution substations, and line transformers. In addition, further efforts were required to identify both iron and winding losses within each of these transformer types in order to obtain reasonable peak (kW) and average energy (kWh) losses. While iron losses were considered essentially constant for each hour, recognition had to be made for the varying degree of winding losses due to hourly equipment loadings.

Standardized test data tables were used to represent no load information (fixed) and full load (variable) losses for different types and sizes of transformers. This test data was incorporated into the loss model to develop relationships representing winding and iron or core losses for the transformer loss calculation. These results were then totaled by various groups, as identified and discussed in Section 4.0.

The remaining miscellaneous losses considered in the loss study consisted of several areas which do not lend themselves to any reasonable level of modeling for estimating their respective losses and were therefore lumped together into a single loss factor. The typical range of values for these losses is from 0.10% to 0.25%, and we have assumed 0.1% value for this study. The losses associated with this loss factor include bus bars, unmetered station use, grounding transformers, cooling fans, heating and air conditioning requirements, and other remaining station use requirements.

3.2.3 Distribution System

The load data at the substation and customer level, coupled with primary and secondary network information, was sufficient to model the distribution system in adequate detail to calculate losses.

Primary Lines

Primary line loadings take into consideration the available distribution load along with the actual customer loads including losses. Primary line loss estimates were prepared by the Company for use in this loss study. These estimates considered loads per substation, voltage levels, loadings, total circuit miles, wire size, and single- to three-phase investment estimates. All of these factors were considered in calculating the actual demand (kW) and energy (kWh) for the primary system.

Line Transformers

Losses in line transformers were determined based on typical transformer sizes for each secondary customer service group and an estimated or calculated number of customers per transformer. Accounting records and estimates of load data provided the necessary database with which to model the loadings. These calculations also made it possible to determine separate winding and iron losses for distribution line transformers, based on a table of representative losses for various transformer sizes.

Secondary Line Circuits

A calculation of secondary line circuit losses was performed for loads served through these secondary line investments. Estimates of typical conductor sizes, lengths, loadings and customer class penetrations were made to obtain total circuit miles and losses for the secondary network. Customer loads which do not have secondary line requirements were also identified so that a reasonable estimate of losses and circuit miles of these investments could be made.

Service Drops and Meters

Service drops were estimated for each secondary customer reflecting conductor size, length and loadings to obtain demand losses. A separate calculation was also performed using customer maximum demands to obtain kWh losses. Meter loss estimates were also made for each customer and incorporated into the calculations of kW and kWh losses included in the Summary Results.

4.0 DISCUSSION OF RESULTS

A brief description of each Exhibit provided in Appendix A follows:

Exhibit 1 - Summary of Company Data

This exhibit reflects system information used to determine percent losses and a detailed summary of kW and kWh losses by voltage level. The loss factors developed in Exhibit 7 are also summarized by voltage level.

Exhibit 2 - Summary of Conductor Information

A summary of MW and MWH load and no load losses for conductors by voltage levels is presented. The sum of all calculated losses by voltage level is based on input data information provided in Appendix A. Percent losses are based on equipment loadings.

Exhibit 3 - Summary of Transformer Information

This exhibit summarizes transformer losses by various types and voltage levels throughout the system. Load losses reflect the winding portion of transformer losses while iron losses reflect the no load or constant losses. MWH losses are estimated using a calculated loss factor for winding and the test year hours times no load losses.

Exhibit 4 - Summary of Losses Diagram (2 Pages)

This loss diagram represents the inputs and output of power at system peak conditions. Page 1 details information from all points of the power system and what is provided to the distribution system for primary loads. This portion of the summary can be viewed as a “top down” summary into the distribution system.

Page 2 represents a summary of the development of primary line loads and distribution substations based on a “bottom up” approach. Basically, loadings are developed from the customer meter through the Company’s physical investments based on load research and other metered information by voltage level to arrive at MW and MVA requirements during peak load conditions by voltage levels.

Exhibit 5 - Summary of Sales and Calculated Losses

Summary of Calculated Losses represents a tabular summary of MW and MWH load and no load losses by discrete areas of delivery within each voltage level. Losses have been identified and are derived based on summaries obtained from Exhibits 2 and 3 and losses associated with meters, capacitors and regulators.

Exhibit 6 - Development of Loss Factors, Unadjusted

This exhibit calculates demand and energy losses and loss factors by specific voltage levels based on sales level requirements. The actual results reflect loads by level and summary totals of losses at that level, or up to that level, based on the results as shown in Exhibit 5. Finally, the estimated values at generation are developed and compared to actual generation to obtain any difference or mismatch.

Exhibit 7 - Development of Loss Factors, Adjusted

The adjusted loss factors are the results of adjusting Exhibit 6 for any difference. All differences between estimated and actual are prorated to each level based on the ratio of each level's total load plus losses to the system total. These new loss factors reflect an adjustment in losses due only to the kW and kWh mismatch.

Exhibit 8 – Adjusted Losses and Loss Factors by Facility

These calculations present an expanded summary detail of Exhibit 7 for each segment of the power system with respect to the flow of power and associated losses from the receipt of energy at the meter to the generation for the KPCO power system.

Exhibit 9 – Summary of Losses by Delivery Voltage

These calculations present a reformatted summary of losses presented in Exhibits 7 and 8 by power system delivery segment as calculated by voltage level of service based on reported metered sales.

