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Energy Efficiency / Demand Response Plan: Plan Year 2 (6/1/2009-5/31/2010)

Low Income Residential Retrofit Energy Efficiency Program Evaluation

Presented to

The Department of Commerce and Economic Opportunity

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Presented by

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Section E. Executive Summary

The Illinois Department of Commerce and Economic Opportunity (DCEO) provides grants to program partners to give funding to their participants for energy efficiency measures or for the direct installation of the energy efficiency measures in low income residences. DCEO provides these grants to partners that already administer low income weatherization programs or other low income home improvement programs in the Illinois electric service territories of Commonwealth Edison or Ameren. This program has been in existence since 2008, however many of the program partners have been running low-income programs for several years and this program provided them with additional funding.

The installation of weatherization measures and other home improvements are generally focused on gas savings, which are not part of this evaluation. However, this report does look at the energy savings achieved from the extra funding for electric efficiency measures that are installed in tandem with the weatherization and home improvement work.

E.1 Evaluation Objectives

The objective of this evaluation report is to provide verification of electric savings impacts during program year 2 (PY2), which covers June 1, 2009 through May 31, 2010.

For this report on PY2, a review of the program tracking data will be done to answer the impact evaluation questions:

1. What are the gross impacts from this program?
2. Did the program meet its energy goals? If not, why not?

The objectives of the process evaluation were to develop an understanding of the final program design and implementation strategies as well as document program processes and tracking efforts.

E.2 Evaluation Methods

The evaluation methods for this year included an algorithm review to verify that reasonable assumptions and methods were used for assigning ex-ante gross kWh and kW savings per measure.

In program year one (PY1) DCEO used the Energy Star Calculator for all of their measure savings estimates, except for the furnace measure. EPA and DOE data was the source of the information used by DCEO in the Energy Star calculators. The furnace information came from the Gas Appliance Manufacturers Association. For PY2 DCEO used the calculation methods suggested in the PY1 evaluation. Ceiling fans are the only new measure for PY2.

Navigant used several sources to verify the reasonableness of the DCEO savings estimates including:

1. The most current California Database for Energy Efficiency Resources (DEER) reports
2. Efficiency Vermont's Technical Reference User Manual (TRM) No. 2009-54
3. Navigant's own measure studies.

The primary form of data collection for the process evaluation was in-depth interviews with program implementation staff and program partners. The team also reviewed secondary data sources including the program implementation plan, the Residential Retrofit Energy Efficiency Program guidelines, and best practices for low income programs.[1]

E.3 Evaluation Findings

Impact Evaluation

Most of the measure-specific ex ante gross savings estimates were reasonable when compared to other authoritative sources. The Weatherization ex ante gross savings were the same as the ex post gross savings. The Home Improvement ex ante gross savings were the same as the ex post gross saving for energy savings. The ex ante gross savings were slightly lower than the ex post gross saving for demand saving in the Home Improvement program. The slightly lower demand savings in the Home Improvement program was on account of the adjustment factor for furnaces.

Table E-1 presents the final gross and net program impact results for the Weatherization program. The summary of final gross and net savings for the Home Improvement program can be found in Table E-2.

Table E-3 and Table E-4 present the net savings impact contributions of ComEd and Ameren for the Weatherization and Home Improvement programs.

[1] ACEEE, "Meeting Essential Needs: The Results of a National Search for Exemplary Utility Funded Low Income Energy Efficiency Programs", September 2005.

Table E-1. Summary of Gross and Net Savings for Low Income Weatherization

ComEd Low Income Weatherization Program PY2	MWh Savings		kW Savings	
	DCEO Claimed	Evaluation Verified	DCEO Claimed	Evaluation Verified
Gross Savings	8,414	8,414	966	966
Net-to-Gross Ratio	1	1	1	1
Net Savings	8,414	8,414	966	966

Table E-2. Summary of Gross and Net Savings for Low Income Home Improvement

ComEd Low Income Home Improvement Program PY2	MWh Savings		kW Savings	
	DCEO Claimed	Evaluation Verified	DCEO Claimed	Evaluation Verified
Gross Savings	666	666	232	227
Net-to-Gross Ratio	1	1	1	1
Net Savings	666	666	232	227

Table E-3. ComEd and Ameren Net Savings for Low Income Weatherization

ComEd Low Income Weatherization Program PY2	MWh Savings		kW Savings	
	DCEO Claimed	Evaluation Verified	DCEO Claimed	Evaluation Verified
ComEd	5,475	5,475	628	628
Ameren	2,939	2,939	338	338
Net Savings	8,414	8,414	966	966

Table E-4. ComEd and Ameren Net Savings for Low Income Home Improvement

ComEd Low Income Weatherization Program PY2	MWh Savings		kW Savings	
	DCEO Claimed	Evaluation Verified	DCEO Claimed	Evaluation Verified
ComEd	461	461	137	135
Ameren	205	205	95	92
Net Savings	666	666	232	227

Process Evaluation

This evaluation found that the program was successful in that it (1) Implemented a program strategy that aligns with low income program best practices by partnering with multiple existing entities already serving the low-income sector thereby leveraging an existing network of organizations familiar with serving the low income sector; (2) Included a full menu of household energy efficiency improvements; (3) Enabled more low-income qualified customers to receive energy efficiency upgrades; and (4) Captured more opportunities for saving energy for the low-income sector.

This evaluation also identified a number of issues during program implementation including:

- The program did not always provide incentives or contracts in a timely manner nor communicate the status of funding and contracts well with outside partners;
- The program has a lack of consistency and transparency in its data tracking, record keeping and reporting documentation; and

Recommendations

Improve ex ante and ex post estimates of measure savings per unit. We recommend that both DCEO and the EM&V team make efforts to find up-to-date measure savings data sources for areas closer to the Illinois region. Some of these may come from evaluation work currently being done on other portfolio programs. If this information is not available, then continued use of the Energy Star calculators is the next best option. It is important that the most recent Energy Star calculators be used each year as these calculators are continually updated with the most recent studies.