Appendix A

Results of 2020 KPCO Integrated Power System Loss Analysis

KENTUCKY POWER 2020 LOSS ANALYSIS

KENTUCKY POWER

EXHIBIT 1

SUMMARY OF COMPANY DATA

ANNUAL PEAK	1,166	MW
ANNUAL SYSTEM INPUT	5,571,823	MWH
ANNUAL SALES OUTPUT	5,207,528	MWH
SYSTEM LOSSES @ INPUT	364,295	or 6.54%
SYSTEM LOSSES @ OUTPUT	364,295	or 7.00%
SYSTEM LOAD FACTOR	54.4%	

SUMMARY OF LOSSES - OUTPUT RESULTS

SERVICE	KV	--- MW ---	Input	% TOTAL	--- MWH ---	Input	% TOTAL
TRANS	765,345	45.1		45.57%	123,941		34.02%
	161,138		3.87%			2.22%	
SUBTRANS	69,46,34	16.5		16.64%	61,686		16.93%
			1.41%			1.11%	
PRIMARY	34,12,1	17.5		17.72%	65,498		17.98%
			1.50%			1.18%	
SECONDARY	120/240,to,477	19.9		20.08%	113,170		31.07%
			1.70%			2.03%	
TOTAL		98.9		100.00%	364,295		100.00%
			8.49%			6.54%	

SUMMARY OF LOSS FACTORS

SERVICE	KV	CUMMULATIVE SALES EXPANSION FACTORS DEMAND (Peak) d	1/d	ENERGY (Annual) e	1/e
TOT TRANS	765,345 161,138	1.04025	0.96130	1.02290	0.97761
SUBTRAN	69,46,34	1.05869	0.94456	1.03651	0.96478
PRIMARY	34,12,1	1.07522	0.93004	1.04930	0.95302
SECONDARY	120/240,to,477	1.10546	0.90460	1.09416	0.91394

KENTUCKY POWER 2020 LOSS ANALYSIS

SUMMARY OF CONDUCTOR INFORMATION

EXHIBIT 2

DESCRIPTION		CIRCUIT MILES	LOADING % RATING	MW LOSSES LOAD	MW LOSSES NO LOAD	MW LOSSES TOTAL	MWH LOSSES LOAD	MWH LOSSES NO LOAD	MWH LOSSES TOTAL
--- BULK -----------	765 KV OR GREATER								
TIE LINES		0.0	0.00%	0.000	0.000	0.000	0	0	0
BULK TRANS		257.6	0.00%	11.918	0.000	11.918	13,821	0	13,821
SUBTOT		257.6		11.918	0.000	11.918	13,821	0	13,821
--- TRANS ---------	138 KV TO 765.00 KV								
TIE LINES		0	0.00%	0.000	0.000	0.000	0	0	0
TRANS1	161 KV	55.9	0.00%	0.911	0.000	0.911	2,893	0	2,893
TRANS2	138 KV	782.2	0.00%	27.013	0.000	27.014	76,409	3	76,412
SUBTOT		838.0		27.924	0.000	27.925	79,302	3	79,304
--- SUBTRANS ------	35 KV TO 138 KV								
TIE LINES		0	0.00%	0.000	0.000	0.000	0	0	0
SUBTRANS1	69 KV	165.7	0.00%	11.004	0.000	11.004	31,214	0	31,214
SUBTRANS2	46 KV	0.0	0.00%	1.937	0.000	1.937	5,354	0	5,354
SUBTRANS3	35 KV	1.3	0.00%	0.008	0.002	0.010	22	20	42
SUBTOT		167.0		12.949	0.002	12.951	36,590	20	36,609
PRIMARY LINES		8,574		12.552	0.784	13.337	25,056	6,888	31,945
SECONDARY LINES		1,785		3.188	0.000	3.188	6,754	0	6,754
SERVICES		2,993		3.925	0.361	4.286	8,481	3,108	11,590
TOTAL		14,614		72.456	1.148	73.604	170,004	10,019	180,023

KENTUCKY POWER 2020 LOSS ANALYSIS

SUMMARY OF TRANSFORMER INFORMATION

EXHIBIT 3

DESCRIPTION		KV CAPACITY VOLTAGE	MVA	NUMBER TRANSFMR	AVERAGE SIZE	LOADING %	MVA LOAD	MW LOSSES LOAD	MW LOSSES NO LOAD	MW LOSSES TOTAL	MWH LOSSES LOAD	MWH LOSSES NO LOAD	MWH LOSSES TOTAL
BULK STEP-UP		765	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
BULK - BULK			0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
BULK - TRANS1		161	1,500.0	3	500.0	28.16%	422	0.253	0.873	1.126	101	7,666	7,767
BULK - TRANS2		138	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS1 STEP-UP		161	1,500.0	3	500.0	28.16%	422	0.042	0.662	0.704	101	5,811	5,912
TRANS1 - TRANS2		138	735.0	4	183.8	46.98%	345	0.376	0.779	1.155	1,389	6,844	8,233
TRANS1-SUBTRANS1		69	54.0	1	54.0	48.19%	26	0.033	0.069	0.102	118	603	721
TRANS1-SUBTRANS2		46	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS1-SUBTRANS3		35	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS2 STEP-UP		138	354.0	3	118.0	94.23%	334	1.151	0.328	1.479	1,668	1,859	3,528
TRANS2-SUBTRANS1		69	1,202.0	17	70.7	53.16%	639	0.829	1.516	2.346	2,944	13,319	16,263
TRANS2-SUBTRANS2		46	290.0	7	41.4	37.86%	110	0.223	0.368	0.591	729	3,232	3,962
TRANS2-SUBTRANS3		35	120.0	2	60.0	19.56%	23	0.032	0.135	0.167	112	1,189	1,300
SUBTRAN1 STEP-UP		69	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN2 STEP-UP		46	0.0	0	0.0	0.00%	0	0.000	0.001	0.001	0	0	0
SUBTRAN3 STEP-UP		35	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN1-SUBTRAN2		46	12.0	1	12.0	13.61%	2	0.003	0.017	0.019	9	145	155
SUBTRAN1-SUBTRAN3		35	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN2-SUBTRAN3		35	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
DISTRIBUTION SUBSTATIONS													
TRANS1 -	161	33	28.2	2	14.1	22.26%	6	0.009	0.040	0.050	28	352	380
TRANS1 -	161	12	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS1 -	161	1	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS2 -	138	33	335.0	12	27.9	42.93%	144	0.326	0.458	0.784	887	4,025	4,911
TRANS2 -	138	12	125.0	6	20.8	43.05%	54	0.153	0.176	0.328	397	1,543	1,940
TRANS2 -	138	1	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN1-	69	33	316.0	14	22.6	40.68%	129	0.294	0.438	0.732	798	3,845	4,642
SUBTRAN1-	69	12	762.4	52	14.7	57.32%	437	1.490	1.185	2.675	3,757	10,410	14,167
SUBTRAN1-	69	1	15.0	2	7.5	7.47%	1	0.001	0.024	0.025	4	214	218
SUBTRAN2-	46	33	105.0	4	26.3	45.97%	48	0.107	0.146	0.253	292	1,281	1,573
SUBTRAN2-	46	12	136.1	11	12.4	48.48%	66	0.005	0.214	0.219	497	1,882	2,379
SUBTRAN2-	46	1	0.7	1	0.7	68.22%	0	0.003	0.002	0.004	6	15	21
SUBTRAN3-	35	33	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN3-	35	12	5.0	1	5.0	82.78%	4	0.023	0.011	0.034	55	95	151
SUBTRAN3-	35	1	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
PRIMARY - PRIMARY			13.2	2	6.6	11.39%	1	0.001	0.021	0.022	3	181	184
LINE TRANSFRMR			3,354.0	100,835	33.3	25.72%	863	2.693	10.741	13.434	6,434	94,347	100,782
			===========	===========	===========	===========		===========	===========	===========	===========	==========	===========
TOTAL			10,962	100,983				8.047	18.203	26.250	20,331	158,859	179,190