Section 1. Introduction to the Program

1.1 Program Description

Each year DCEO administers a grant application and acceptance process that provides extra funding for electric energy efficiency measures installed in low income residential homes. They award these grants to state agencies, local governments, lending institutions, affordable housing developers and other entities that administer low income weatherization programs or other low income home improvement programs in the Illinois electric service territories of Commonwealth Edison or Ameren. The objective of the grant process is to leverage existing energy efficiency programs to maximize electricity savings in low income residences. This program delivery mechanism will provide a cost-effective means to meet annual electric savings targets.

Evaluation of these two programs, Low Income Weatherization and Low Income Home Improvement, is combined into a single report because they both provide incentives for a similar set of retrofit measures that improve electric efficiency in existing homes.

The installation of weatherization measures is focused on gas savings which are not part of this evaluation. However, this report does look at the energy savings achieved from the extra funding for electric efficiency measures that are installed in tandem with the weatherization work. It also looks at the energy savings achieved from the extra funding for electric efficiency measures given to organizations that run home improvement programs that are not part of the Low Income Weatherization program.

When funding is provided to Low Income Weatherization programs, grants are more likely to cover 100% of the cost of the approved electric efficiency measures for each home but fewer measures are covered. When funding is provided to organizations with Home Improvement programs that promote home repair and rehab in low-income neighborhoods, grants are more likely to cover only the incremental costs for the electric efficiency measures but more measures are eligible for funding.

1.1.1 Implementation Strategy

The goal of the program is to leverage existing programs to maximize electricity savings in low income residences, and to capture electricity savings that would otherwise be missed due to insufficient funding. The overall implementation strategy for this program is to give additional funding to pre-existing home improvement and weatherization programs that target the low-income sector. The overall program is managed by DCEO, and DCEO works with program partners throughout the implementation of the program. The partners themselves can work with program administrators, homeowners, property owners (in the case of a multi-family building), contractors, and/or developers.

In order to be eligible to participate in the program, program partners need to meet the following requirements:

- They must administer a low income weatherization or low income home improvement program for residences that are located in Illinois and receive electricity from either ComEd or Ameren.
- The projects funded need to result in the installation of energy efficiency measures in existing residential buildings.
- If the partners' program is a weatherization program, it must be targeted to households at or below 200% of the poverty level.
- If a partners' program is a home improvement program, it must be targeted to households at or below 80% of the Area Median Income (AMI).

1.1.2 Measures and Incentives

Table 1-1 shows the electric efficiency measures and the associated incentive levels provided by the program. The measures and incentives vary depending on whether the grantee's pre-existing program is defined as a low income weatherization program or a low income home improvement program. The first column shows the eligible measures for weatherization programs. Grants are usually given to cover 100% of the cost of the approved electric efficiency measures for each home. The second column shows the eligible measures for low income home improvement programs. In this case, grants are given up to the amount shown in column 2 and cannot be more than 100% of the costs. In addition to the measures shown in Table 1-1, applicants can propose other electric energy efficiency measures for review and possible approval.

Table 1-1. Energy Efficiency Measures and Incentives for LI Residential Retrofit

	PY2 Goal Measure	Weatherization Incentive per Unit	Home Improvement Incentive per Unit
1	Energy Star Refrigerator	$550	$700
2a	CFL Installation	$5	$5
2b	Energy Star Fixture	$65	$65
3	Energy Star rated bathroom exhaust fan	$200	$300
4	High SEER central air conditioner w/ programmable thermostat	$2,500 (SEER 14)	$500 (SEER 14)
5	Energy Star rated room air conditioner	$275	$400
6	90% AFUE furnace with efficient air handler	$250	$600
7	Energy Star Dishwasher		$425
8	Reduce required AC tonnage as a result of thermal envelope improvements		$2,500
9	Ceiling Fan		$250

1.2 Evaluation Questions

The evaluation sought to answer the following key researchable questions. Some of the researchable questions can be addressed in Program Year 3.

Impact Questions:

1. What are the gross impacts from this program?
2. Did the program meet its energy goals? If not, why not?

Process questions:

1. What are the characteristics of the customers and the program partners (which encompass contractors, other state agencies, and non-profit agencies) participating in the programs?

2. Because the program funds are funneled through pre-existing programs, has the additional funding changed how these programs were implemented and were these changes advantageous?
3. Is the program outreach to program partners effective in increasing awareness of the program opportunities?
4. Are the program processes effective for smoothly providing incentives to partners and motivating the program partners to participate?
5. Effectiveness of program implementation - Is implementation on track for meeting its goals?
6. What challenges have occurred in implementation of the additional funding and how were they handled?

Section 2. Evaluation Methods

2.1 Analytical Methods

2.1.1 Impact Evaluation Methods

An algorithm review was done to verify reasonable assumptions and methods for assigning ex-ante gross kWh and kW savings per measure.

The first step was a verification of the mathematical soundness of the savings calculations for each measure. The measure algorithm's components were verified with the savings assumptions provided by DCEO. The calculations were checked to ensure that the same numbers could be replicated.

Once the calculation methods were verified, the reasonableness of the calculation was assessed. The assessment of reasonableness of the savings estimates was based on reputable measure savings evaluations from other sources and Navigant's own engineering calculations for similar measures.

For PY2 the intent was to use billing analysis to verify program impacts. It was assumed that this program would be a good candidate for using billing analysis as the impact evaluation method for two reasons – the expected savings are high enough and both pre- and post- billing data would be available for participants. However, it was not possible to obtain the account information for participants for this year's analysis. Another attempt will be made in PY3 to provide the data needed to perform a billing analysis for the Weatherization program to verify electric savings estimates.

2.1.2 Process Evaluation Methods

Due to the limited budget allocated for process evaluation and the limited number of research questions to explore, we employed a limited number of methods for the process evaluation. In-depth interviews with program implementation staff and program partners were the primary form of data collection for this process evaluation. In total, we interviewed 5 individuals between July and September 2010. Two of the interviews were with program implementation staff (the DCEO program manager and the manager's technical consultant) and 3 were with program partners. We attempted to interview several more partners but experienced difficulty obtaining partner contact information from DCEO and from secondary sources. Regardless, the interviews allowed the evaluation team to explore the research questions. We used qualitative analysis to synthesize the responses from all interviewed parties.

The evaluation team also reviewed secondary data sources including DCEO program implementation plan and Residential Retrofit Energy Efficiency Program guidelines. We also performed a comparative assessment of the program against ACEEE's best practices in low

income programs report[2] as well as findings from the evaluation team's past experience evaluating low income programs in other jurisdictions.

2.2 *Data Sources*

2.2.1 Impact Evaluation Sources

Data used to prepare this evaluation came from several sources. Program documentation, tracking information and energy savings calculation algorithms were received from DCEO. The tracking information was at a summary level for each participating organization that receives a grant from DCEO. Savings were disaggregated by measure and by utility service territory.

DCEO used the Energy Star calculator for all of their measure savings estimates, except for the furnace measure. EPA and DOE data was the source of the information used by DCEO in the Energy Star calculators. The furnace information came from the Gas Appliance Manufacturers Association. The ceiling fan measure savings information was obtained from an Ameren spreadsheet.

Several additional sources were used by Navigant to verify the reasonableness of the DCEO savings estimates:

- The most current California Database for Energy Efficiency Resources (DEER) reports
- Efficiency Vermont's Technical Reference User Manual (TRM) No. 2009-54
- Navigant's own measure studies.

2.3 *Sampling Plan*

No samples were needed for the evaluation work included in this report.

[2] ACEEE, "Meeting Essential Needs: The Results of a National Search for Exemplary Utility Funded Low Income Energy Efficiency Programs", September 2005.

Section 3. Program Level Results

3.1 Impact Results

The impact evaluation will cover verification and due diligence issues, program tracking system review, and verification of gross and net savings for the program.

3.1.1 Verification and Due Diligence

There was no additional field verification work done for these programs as part of this evaluation since there are already tight verification requirements for both programs. Every site in the Weatherization program receives a follow-up on-site inspection. For the Home Improvement program, grantees have to provide receipts for all installations to collect their grant money.

Grantees are responsible for ensuring that funded measures meet program requirements and are properly installed. The DCEO program manager monitors Grantee compliance with the terms of the grant agreement.

3.1.2 Tracking System Review

The tracking system data reviewed for this program was summary-level data prepared by DCEO. Since DCEO administers the program by providing grants to specific agencies, the focus of their tracking system is energy savings achievements for each agency. The number of installations is recorded for each measure within each agency. Deemed savings per measure are used to estimate total program savings. Care is taken to identify which installations are in ComEd service territory and which are in Ameren since funding is tied back to these two different sources.

The summary data is based on quarterly reports from each grantee which provide addresses of all installations completed over the quarter, the number of occupants meeting the income qualifications, and documentation on the electric service provider (ComEd or Ameren).

3.1.3 Gross Program Impact Parameter Estimates

A technical review of the gross savings assumptions for each measure included in either the Weatherization program or the Home Improvement program will be presented here. The review will assess the reasonableness of the algorithms, technology assumptions and the calculated savings on a per unit basis.

Energy Star Refrigerator

DCEO assumes annual savings of 550 kWh per unit for their Energy Star Refrigerator measure.

DCEO used the savings estimates from the PY1 evaluation to calculate gross savings for program refrigerators. For this application, DCEO assumes that the standard refrigerator being replaced and the replacement refrigerator are both "Top Mount Freezer without through-the-door ice".

The EM&V team verified the savings estimate using the Energy Star calculator. Savings were calculated taking the conventional refrigerator that uses 1000 kWh per year and comparing it to the Energy Star replacement which uses 450 kWh per year. Total annual savings per unit from this calculation is 550 kWh.[3]

The EM&V team also compared this value to savings estimates for refrigerators from other sources. The ex ante refrigerator savings look reasonable when compared to data from the Association of Home Appliance Manufactures (AHAM) database for all current refrigerators. According to AHAM, the average new refrigerator uses 417 kWh per year. This is lower than the 450 kWh number used by DCEO, indicating the program's ex ante estimate is conservative. One of the seminal studies on refrigeration replacement programs reports savings of 593 kWh, another indication that the DCEO value is a conservative estimate.[4]

Given that the per unit savings of 550 kWh is verified in the Energy Star Calculator and is consistent with savings estimates from other authoritative sources, the EM&V team recommends using 550 kWh per unit for the calculation of verified gross program impacts. The Energy Star Calculator uses an area adjustment making the 550 kWh a preferable energy savings estimate to the 593 kWh that does not take the Illinois location into account.

CFL Installation

DCEO assumes annual savings of 38.25 kWh per 15-watt CFL for their CFL Installation measure.

DCEO used the savings estimates from the PY1 evaluation to calculate the gross savings from this measure. There are several key assumptions to the calculation of savings for CFLs.

In-service Rate. An in-service rate of 67% is reported in the 2008 DEER database. However, in this program the bulbs are installed for the customer while other energy efficiency work is being done on the home. This justifies the use of the 100% in-service rate for this program. If the bulbs were distributed to the customer but not installed for them a lower in-service rate would be appropriate.

[3] See Appendix 5.2 for the detailed assumptions used in the Energy Star calculators for this and the other measures.
[4] "Refrigerator Replacement in the Weatherization Program: Putting a Chill on Energy Waste", Larry Kinney and Rana Belshe, E Source, 2001.

Hours of Use. The DEER estimation of hours of use is 2.34 hours per day, taken from a California metering study. However, average hours of use depends on the number of bulbs per home and their room placement. It is unknown how this may be different for the California study group vs. the DCEO program participants. It is also unknown if low income customers use lighting differently than the general population. On the one hand, they may be more likely to be at-home because they are retired or not employed outside of the home. This could lead to greater use of lighting. On the other hand, they may be more budget-conscious because of their limited funds and keep a closer eye on their use of lighting. This could lead to a lower use of lighting. This is a key input and additional investigation would be beneficial for improving the savings estimate. Navigant consulting is currently conducting a logger study for ComEd that will provide a more accurate hour of use estimate for the region.

Saved Watts per Bulb. DCEO assumed that the average replaced light bulb was a 60 Watt bulb and it was replaced with a 15 Watt CFL bulb. It is known that all of the installed bulbs were 15 watt bulbs for this program, however, this is only half of the equation. The wattage of the replaced light would be needed to improve the estimate of saved watts per bulb. The EM&V team does not recommend changing the assumption of 45 saved watts per bulb at this time.