KENTUCKY POWER 2020 LOSS ANALYSIS

SUMMARY OF LOSSES DIAGRAM - DEMAND MODEL - SYSTEM PEAK 1166 MW

EXHIBIT 4 PAGE 1 of 2

BULK TIE LINES
LOAD 0.00% MW
LOAD LOSS 0.000 MW
NOLD LOSS 0.000 MW

BULK LINES
LOADING 0.00%
LOAD LOSS 11.918 MW
NOLD LOSS 0.000 MW

BULK STEP UP
LOADING 0.00%
NO LOAD 0.000 MW
LOAD 0.000 MW
AVG SIZE 0 MVA
NUMBER 0

BULK-BULK
LOADING 0.00%
NO LOAD 0 MW
LOAD 0 MW
AVG SIZE 0 MVA
NUMBER 0

TRANS TIE LINES
LOAD 0.00% MW
LOAD LOSS 0.000 MW
NOLD LOSS 0.000 MW

BULK-TRANS1 STEP DOWN
LOADING 28.16%
NO LOAD 0.873 MW
LOAD 0.253 MW
AVG SIZE 500 MVA
NUMBER 3

TRAN1-TRAN2 STEP DOWN
LOADING 46.98%
NO LOAD 0.779 MW
LOAD 0.376 MW
AVG SIZE 183.75 MVA
NUMBER 4

BULK-TRANS2 STEP DOWN
LOADING 0.00%
NO LOAD 0.000 MW
LOAD 0.000 MW
AVG SIZE 0 MVA
NUMBER 0

TRANS 1&2 STEP UPS
LDNG TR1SU 28.16%
NOLOAD1&2 0.990 MW
LOAD 1&2 1.193 MW
AVSIZ TR1SU 500.0 MVA
NUMBER 3

TRANS1 161.0 KV
LOADING 0.00%
LOAD LOSS 0.911 MW
NOLD LOSS 0.000 MW

TRANS2 138.0 KV
LOADING 0.00%
LOAD LOSS 27.013 MW
NOLD LOSS 0.000 MW

TRANS CUST
SUBS 0.000 MW
0.000 MVA
LINES MW
MVA

SUBTRANS TIE LINES
LOAD 0.00% MW
LOAD LOSS 0.000 MW
NOLD LOSS 0.000 MW

TRANS1&2-SUBTRANS1
LDNG TR2-ST 53.16%
NO LOAD 1.585 MW
LOAD 0.863 MW
AVSIZ TR2 70.70588235 MVA
NUMBER 18

SUBTR1&2-SUBTRANS2&3
LOADING 0.00%
NO LOAD 0.017 MW
LOAD 0.003 MW
AVG SIZE 0 MVA
NUMBER 1

TRANS1&2- SUBTRANS2
LDNG TR2-ST 37.86%
NO LOAD 0.368 MW
LOAD 0.223 MW
AVSIZ TR2-ST 41.43 MVA
NUMBER 7

TRANS1&2-SUBTRANS3
LDNG TR2-ST2 19.56%
NO LOAD 0.14
LOAD 0.03
AVSIZ TR2-ST2 60.00
NUMBER 2

SUBTRANS1,2,&3 STEP UPS
LDNG ST1SU 0.00%
NO LOAD 0.001 MW
LOAD 0.000 MW
AVSIZ ST2 0.0 MVA
NUMBER 0

SUBTRANS1 69 KV
LOADING 0.00%
LOAD LOSS 11.004 MW
NOLD LOSS 0.000 MW

SUBTRANS2 46 KV
LOADING 0.00%
LOAD LOSS 1.937 MW
NOLD LOSS 0.000 MW

SUBTRANS2 35 KV
LOADING 0.00%
LOAD LOSS 0.008 MW
NOLD LOSS 0.002 MW

SUBTRANS CUST
SUBS - MW 0.000
MVA 0.000
LINES- MW
MVA

TO DISTRIBUTION SYSTEM
TOTAL 889.4 MVA 871.7 MW

TRANS1 6.3 MVA
0.71%
161 KV

TRANS2 197.6 MVA
22.22%
138 KV

SUBTRANS1 566.7 MVA
63.71%
69 KV

SUBTRANS2 114.7 MVA
12.90%
46 KV

SUBTRANS3 4.1 MVA
0.47%
35 KV

KENTUCKY POWER 2020 LOSS ANALYSIS

EXHIBIT 4 PAGE 2 of 2

FROM HIGH VOLTAGE SYSTEM

TOTAL 889 MVA 872 MW

TRANS1	TRANS2	SUBTRANS1	SUBTRANS2	SUBTRANS3
6.3 MVA	197.6 MVA	566.7 MVA	114.7 MVA	4.1 MVA
0.71%	22.22%	63.71%	12.90%	0.47%
161 KV	138 KV	69 KV	46 KV	35 KV

DISTRIBUTION SYSTEM LOAD

	PRIM1	PRIM2	PRIM3	PRIM1	PRIM2	PRIM3	PRIM1	PRIM2	PRIM3	PRIM1	PRIM2	PRIM3	PRIM1	PRIM2	PRIM3
VOLTAGE	33	12	1	33	12	1	33	12	1	33	12	1	33	12	1
LOAD MVA	6	0	0	144	54	0	129	437	1	48	66	0	0	4	0
% SYS TOT	0.71%	0.00%	0.00%	16.17%	6.05%	0.00%	14.45%	49.13%	0.13%	5.43%	7.42%	0.05%	0.00%	0.47%	0.00%
NOLD LOSS	0.040	0.000	0.000	0.458	0.176	0.000	0.438	1.185	0.024	0.146	0.214	0.002	0.000	0.011	0.000
LOAD LOSS	0.009	0.000	0.000	0.326	0.153	0.000	0.294	1.490	0.001	0.107	0.005	0.003	0.000	0.023	0.000
AVG SIZE	14.1	0.0	0.0	27.9	20.8	0.0	22.6	14.7	7.5	26.3	12.4	0.7	0.0	5.0	0.0
NUMBER	2	0	0	12	6	0	14	52	2	4	11	1	0	1	0
DIVERSITY RATIO	1.000	0.000	0.000	1.000	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	0.000

PRIMARY LINES		
LOADING	866.487	MW
@ SYS PF	884.171	MVA
LOAD LOSS	12.552	MW
NOLD LOSS	0.784	MW
TOT LOSS	13.337	MW

PRIM/PRIM TRANSF		
LOADING	1.497	MW
NOLD LOSS	0.021	MW
LOAD LOSS	0.001	MW
AVG SIZE	6.58	
NUMBER	2	

PRIM CUST LOADS		
NO LINES CUST SUB	0.000	MW
	0.000	MVA
NO LINES CO. SUB	0.000	MW
	0.000	MVA
PRIM WITH LINES	59.300	MW
	64.457	MVA

LINE TRANSFORMERS				
LOADING	793.829	MW	MVA	876.237
NOLD LOSS	10.741	MW		
LOAD LOSS	2.693	MW		
AVG SIZE	33.3	KVA		
NUMBER	100835			

SECONDARY LINES		
LOAD	255.407	MW
LOAD LOSS	3.188	MW
NOLD LOSS	0.000	MW
TOT LOSS	3.188	MW

NO SECONDARY LINES		
LOAD	524.988	MW

SERVICES		
LOAD	777.207	MW
LOAD LOSS	3.925	MW
NOLD LOSS	0.361	MW
TOT LOSS	4.286	MW

CUSTOMER SECONDARY LOAD

772.921 MW

KENTUCKY POWER 2020 LOSS ANALYSIS

EXHIBIT 5

SUMMARY of SALES and CALCULATED LOSSES

LOSS # AND LEVEL	MW LOAD	NO LOAD +	LOAD =	TOT LOSS	EXP FACTOR	CUM EXP FAC	MWH LOAD	NO LOAD +	LOAD =	TOT LOSS	EXP FACTOR	CUM EXP FAC
1 BULK XFMMR	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0	0
2 BULK LINES	420.0	0.00	11.92	11.92	1.029205	1.029205	1,900,000	0	13,821	13,821	1.0073276	1.0073276
3 TRANS1 XFMR	414.0	0.87	0.25	1.13	1.002727	1.032012	1,818,288	7,666	101	7,767	1.0042902	1.0116493
4 TRANS1 LINES	828.0	0.66	0.95	1.61	1.001954	1.017991	3,636,576	5,811	2,994	8,805	1.0024271	1.0082659
5 TRANS2TR1 SD	338.4	0.78	0.38	1.15	1.003424	1.021477	1,605,153	6,844	1,389	8,233	1.0051555	1.0134640
6 TRANS2BLK SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
7 TRANS2 LINES	1,015.3	0.33	28.16	28.49	1.028874	1.036239	4,770,525	1,862	78,077	79,939	1.0170424	1.0216499
TOTAL TRAN	1,165.0	2.64	41.66	44.31	1.039535	1.039535	5,535,653	22,182	96,384	118,566	1.0218873	1.0218873
8 STR1BLK SD												
9 STR1T1 SD	25.5	0.07	0.03	0.10	1.004002	1.043695	120,956	603	118	721	1.0059933	1.0280119
10 SRT1T2 SD	626.2	1.52	0.83	2.35	1.003760	1.043443	2,970,292	13,319	2,944	16,263	1.0055055	1.0275133
11 SUBTRANS1 LINES	751.7	0.00	11.00	11.00	1.014856	1.054978	3,941,248	0	31,214	31,214	1.0079830	1.0300451
12 STR2T1 SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
13 STR2T2 SD	107.6	0.37	0.22	0.59	1.005522	1.045275	510,386	3,232	729	3,962	1.0078231	1.0298817
14 STR2S1 SD	1.6	0.02	0.00	0.02	1.012243	1.067895	7,589	145	9	155	1.0208100	1.0514803
15 SUBTRANS2 LINES	109.2	0.00	1.94	1.94	1.018065	1.058314	767,975	0	5,354	5,354	1.0070202	1.029061
16 STR3T1 SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
17 STR3T2 SD	23.0	0.14	0.03	0.17	1.007317	1.047141	109,097	1,189	112	1,300	1.0120639	1.0342153
18 STR3S1 SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
19 STR3S2 SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
20 SUBTRANS3 LINES	23.0	0.00	0.01	0.01	1.000445	1.039997	109,097	20	22	42	1.0003827	1.0222784
21 SUBTRANS TOTAL	945.0	2.11	14.07	16.18	1.017416	1.057639	4,698,987	18,508	40,502	59,010	1.0127178	1.034884
DISTRIBUTION SUBST												
TRANS1	6.2	0.04	0.01	0.05	1.008114	1.047969	25,230	352	28	380	1.0153109	1.0375333
TRANS2	193.7	0.63	0.48	1.11	1.005778	1.045541	794,557	5,568	1,284	6,851	1.0086975	1.0307752
SUBTR1	555.3	1.65	1.78	3.43	1.006218	1.061538	2,278,098	14,469	4,558	19,028	1.0084229	1.0387210
SUBTR2	112.4	0.36	0.11	0.48	1.004258	1.062821	461,131	3,178	795	3,973	1.0086912	1.0380050
SUBTR3	4.1	0.01	0.02	0.03	1.008516	1.048853	16,638	95	55	151	1.0091492	1.0316315
WEIGHTED AVERAGE	871.7	2.69	2.41	5.11	1.005891	1.057994	3,575,654	23,663	6,721	30,383	1.0085701	1.0368217
PRIMARY INTRCHNGE	0.0				0.000000		0				0.0000000	
PRIMARY LINES	866.5	0.78	12.55	13.34	1.015634	1.074535	3,546,451	13,502	25,059	38,561	1.0109927	1.0482191
LINE TRANSF	793.8	10.74	2.69	13.43	1.017214	1.093032	3,127,930	94,347	6,434	100,782	1.0332926	1.0831170
SECONDARY	780.4	0.00	3.19	3.19	1.004101	1.097515	3,027,148	0	6,754	6,754	1.0022360	1.0855389
SERVICES	777.2	0.36	3.93	4.29	1.005546	1.103601	3,020,395	3,108	8,481	11,590	1.0038519	1.0897203
		===========	===========	===========				===========	===========	===========		
TOTAL SYSTEM		19.33	80.50	99.83				175,310	190,335	365,646		