The EM&V team does not recommend any changes to the estimate of 45 watts saved per bulb.

Energy Star Fixtures

DCEO estimated annual savings of 54.8 kWh per unit for their Energy Star Fixture program. Two outdoor fixtures and eight indoor fixtures were installed at each dwelling.

DCEO used the savings estimates from the PY1 evaluation to calculate the ex ante gross savings for eight indoor lighting fixtures and two outdoor lighting fixtures.

DCEO total ex ante annual savings per household from this calculation is 54.8 kWh, as shown in Table 3-1. Similar to our discussion of savings from CFL bulbs, all of these fixtures were installed for the customer so the in-service rate is 100%.

Table 3-1. Savings per Home from Energy Star Fixtures

	DCEO Savings Estimates			Recommended Savings Estimates		
PY2 Goal	Outdoor Fixtures	Indoor Fixtures	Total	Indoor Fixtures	Outdoor Fixtures	Total
Conventional use per year	7.0 kWh	5.1 kWh		7. kWh	5.1 kWh	
Number of fixtures per home	2	8		2	8	
Annual kWh savings per home	14.0 kWh	40.8 kWh	54.8 kWh	14.0 kWh	40.8 kWh	54.8 kWh

The EM&V team recommends using the estimate of annual savings of 54.8 kWh per home for this measure in PY2. However, similar to the discussion of underlying assumptions presented for the CFL measure, consideration should be given to applying results from evaluation work on other Illinois residential lighting programs to improve this estimate of savings in PY3. It is particularly important for this measure to look at the differentiation between indoor and outdoor use of the bulbs related to hours of use and saved watts per bulb. Navigant Consulting is currently conducting a logger study that will provide improved saving estimates for PY3.

The EM&V team recommends using the estimate of annual savings of 54.8 kWh per home for this measure in PY2.

Energy Star rated Bathroom Exhaust Fan

DCEO assumes annual savings of 89 kWh per unit for their Energy Star rated Bathroom Exhaust Fan measure.

Energy Star bathroom exhaust fan ratings were used for the DCEO calculation. It was assumed that the fans would be run for two hours per day. The conventional fan was rated to use 150 watts an hour while the Energy Star fan was rated to use 28 watts an hour. This is a difference of 122 watts per hour. Total annual savings per unit from this calculation is 89 kWh (365 days x 2 hours/day x 122 watts/hour = 89 kWh).

The EM&V team examined the Home Ventilating Institute's (HVI) bathroom fan ratings and verified the reasonableness of the conventional and replacement bathroom fan wattages used by DCEO.

The EM&V team does not recommend any changes to the ex ante estimate of savings for Energy Star rated Bathroom Exhaust Fans.

SEER=14 Central Air Conditioner with Programmable Thermostat

In PY2, DCEO assumed annual savings of 1,119 kWh per unit for their SEER=14 Central Air Conditioner with Programmable Thermostat measure.

This measure is part of the Weatherization program which looks at savings from replacing an existing unit. The conventional existing central AC unit was assumed to have a SEER rating of 9 and no programmable thermostat. The low SEER value used for this savings estimation is appropriate given that this is for the Weatherization program where an older central air conditioning model is being replaced before its normal end of life, as opposed to the Home Improvement program that is installing a new central air conditioning unit in a home that does not have one.

In PY1, the Energy Star calculator was initially used by DCEO to estimate savings for this measure. The EM&V team compared this savings estimate to other sources. The updated 2008 DEER study showed less savings than the Energy Star calculator accounts for. The main issue was the Energy Star calculator's use of 16% savings for a programmable thermostat. A current study of several thousand homes found that a savings of 6% was achieved.[5] Adjusting the Energy Star calculator savings estimate for 6% savings from thermostats creates a revised savings estimate of 1,119 kWh for this measure.

The EM&V team continues to recommend using 1,119 kWh per unit for the estimation of verified gross savings.

SEER=14 Central Air Conditioner with Programmable Thermostat

DCEO assumes annual savings of 240 kWh per unit for their SEER=14 Central Air Conditioner with Programmable Thermostat measure.

DCEO used the savings estimates from the PY1 evaluation to calculate the gross savings for this measure. This measure is part of the Home Improvement program which looks at incremental savings compared to installation of a baseline new unit with a lower SEER. The conventional baseline unit was assumed to have a SEER rating of 13 and no programmable thermostat. This conventional unit was estimated to use 1,662 kWh per year. The Energy Star central AC unit was assumed to have a SEER rating of 14 and have a programmable thermostat. The Energy

[5] ibid

Star central AC unit was estimated to use 1,296 kWh per year. Without additional adjustment, this would suggest savings of 366 kWh.

However, in PY1 the EM&V team compared this savings estimate to other sources. The updated 2008 DEER study showed less savings than the Energy Star calculator accounts for. The main issue was the Energy Star calculator's use of 16% savings for a programmable thermostat. A current study of several thousand homes found that a savings of 6% was achieved.[6] This is a significant difference for savings. The EM&V team believes that the 2008 DEER study is a more accurate assessment of the programmable thermostats saving contribution than the Energy Star calculator's estimate and recommended use of 240 kWh per year for gross savings. DCEO followed this recommendation in PY2.

The EM&V team continues to recommend using 240 kWh per unit for the estimation of verified gross savings.

Energy Star rated Room Air Conditioner

DCEO assumes annual savings of 176 kWh per unit for their Energy Star rated Room Air Conditioner measure.

DCEO uses an Energy Star calculator to calculate gross savings for this measure. As part of the Home Improvement program, it is assumed that the Energy Star rated room air conditioner would be installed instead of a conventional new room air conditioner. DCEO assumes the conventional room AC unit has an EER rating of 8.8, while the Energy Star room AC has an EER rating of 11.5. Based on these values, the Energy Star calculator estimates an annual kWh usage of 750 for the conventional unit and 574 for the efficient unit. The total annual savings per unit from this calculation is 176 kWh.

The EM&V team went to other sources to verify the SEER assumptions that were used, and found that they are reasonable when compared to data from the Association of Home Appliance Manufactures (AHAM) database of SEER levels for all current room air conditioner models.