KENTUCKY POWER 2020 LOSS ANALYSIS

EXHIBIT 6

DEVELOPMENT of LOSS FACTORS
UNADJUSTED
DEMAND

LOSS FACTOR LEVEL	CUSTOMER SALES MW a	CALC LOSS TO LEVEL b	SALES MW @ GEN c	CUM PEAK EXPANSION FACTORS d	1/d
BULK LINES	0.0	0.0	0.0	0.00000	0.00000
TRANS SUBS	0.0	0.0	0.0	0.00000	0.00000
TRANS LINES	43.9	1.7	45.6	1.03953	0.96197
TOTAL TRANS	0.0	0.0	0.0	0.00000	0.00000
SUBTRANS	190.9	11.0	201.9	1.05764	0.94550
PRIM SUBS	0.0	0.0	0.0	0.00000	0.00000
PRIM LINES	59.3	4.4	63.7	1.07453	0.93064
SECONDARY	772.9	80.1	853.0	1.10360	0.90612
TOTALS	1,067.1	97.2	1,164.3		

DEVELOPMENT of LOSS FACTORS
UNADJUSTED
ENERGY

LOSS FACTOR LEVEL	CUSTOMER SALES MWH a	CALC LOSS TO LEVEL b	SALES MWH @ GEN c	CUM ANNUAL EXPANSION FACTORS d	1/d
BULK LINES	0	0	0	0.00000	0.00000
TRANS SUBS	0	0	0	0.00000	0.00000
TRANS LINES	307,657	6,734	314,391	1.02189	0.97858
TOTAL TRANS	0	0	0	0.00000	0.00000
SUBTRANS	1,511,106	52,713	1,563,819	1.03488	0.96629
PRIM SUBS	0	0	0	0.00000	0.00000
PRIM LINES	379,960	18,321	398,281	1.04822	0.95400
SECONDARY	3,008,805	269,951	3,278,756	1.08972	0.91767
TOTALS	5,207,528	347,719	5,555,247		

ESTIMATED VALUES AT GENERATION

LOSS FACTOR AT VOLTAGE LEVEL	MW	MWH
BULK LINES	0.00	0
TRANS SUBS	0.00	0
TRANS LINES	45.64	314,391
SUBTRANS SUBS	0.00	0
SUBTRANS LINES	201.95	1,563,819
PRIM SUBS	0.00	0
PRIM LINES	63.72	398,281
SECONDARY	853.00	3,278,756
SUBTOTAL	1,164.30	5,555,247
ACTUAL ENERGY	1,166.00	5,571,823
MISSMATCH	(1.70)	(16,576)
% MISSMATCH	-0.15%	-0.30%

KENTUCKY POWER 2020 LOSS ANALYSIS

EXHIBIT 7

DEVELOPMENT of LOSS FACTORS
ADJUSTED
DEMAND

LOSS FACTOR LEVEL	CUSTOMER SALES MW a	SALES ADJUST b	CALC LOSS TO LEVEL c	SALES MW @ GEN d	CUM PEAK EXPANSION FACTORS e	f=1/e
BULK LINES	0.0	0.0	0.0	0.0	0.00000	0.00000
TRANS SUBS	0.0	0.0	0.0	0.0	0.00000	0.00000
TRANS LINES	43.9	0.0	1.8	45.7	1.04025	0.96130
TOTAL TRANS	0.0	0.0	0.0	0.0	0.00000	0.00000
SUBTRANS	190.9	0.0	11.2	202.1	1.05869	0.94456
PRIM SUBS	0.0	0.0	0.0	0.0	0.00000	0.00000
PRIM LINES	59.3	0.0	4.5	63.8	1.07522	0.93004
SECONDARY	772.9	0.0	81.5	854.4	1.10546	0.90460
			98.9			
TOTALS	1,067.1	0.0	98.9	1,166.0	1.09273	<COMPOSITE

DEVELOPMENT of LOSS FACTORS
ADJUSTED
ENERGY

LOSS FACTOR LEVEL	CUSTOMER SALES MWH a	SALES ADJUST b	CALC LOSS TO LEVEL c	SALES MWH @ GEN d	CUM ANNUAL EXPANSION FACTORS e	f=1/e
BULK LINES	0	0	0	0	0.00000	0.00000
TRANS SUBS	0	0	0	0	0.00000	0.00000
TRANS LINES	307,657	0	7,046	314,703	1.02290	0.97761
TOTAL TRANS	0	0	0	0	0.00000	0.00000
SUBTRANS	1,511,106	0	55,169	1,566,275	1.03651	0.96478
PRIM SUBS	0	0	0	0	0.00000	0.00000
PRIM LINES	379,960	0	18,732	398,692	1.04930	0.95302
SECONDARY	3,008,805	0	283,317	3,292,122	1.09416	0.91394
			364,264			
TOTALS	5,207,528	0	364,295	5,571,792	1.06995	<COMPOSITE