The EM&V team recommends using 176 kWh per unit.

[6] "Validating the Impact of Programmable Thermostats", RLW Analytics, 2007.

90% AFUE Furnace with efficient air handler

DCEO assumes annual savings of 400 kWh per unit for their 90% AFUE Furnace with efficient air handler measure. Since these are electric savings, they come from the efficiency of the air handler (furnace fan) and are not directly related to the AFUE rating on the furnace.

DCEO used the Gas Appliance Manufacturers Association ratings to calculate the gross electric savings from this measure. The typical furnace was assumed to be 90% AFUE without an Electronically Commutated Motor (ECM). The typical furnace is estimated to use 625 kWh per year. The more efficient furnace had a 90% AFUE with an ECM. The more efficient furnace is estimated to use 225 kWh per year. DCEO assumes the total annual savings per unit from this calculation is 400 kWh.[7]

The EM&V team searched for additional sources to verify the savings estimates for an ECM used in this region of the country. Results from a field study conducted by the Energy Center of Wisconsin were found.[8] This study concluded that a savings of 465 kWh per year could be attributed to an ECM. This leads the EM&V team to accept the 400 kWh per year assumption by DCEO.

The EM&V team recommends using 400 kWh per unit as a reasonable estimate of savings from an efficient air handler on a furnace. The 400 kWh estimate is preferable to the EM&V 465 kWh estimate as the Gas Appliance Manufacturers Association rating is specific to the model of furnace used by DCEO. The researched EM&V savings estimate of 465 kWh is an aggregate number for many different models of furnaces.

Energy Star Dishwasher

DCEO assumes annual savings of 62 kWh per unit for their Energy Star Dishwasher program.

DCEO used an Energy Star calculator to calculate gross savings for this measure. Conventional dishwashers were rated as using 211 kWh per year. Energy Star dishwashers were rated as using 149 kWh per year. DCEO assumes total annual savings per unit from this calculation is 62 kWh.[9]

The EM&V team verified this savings estimate by comparing it to other sources. An examination of AHAM's and the California Energy Commission's databases shows power consumption kWh per cycle to be very close to the Energy Star calculator number. The

[7] Additional detail on these savings assumptions can be found in Appendix 5.3.
[8] "Electricity Use by New Furnaces", Energy Center of Wisconsin, 2003.
[9] Additional detail on these savings assumptions can be found in Appendix 5.1.

calculator shows 1.54 kWh per cycle for an Energy Star rated dishwasher. The California Energy Commission shows an average of 1.47 kWh per cycle for efficient units.

The EM&V team recommends using 62 kWh per unit.

Reduce required AC tonnage as a result of weatherization improvements

DCEO assumes annual savings of 216 kWh per unit when a new air conditioner is installed in a home that also received weatherization improvements. This savings is attributed to the fact that the size (tonnage) of the unit can be reduced because the cooling requirements of the home have been lowered.

The DCEO estimate of savings for this measure is based on several assumptions. They assumed the weatherization improvements to the home were sidewall insulation, roof cavity insulation, and improved window thermal efficiency. They then made an engineering judgment that this would contribute to a ½ ton reduction in cooling requirements for the home. This judgment was based on their knowledge that homes being rehabbed under the Home Improvement program are old. It is likely they had no or poor insulation in the sidewalls and attic, giving an overall low effective R-value. If windows were being replaced, it was assumed the old windows were single-pane or single-pane with storms. This situation was expected to create a cooling load reduction of ½ ton after the sidewalls and attics were insulated. This was considered a broad assumption given that homes in the program are spread across the state and vary in size. The ½ ton reduction in capacity led to an estimate of 216 kWh of savings per year.

The EM&V team believes that more information would be needed before making an adjustment to these savings estimates. It would be helpful to have a detailed breakdown of the type of weatherization measures that were installed in each dwelling. An initial examination of Oak Ridge National Laboratory and Green Builders databases on insulation and window improvement savings suggest that DCEO's savings estimates are possible depending on the amount of weatherization measures installed.

The EM&V team recommends using 216 kWh per unit this year.

Ceiling Fan

DCEO assumes annual savings of 88 kWh per unit when a new ceiling fan is installed.

DCEO used an Ameren spreadsheet to calculate gross savings for this measure.

The EM&V team compared this savings estimate to other sources. The Efficiency Vermont's Technical Reference User Manual (TRM) No. 2009-54 concluded that annual savings from the replacement of a ceiling fan is 180 kWh. The most recent Energy Star calculator lists the savings from a ceiling fan in the East North Central region to be 90 kWh. The discrepancy in the two

saving estimates is a result of the assumptions of the replaced ceiling fan. The Vermont Manual assumed the ceiling fan had four bulbs and 1241 annual hours of use. The Energy Star calculator assumed three bulbs and 1022 hours of annual use. Based on this range of savings, the 88 kWh savings estimated by DCEO is a reasonable savings estimate.

The EM&V team recommends using 88 kWh per unit this year.

Summary of Energy Savings Assessment

Table 3-2 compares the original estimates of ex ante gross savings per unit to the final recommended verified values for each program measure.

Most of the measure-specific ex ante gross savings estimates were reasonable when compared to other authoritative sources.

Table 3-2. Summary of PY2 Verified Gross Energy Savings per Unit

	Measure	Ex Ante kWh per unit	Verified kWh per unit	Difference
1	Energy Star Refrigerator	550	550	0
2a	CFL Installation	38.25	38.25	0
2b	Energy Star Fixture	54.8	54.8	0
3	Energy Star rated bathroom exhaust fan	89	89	0
4a	SEER 14 replacement central air conditioner w/ programmable thermostat	1,287	1,287	0
4b	SEER 14 new central air conditioner w/ programmable thermostat	240	240	0
5	Energy Star rated room air conditioner	176	176	0
6	90% AFUE furnace with efficient air handler	400	400	0
7	Energy Star Dishwasher	62	62	0
8	Reduce required AC tonnage as a result of thermal envelope improvements	216	216	0
9	Ceiling Fan	88	88	0

Estimates of Peak Demand Savings

Peak demand savings were estimated for each measure in addition to annual energy savings. For this evaluation, the peak period is defined as 1:00 to 6:00 p.m. on the hottest summer weekday.

DCEO's estimates of peak demand savings for most measure types in both PY1 and PY2 were based on the assumption of uniform use over all hours of the year. That is, annual energy savings estimates were divided by 8760 hours to get an estimate of peak demand savings for the

measure. The EM&V team concurs that a uniform load shape based on 8760 hours is an appropriate assumption to use for peak contributions for most of the measure types until more detailed load shape data is available. However, we believe the hours of use should be modified for air-conditioning and furnace measures as detailed in the following discussion.

Air-conditioning Measures

DCEO used the recommended savings estimates from the PY1 evaluation as their estimates of ex ante peak savings from air conditioning measures in PY2. In PY1, DCEO's estimation of ex ante peak savings from air conditioning measures assumed that energy use occurs uniformly over 600 hours of use. This assumption came from the Energy Star calculator and reflected the expected number of full load hours for air conditioning in the Illinois area. Using this value to estimate peak savings from energy savings is equivalent to saying that all air conditioners will be running at full load, or 100% of their capacity, for the entire summer peak period. The PY1 evaluation recommended changing the adjustment factor to 70% based on two Wisconsin based studies of air conditioners during peak times.[10] [11] DCEO adjusted their kW estimates to reflect an adjustment factor of 70% for air conditioners measures in PY2.

90% AFUE furnace with efficient air handler.

The EM&V team recommends modifying the peak contribution for the 90% AFUE furnace with efficient air handler.

The energy savings estimates for this measure assume all savings come from winter operation of the furnace. The corresponding estimate of summer peak savings from this measure would be zero since it is not expected to be in use during the summer.

While it is possible that some furnace air handlers will be running during the summer peak if central air conditioning is in use, the saturation of central air conditioners in this group is considered to be low. Additional investigation into the saturation of central air conditioning for this group could warrant a change in the estimated peak demand savings, but given the absence of this information at the current time the EM&V team recommends zero peak savings per unit for this measure in PY2.

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10 "Switches vs. Stats: Who Wants What?: A Comparison of Load Control Switches and Web-enabled Programmable Thermostats", Mary Klos, presentation at the 2007 Association of Energy Services Professionals (AESP) Conference, February 2007.

11 Energy Efficiency and Customer-Sited Renewable Energy: Achievable Potential in Wisconsin 2006-2015, Volume II: Technical Appendix, Energy Center of Wisconsin, ECW Report Number 236-2, November 2005.

Table 3-3. Calculation of Verified Gross Demand Savings

	Measure	Verified kWh per unit	Hours	Unadjusted kW per unit	Adjustment Factor	Verified kW per unit
1	Energy Star Refrigerator	550	8760	0.0628	1	0.0628
2a	CFL Installation	459	8760	0.0524	1	0.0524
2b	Energy Star Fixture	54.8	8760	0.00626	1	0.00626
3	Energy Star rated bathroom exhaust fan	89	8760	0.0102	1	0.0102
4a	SEER 14replacement central air conditioner w/ programmable thermostat	1,287	600	2.1450	70%	1.5015
4b	SEER 14 new central air conditioner w/ programmable thermostat	240	600	0.4000	70%	0.2800
5	Energy Star rated room air conditioner	176	600	0.2933	70%	0.2053
6	90% AFUE furnace with efficient air handler	400	8760	0.0457	0	0
7	Energy Star Dishwasher	62	8760	0.0071	1	0.0071
8	Reduce required AC tonnage as a result of thermal envelope improvements	216	600	0.3600	70%	0.2520
9	Ceiling Fan	88	8760	0.147	1	0.147

Table 3-4. Summary of Verified Gross Demand Savings

	Measure	Ex Ante kW per unit	Ex Post kW per unit	Difference
1	Energy Star Refrigerator	0.0628	0.0628	0
2a	CFL Installation	0.0436	0.0436	0
2b	Energy Star Fixture	0.00626	0.00626	0
3	Energy Star rated bathroom exhaust fan	0.0102	0.0102	0
4a	SEER 14 replacement central air conditioner w/ programmable thermostat	1.5015	1.5015	0
4b	SEER 14 new central air conditioner w/ programmable thermostat	0.2800	0.2800	0
5	Energy Star rated room air conditioner	0.2053	0.2053	0
6	90% AFUE furnace with efficient air handler	0.0457	0	-0.0457
7	Energy Star Dishwasher	0.0071	0.0071	0
8	Reduce required AC tonnage as a result of thermal envelope improvements	0.2520	0.2520	0
9	Ceiling Fan	0.147	0.147	0

3.1.4 Gross Program Impact Results

The verified gross savings per unit for energy and demand savings can be used with the actual number of installations for each measure to show the overall gross program impact results for PY2.

Weatherization Program

Table 3-5 presents the ex ante and ex post gross MWh savings for the Weatherization program. Table 3-6 presents the companion MW savings. The ex post energy savings and demand savings for the Weatherization program are the same as the ex ante energy savings and demand savings.

Table 3-5. Weatherization Program Ex Ante and Ex Post Gross MWh Savings

	Ex Ante			Ex Post		
Measure	kWh/Unit	Units	Total MWh	kWh/Unit	Units	Total MWh
Energy Star Refrigerator	550	3,108	1,709	550	3,108	1,709
CFL	38.25	173,595	6,640	38.25	173,595	6,640
Energy Star Bathroom Exhaust Fan	89	729	65	89	729	65
TOTAL			8,414			8,414

Table 3-6. Weatherization Program Ex Ante and Ex Post Gross kW Savings

	Ex Ante			Ex Post		
Measure	kW/Unit	Units	Total kW	kW/Unit	Units	Total kW
Energy Star Refrigerator	0.0628	3,108	195	0.0628	3,108	195
CFL	0.0044	173,595	764	0.0044	173,595	764
Energy Star Bathroom Exhaust Fan	0.0102	729	7	0.0102	729	7
TOTAL			966			966

Note: These tables only include the electric efficiency measures actually installed through the Weatherization program in PY2.