ESTIMATED VALUES AT GENERATION

LOSS FACTOR AT VOLTAGE LEVEL	MW	MWH
BULK LINES	0.00	0
TRANS SUBS	0.00	0
TRANS LINES	45.67	314,703
SUBTRANS SUBS	0.00	0
SUBTRANS LINES	202.15	1,566,275
PRIM SUBS	0.00	0
PRIM LINES	63.76	398,692
SECONDARY	854.44	3,292,122
	1,166.01	5,571,792
ACTUAL ENERGY	1,166.00	5,571,823
MISSMATCH	0.01	(31)
% MISSMATCH	0.00%	0.00%

KENTUCKY POWER 2020 LOSS ANALYSIS

Adjusted Losses and Loss Factors by Facility EXHIBIT 8

Unadjusted Losses by Segment

	MW	Unadjusted	MWH	Unadjusted
Service Drop Losses	4.29	4.00	11,590	10,485
Secondary Losses	3.19	2.98	6,754	6,110
Line Transformer Losses	13.43	12.55	100,782	91,175
Primary Line Losses	13.34	12.46	38,561	34,885
Distribution Substation Losses	5.11	4.77	30,383	27,487
Subtransmission Losses	16.18	16.18	59,010	59,010
Transmission System Losses	44.31	44.31	118,566	118,566
Total	99.83	97.24	365,646	347,719

Mismatch Allocation by Segment

	MW	MWH	Note adjusting a
Service Drop Losses	-0.07	-525	-525
Secondary Losses	-0.05	-306	-306
Line Transformer Losses	-0.22	-4,569	-4,569
Primary Line Losses	-0.22	-1,748	-1,748
Distribution Substation Losses	-0.08	-1,377	-1,377
Subtransmission Losses	-0.28	-2,675	-2,675
Transmission System Losses	-0.78	-5,375	-5,375
Total	-1.70	-16,576	(16,576)
			-16,576

Adjusted Losses by Segment

	MW	% of Total	MWH	% of Total
Service Drop Losses	4.07	4.1%	11,010	3.0%
Secondary Losses	3.03	3.1%	6,416	1.8%
Line Transformer Losses	12.77	12.9%	95,744	26.3%
Primary Line Losses	12.68	12.8%	36,634	10.1%
Distribution Substation Losses	4.85	4.9%	28,865	7.9%
Subtransmission Losses	16.46	16.6%	61,686	16.9%
Transmission System Losses	45.08	45.6%	123,941	34.0%
Total	98.94	100.0%	364,295	100.0%

Loss Factors by Segment	**MW**	**MWH**
Retail Sales from Service Drops	772.92	3,008,805
Adjusted Service Drop Losses	4.07	11,010
Input to Service Drops	776.99	3,019,815
Service Drop Loss Factor	**1.00527**	**1.00366**
Output from Secondary	776.99	3,019,815
Adjusted Secondary Losses	3.03	6,416
Input to Secondary	780.02	3,026,231
Secondary Conductor Loss Factor	**1.00390**	**1.00212**
Output from Line Transformers	780.02	3,026,231
Adjusted Line Transformer Losses	12.77	95,744
Input to Line Transformers	792.79	3,121,975
Line Transformer Loss Factor	**1.01637**	**1.03164**
Secondary Composite	1.02571	1.03761
Retail Sales from Primary	59.30	379,960
Req. Whls Sales from Primary	0.00	0
Input to Line Transformers	792.79	3,121,975
Output from Primary Lines	852.09	3,501,935
Adjusted Primary Line Losses	12.68	36,634
Input to Primary Lines	864.77	3,538,569
Primary Line Loss Factor	**1.01488**	**1.01046**
Out TO PR from Distribution Substations	864.77	3,538,569
Req. Whls Sales from Substations	0.00	0
Retail Sales from Substations	0.00	0
TotalOutput from Distribution Substations	864.77	3,538,569
Adjusted Distribution Substation Losses	4.85	28,865
Input to Distribution Substations	869.62	3,567,434
Distribution Substation Loss Factor	**1.00561**	**1.00816**
Retail Sales at from SubTransmission	186.04	1,488,956
Req. Whls Sales from SubTransmission	4.90	22,150
Input to Distribution Substations	671.81	2,755,867
Output from SubTransmission	928.54	4,637,301
Adjusted SubTransmission System Losses	16.46	61,686
Input to SubTransmission	945.00	4,698,987
SubTransmission Loss Factor	**1.01773**	**1.01330**
OUT DISTR SUBS	199.84	819,787
Retail Sales at from Transmission	32.60	252,009
Req. Whls Sales from Transmission	11.30	55,648
Input Subtransmission	876.17	4,284,268
Output from Transmission	1119.92	5,411,712
Adjusted Transmission System Losses	45.08	123,941
Input to Transmission	1165.00	5,535,653
Transmission Loss Factor	**1.04025**	**1.02290**

KENTUCKY POWER 2020 LOSS ANALYSIS

DEMAND MW **SUMMARY OF LOSSES AND LOSS FACTORS BY DELIVERY VOLTAGE** **EXHIBIT 9**

PAGE 1 of 2

	SERVICE LEVEL		SALES MW	LOSSES	SECONDARY	PRIMARY	SUBSTATION	SUBTRANS	TRANSMISSION
1	**SERVICES**								
2	SALES		772.92		772.9				
3	LOSSES			4.1	4.1				
4	INPUT				777.0				
5	**EXPANSION FACTOR**	**1.00527**							
6	**SECONDARY**								
7	SALES								
8	LOSSES			3.0	3.0				
9	INPUT				780.0				
10	**EXPANSION FACTOR**	**1.00390**							
11	**LINE TRANSFORMER**								
12	SALES								
13	LOSSES			12.8	12.8				
14	INPUT				792.8				
15	**EXPANSION FACTOR**	**1.01637**							
16	**PRIMARY**								
17	SECONDARY				792.8				
18	SALES		59.30			59.3			
19	LOSSES			12.7	11.8	0.9			
20	INPUT								
21	**EXPANSION FACTOR**	**1.01488**							
22	**SUBSTATION**								
23	PRIMARY				804.6	60.2			
24	SALES		0.0						
25	LOSSES			4.9	4.5	0.3			
26	INPUT				809.1	60.5			
27	**EXPANSION FACTOR**	**1.00561**							
28	**SUB-TRANSMISSION**								
29	DISTRIBUTION SUBS				596.8	75.0			
30	SALES		190.94					190.9	
31	LOSSES			16.5	10.6	1.3		3.4	
32	INPUT				607.4	76.3		194.3	
33	**EXPANSION FACTOR**	**1.01773**							
34	**TRANSMISSION**								
35	SUBTRANSMISSION				431.2	54.2		194.3	
36	DISTRIBUTION SUBS				214.3	-14.5			
37	SALES		43.90						43.9
38	LOSSES			45.1	26.0	1.6		7.8	1.8
39	INPUT				657.1	41.3		202.1	45.7
40	**EXPANSION FACTOR**	**1.04025**							
41	**TOTALS** LOSSES	CALCULATED		98.9	72.7	4.1		11.2	1.8
		SCALED		98.9	81.5	4.5		11.2	1.8
42	% OF TOTAL			100%	82.39%	4.51%		11.33%	1.79%
43	SALES		1,067.1		772.9	59.3		190.9	43.9
44	% OF TOTAL		100.00%		72.43%	5.56%		17.89%	4.11%
45	INPUT		1,166.0		854.4	63.8		202.1	45.7
46	**CUMMULATIVE EXPANSION LOSS FACTORS** (from meter to system input)				**1.10546**	**1.07522**	**NA**	**1.05869**	**1.04025**

KENTUCKY POWER 2020 LOSS ANALYSIS

ENERGY MWH **SUMMARY OF LOSSES AND LOSS FACTORS BY DELIVERY VOLTAGE** **EXHIBIT 9**

PAGE 2 of 2

	SERVICE LEVEL		SALES	LOSSES	SECONDARY	PRIMARY	SUBSTATION	SUBTRANS	TRANSMISSION
1	**SERVICES**								
2	SALES		3,008,805		3,008,805				
3	LOSSES			11,010	11,010				
4	INPUT				3,019,815				
5	**EXPANSION FACTOR**	**1.00366**							
6	**SECONDARY**								
7	SALES								
8	LOSSES			6,416	6,416				
9	INPUT				3,026,231				
10	**EXPANSION FACTOR**	**1.00212**							
11	**LINE TRANSFORMER**								
12	SALES								
13	LOSSES			95,744	95,744				
14	INPUT				3,121,975				
15	**EXPANSION FACTOR**	**1.03164**							
16	**PRIMARY**								
17	SECONDARY				3,121,975				
18	SALES		379,960.000			379,960			
19	LOSSES			36,634	32,659	3,975			
20	INPUT								
21	**EXPANSION FACTOR**	**1.01046**							
22	**SUBSTATION**								
23	PRIMARY				3,154,634	383,935			
24	SALES		0						
25	LOSSES			28,865	25,733	3,132			
26	INPUT				3,180,367	387,067			
27	**EXPANSION FACTOR**	**1.00816**							
28	**SUB-TRANSMISSION**								
29	DISTRIBUTION SUBS				2,695,867	60,000			
30	SALES		1,511,106					1,511,106	
31	LOSSES			61,686	35,861	798		20,101	
32	INPUT				2,731,728	60,798		1,531,207	
33	**EXPANSION FACTOR**	**1.01330**							
34	**TRANSMISSION**								
35	SUBTRANSMISSION				1,639,037	60,798		1,531,207	
36	DISTRIBUTION SUBS				492,720	327,067			
37	SALES		307,657						307,657
38	LOSSES			123,941	48,822	7,491		35,068	7,046
39	INPUT				2,180,579	334,557		1,566,275	314,703
40	**EXPANSION FACTOR**	**1.02290**							
41	**TOTALS** LOSSES	Calculated		364,295	256,245	15,395		55,169	7,046
		Scaled		364,264	283,317	18,732		55,169	7,046
42	% OF TOTAL			100%	70.34%	4.23%			1.93%
43	SALES		5,207,528		3,008,805	379,960		1,511,106	307,657
44	% OF TOTAL		100.00%		57.78%	7.30%		29.02%	5.91%
45	INPUT		5,571,792		3,292,122	398,692		1,566,275	314,703
46	**CUMMULATIVE EXPANSION LOSS FACTORS** (from meter to system input)				**1.09416**	**1.04930**	**NA**	**1.03651**	**1.02290**

Appendix B

Discussion of Hoebel Coefficient

Kentucky Power Company
2020 Analysis of System Losses

COMMENTS ON THE HOEBEL COEFFICIENT

The Hoebel constant represents an established industry standard relationship between peak losses and average losses and is used in a loss study to estimate energy losses from peak demand losses. H. F. Hoebel described this relationship in his article, "Cost of Electric Distribution Losses," Electric Light and Power, March 15, 1959.

Within any loss evaluation study, peak demand losses can readily be calculated given equipment resistance and approximate loading. Energy losses, however, are much more difficult to determine given their time-varying nature. This difficulty can be reduced by the use of an equation which relates peak load losses (demand) to average losses (energy). Once the relationship between peak and average losses is known, average losses can be estimated from the known peak load losses.

Within the electric utility industry, the relationship between peak and average losses is known as the loss factor. For definitional purposes, loss factor is the ratio of the average power loss to the peak load power loss, during a specified period of time. This relationship is expressed mathematically as follows:

$$(1)\ F_{LS} \cong A_{LS} \div P_{LS}$$

where: F_{LS} = Loss Factor
A_{LS} = Average Losses
P_{LS} = Peak Losses

The loss factor provides an estimate of the degree to which the load loss is maintained throughout the period in which the loss is being considered. In other words, loss factor is the ratio of the actual kWh losses incurred to the kWh losses which would have occurred if full load had continued throughout the period under study.