Home Improvement Program

Table 3-7 presents the ex ante and ex post gross MWh savings for the Home Improvement program. Table 3-8 presents the companion kW savings. For this program, the ex post savings are the same as the ex ante savings and the ex post demand savings are slightly lower than the ex ante demand savings.

Table 3-7. Home Improvement Program Ex Ante and Ex Post Gross MWh Savings

	Ex Ante			Ex Post		
Measure	kWh/Unit	Units	Total MWh	kWh/Unit	Units	Total MWh
Energy Star Refrigerator	550	617	339	550	512	339
Energy Star Fixture	54.80	1,717	94	54.80	979	94
Energy Star Bathroom Exhaust Fan	89	155	14	89	38	14
Energy Star Dishwasher	62	73	5	62	51	5
SEER 14 Central AC with programmable thermostat (new installation)	240	64	15	240	9	15
Energy Star Room AC	176	152	27	176	139	27
Reduce required tonnage as a result of thermal envelope improvements	216	282	61	216	133	61
90% AFUE furnace with EE air handler	400	108	43	400	41	43
CFL Installation	38.25	984	38	38.25	805	38
Ceiling Fan	88	346	30	88	193	30
TOTAL			666			666

Table 3-8. Home Improvement Program Ex Ante and Ex Post Gross kW Savings

Measure	Ex Ante			Ex Post		
	kW/Unit	Units	Total kW	kW/Unit	Units	Total kW
Energy Star Refrigerator	0.0628	617	39	0.0628	617	39
Energy Star Fixture	0.00626	1,717	11	0.00626	1,717	11
Energy Star Bathroom Exhaust Fan	0.0102	155	1.6	0.0102	155	1.6
Energy Star Dishwasher	0.0071	73	0.5	0.0071	73	0.5
SEER 14 Central AC with programmable thermostat (new installation)	0.2800	64	18	0.2800	64	18
Energy Star Room AC	0.2053	152	31	0.2053	152	31
Reduce required tonnage as a result of thermal envelope improvements	0.2520	282	71	0.2520	282	71
90% AFUE furnace with EE air handler	0.0457	108	5	0	108	0
CFL Installation	0.0044	984	4	0.0044	984	4
Ceiling Fan	0.1467	346	51	0.1467	346	51
TOTAL			232			227

Total numbers reflect actual sum. Rounding for the individual measures shows a discrepancy in the total row. The discrepancy is due to rounding. The total row is accurate.

3.1.5 Net Program Impact Parameter Estimates

Since these programs specifically target customers of limited income it is likely that the customers would not have funded new energy efficiency measures on their own. As a result, the EM&V team believes the Net-to-Gross factor should be 100%, which is the value used by DCEO for PY2. This is the practice in other jurisdictions, such as Wisconsin.[12]

[12] Telephone conversation with Oscar Bloch, DSM Evaluation Supervisor, Public Service Commission of Wisconsin, 10-29-2009. Mr. Bloch verified that Wisconsin has always used a net-to-gross ratio of 1 for evaluation of programs targeted to limited income customers. However, there is no current documentation stating this. It can be seen by looking at program evaluation reports, such as "Focus on Energy Evaluation, Semiannual Report (First Half of 2009)", PA Consulting Group, Revised Final October 19, 2009, p. 4-21, and noting that programs targeted at limited income customers are only required to report verified gross savings, not verified net savings.

3.1.6 Net Program Impact Results

Table 3-9 presents the final gross and net program impact results for the Weatherization program. The summary of final gross and net savings for the Home Improvement program can be found in Table 3-10.

Table 3-9. Summary of Gross and Net Savings for Low Income Weatherization

ComEd Low Income Weatherization Program PY2	MWh Savings		kW Savings	
	DCEO Claimed	Evaluation Verified	DCEO Claimed	Evaluation Verified
Gross Savings	8,414	8,414	966	966
Net-to-Gross Ratio	1	1	1	1
Net Savings	8,414	8,414	966	966

Table 3-10. Summary of Gross and Net Savings for Low Income Home Improvement

ComEd Low Income Weatherization Program PY2	MWh Savings		kW Savings	
	DCEO Claimed	Evaluation Verified	DCEO Claimed	Evaluation Verified
Gross Savings	666	666	232	227
Net-to-Gross Ratio	1	1	1	1
Net Savings	666	666	232	227

3.2 Process Evaluation Results

The detailed findings from this process evaluation of the Residential Retrofit Energy Efficiency Program are presented below.

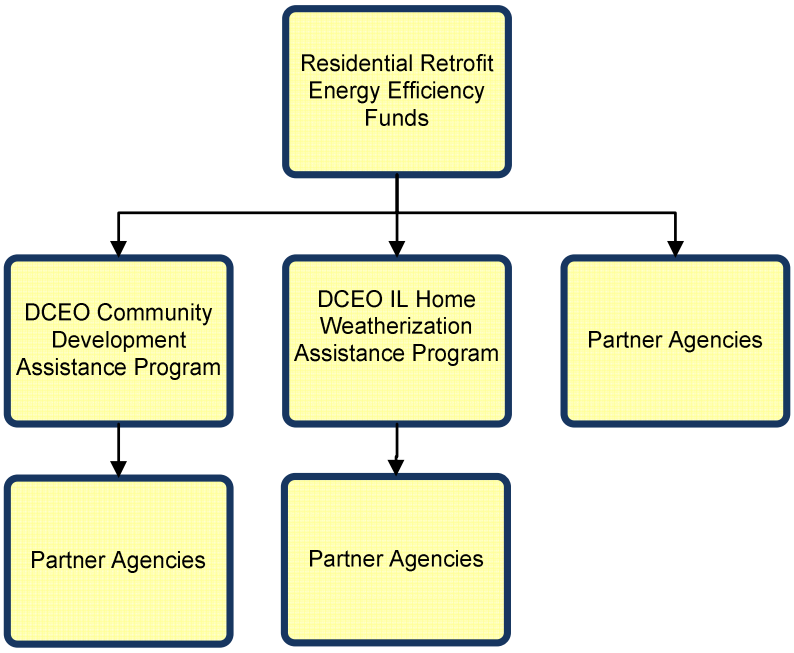
3.2.1 Process Themes

Customer and Partner Characteristics

As described earlier, DCEO provides grants to fund pre-existing low income weatherization or home improvement programs. The Residential Retrofit Energy Efficiency program had at least 10 partners in PY2. Some of these partners work within DCEO (The Community Development

Assistance Program and The Illinois Home Weatherization Assistance Program) while others are outside organizations (such as The Illinois Housing Development Authority, The Historic Chicago Bungalow Association and The Delta Institute). The diagram below shows how the funding is dispensed to partners.