Examining the loss factor expression in light of a similar expression for load factor indicates a high degree of similarity. The mathematical expression for load factor is as follows:

$$(2)\ F_{LD} \cong A_{LD} \div P_{LD}$$

where: F_{LD} = Load Factor
A_{LD} = Average Load
P_{LD} = Peak Load

This load factor result provides an estimate of the degree to which the load loss is maintained throughout the period in which the load is being considered. Because of the similarities in definition, the loss factor is sometimes called the "load factor of losses." While the definitions are similar, a strict equating of the two factors cannot be made. There does exist, however, a relationship between these two factors which is dependent upon the shape of the load duration curve. Since resistive losses vary as the square of the load, it can be shown mathematically that the loss factor can vary between the extreme limits of load factor and load factor squared. The relationship between load factor and loss factor has become an industry standard and is as follows:

$$(3)\ F_{LS} \cong H*F_{LD}^2 + (1-H)*F_{LD}$$

where:
F_{LS} = Loss Factor
F_{LD} = Load Factor
H = Hoebel Coefficient

As noted in the attached article, the suggested value for H (the Hoebel coefficient) is 0.7. The exact value of H will vary as a function of the shape of the utility's load duration curve. In recent years, values of H have been computed directly for a number of utilities based on EEI load data. It appears on this basis, the suggested value of 0.7 should be considered a lower bound and that values approaching unity may be considered a reasonable upper bound. Based on experience, values of H have ranged from approximately 0.85 to 0.95. The standard default value of 0.9 is generally used.

Inserting the Hoebel coefficient estimate gives the following loss factor relationship using Equation (3):

$$(4)\ F_{LS} \cong 0.90*F_{LD}^2 + 0.10*F_{LD}$$

Once the Hoebel constant has been estimated and the load factor and peak losses associated with a piece of equipment have been estimated, one can calculate the average, or energy losses as follows:

$$(5)\ A_{LS} \cong P_{LS} * [H*F_{LD}^2 + (1-H)*F_{LD}]$$

where:
A_{LS} = Average Losses
P_{LS} = Peak Losses
H = Hoebel Coefficient
F_{LD} = Load Factor

Loss studies use this equation to calculate energy losses at each major voltage level in the analysis.

docVerify

SEALED A13932A7 DOCVERIFY

Hirons Verification Form.doc

DocVerify ID:	A13932A7-F766-4E9F-9983-D4471E49CA24
Created:	July 01, 2024 05:28:19 -8:00
Pages:	1
Remote Notary:	Yes / State: KY

E-Signature Summary

E-Signature 1: Warren Edward Hirons (WEH)
July 01, 2024 05:36:16 -8:00 [4AF86BBD0A42] [69.165.113.105]
warren.hirons@gdsassociates.com (Principal) (Personally Known)

E-Signature Notary: Marilyn Michelle Caldwell (MMC)
July 01, 2024 05:36:16 -8:00 [9FCF6FDEC1CE] [167.239.221.102]
mmcaldwell@aep.com
I, Marilyn Michelle Caldwell, did witness the participants named above electronically sign this document.

VERIFICATION

The undersigned, Warren E. Hirons, being duly sworn, deposes and says he is a Project Manager, for GDS Associates, that he has personal knowledge of the matters set forth in the foregoing responses and the information contained therein is true and correct to the best of his information, knowledge, and belief.

Warren Edward Hirons

Warren E. Hirons

State of Kentucky)
) Case No. 2024-00115
County of Boyd)

Subscribed and sworn to before me, a Notary Public in and before said County and State, by Warren E. Hirons, on ____________________.

Notary Public

MARILYN MICHELLE CALDWELL
ONLINE NOTARY PUBLIC
STATE AT LARGE KENTUCKY
Commission # KYNP71841
My Commission Expires May 05, 2027

Notarial act performed by audio-visual communication

My Commission Expires ______________________

Notary ID Number ______________________

docVerify

SEALED D26BC158 DOCVERIFY

Nolen Verification Form.doc

DocVerify ID: D26BC158-4BDF-4E1C-8FA5-BD4A921A81A0
Created: July 01, 2024 10:07:53 -8:00
Pages: 1
Remote Notary: Yes / State: KY

This document is a DocVerify VeriVaulted protected version of the document named above. It was created by a notary or on the behalf of a notary, and it is also a DocVerify E-Sign document, which means this document was created for the purposes of Electronic Signatures and/or Electronic Notary. Tampered or altered documents can be easily verified and validated with the DocVerify veriCheck system. This remote online notarization involved the use of communication technology.

Go to www.docverify.com at any time to verify or validate the authenticity and integrity of this or any other DocVerify VeriVaulted document.

E-Signature Summary

E-Signature 1: Barrett Nolen (BN)
July 01, 2024 10:14:51 -8:00 [FD8DE7F93E01] [167.239.221.104]
blnolen@aep.com (Principal) (Personally Known)

E-Signature Notary: Marilyn Michelle Caldwell (MMC)
July 01, 2024 10:14:51 -8:00 [B01E8CE9CA71] [167.239.221.102]
mmcaldwell@aep.com
I, Marilyn Michelle Caldwell, did witness the participants named above electronically sign this document.

VERIFICATION

The undersigned, Barrett L. Nolen, being duly sworn, deposes and says he is the Customer and Distribution Services Manager for Kentucky Power Company, that he has personal knowledge of the matters set forth in the foregoing responses and the information contained therein is true and correct to the best of his information, knowledge, and belief.

Barrett Nolen

Barrett L. Nolen

Commonwealth of Kentucky)
) Case No. 2024-00115
County of Boyd)

Subscribed and sworn to before me, a Notary Public in and before said County and State, by Barrett L. Nolen, on July 1, 2024.

Notary Public

MARILYN MICHELLE CALDWELL
ONLINE NOTARY PUBLIC
STATE AT LARGE KENTUCKY
Commission # KYNP71841
My Commission Expires May 05, 2027

My Commission Expires May 5, 2027

Notarial act performed by audio-visual communication

Notary ID Number KYNP71841

VERIFICATION

The undersigned, Tanner S. Wolffram, being duly sworn, deposes and says he is the Director of Regulatory Services for Kentucky Power, that he has personal knowledge of the matters set forth in the foregoing responses and the information contained therein is true and correct to the best of his information, knowledge, and belief.

Tanner A Wolffram

Tanner S. Wolffram

Commonwealth of Kentucky)
) Case No. 2024-00115
County of Boyd)

Subscribed and sworn to before me, a Notary Public in and before said County and State, by Tanner S. Wolffram, on July 8, 2024.

Marilyn Michelle Caldwell

Notary Public

My Commission Expires May 5, 2027

Notary ID Number KYNP71841

MARILYN MICHELLE CALDWELL
Notary Public
Commonwealth of Kentucky
Commission Number KYNP71841
My Commission Expires May 5, 2027