Figure 1. Funding Allocation to Partner Agencies



The grantee's programs have their own specific participation requirements, but all must target low income households to receive the DCEO funding. In the case of weatherization programs, these programs must target households at or below 200% of the poverty level, while home improvement programs must target households at or below 80% of the Average Median Income (AMI).

Marketing and Outreach Effectiveness

As described above, DCEO channeled money to both pre-existing programs within DCEO and outside programs. DCEO had a pre-existing network of organizations and established relationships with potential partners. As such, marketing efforts were minimal for this program and the program primarily relied upon one-on-one conversations and word of mouth to promote the program. The program also had help from the City of Chicago, which suggested the program to several outside agencies. Additionally, program staff posted program information on the DCEO website. These efforts appear to have been effective in recruiting qualified partners for the program.

Impact of Funneling Funds Through Pre-Existing Programs

Funneling program funds through pre-existing programs advantageously changed how these programs were implemented. First, the additional funding allowed these programs to increase the number of homes upgraded in a given year.

> *"It relieves their budget. If they were only being able to do a hundred and fifty homes, and I give them all these funds, now it frees up a lot of their money so they're now able to do many additional homes."*
> - DCEO Program Staff

Second, the funding increased the amount of energy savings within each home. The funding allowed partners to install additional energy saving measures in the homes. For one partner, improvements to the thermal envelope was the area where the funding had the most benefit since they believe homeowners are unlikely to make improvements to this area without incentives. Additionally, our interviews indicated that some programs had not included Energy Star appliances prior to receiving the additional funding from this program.

The new Energy Star appliances faced initial resistance by some contractors. These contractors were hesitant to adopt the appliances due to concerns over their cost and availability. However, this problem was overcome and is no longer an issue.

Program Implementation Effectiveness

The program's implementation strategy met many of the industry best practices for low income programs. Some key best practices for low income programs include:

- Partnering with existing entities serving the low income sector;
- Ensuring that participant contact information is captured;
- Including a full menu of household energy efficiency improvements;
- Smoothly providing incentives to partners to encourage participation;
- Designing a program that is easily understood by its intended targets;
- Conducting pre and post verification; and
- Providing timely responses to partner questions.

Below we discuss how this program met these best practices and identify some areas of improvement for the next program year.

<u>Partnering with existing entities serving the low income sector</u>

One key best practice for low-income programs is to partner with existing entities serving the low income sector. These entities have the knowledge of where to best market their services, as well as the infrastructure to implement the actions required by the program in a timely manner. In addition, this tends to ensure quality of program services as the agencies tend to be

experienced in providing weatherization services. Our interviews found that the Low Income Residential Retrofit Energy Efficiency Program had at least 10 partnerships with existing entities servicing the low income sector in PY2. Our interviews with program partners found that the program is working well and that the partners are generally satisfied with the program processes that they have been involved with.

Ensuring that participant contact information is captured

Another best practice for any energy efficiency program is to ensure that participant contact information is captured. DCEO requires that partners submit quarterly progress reports, and the reports must include the addresses of funded projects and the addresses of projects completed during the quarter. Program partners submit quarterly progress reports to DCEO containing information about the projects funded. Partners are required to submit the following information:

- Grantee expenditure per project
- Energy efficiency measures funded by the project
- Total grant expenditures during the quarter
- Total numbers of measures funded during the quarter
- Addresses of funded projects
- Addresses of completed projects during the quarter
- Number of owners/occupants that are at or below 80% AMI
- Documentation that projects which receive funding are situated in Ameren or ComEd electric service territory
- Fuel Bill Release forms (grantees must require program participants to sign these)

Our interviews found that partners submitted their reports in varying formats, with some partners submitting paper files and some electronic files. Program staff did create a uniform spreadsheet for reporting purposes but it was not used by partners. The varying format that the program receives from each partner likely creates much work for DCEO to synthesize all of the information for program tracking purposes. DCEO plans to use a common format in PY3.

Including a full menu of household energy efficiency improvements

Another best practice for low income programs is to include a full menu of household energy efficiency improvements. DCEO provides grants for different types of electric saving measures, for example Energy Star rated refrigerators, CFL installation, and Energy Star rated bathroom exhaust fans. A shown in Table 1-1, this program provided funding for a full menu of household energy efficiency measures from low-cost measures such as CFLs to energy efficient appliances and building envelope measures.

Smoothly providing incentives to partners to encourage participation

Smoothly providing incentives to partners contributes to program satisfaction and motivates partners to participate. Some external partners whom we interviewed indicated that the program took longer than expected to provide both a contract and grant funding.

Paying out grant funding requires the approval of several offices within DCEO.

Designing a program that is easily understood by its intended targets

One program challenge has been the program design itself. Combining two programs into one program that offers different measures depending on certain criteria has caused confusion in the market amongst partners, potential partners and evaluators alike. Originally, the program consisted of two separate programs, which were later combined into one program with different incentive amounts for home improvement and weatherization programs. This has led to the confusion in the market over whether the program is one program or two programs and the measures incented by the program.

Providing timely responses to partner questions

Providing timely responses to partner questions contributes to program satisfaction and motivates partners to participate. DCEO generally provided timely responses to partner questions. When contracts or grant funding will be delayed additional communication is necessary. After contracts were signed, partners reported that questions were quickly answered and DCEO is easy to get a hold of. However, external partners found it difficult to obtain feedback about their pending contracts.

Pre and post verification is essential for low income program best practices

Pre and post verification of installation is essential for low income programs. For this program, it is the responsibility of program partners rather than DCEO staff to ensure that measures meet program requirements and are properly installed. Verification procedures are in place for the programs receiving the DCEO funding.

3.3 Cost Effectiveness

This section addresses the cost effectiveness of the DCEO Residential Retrofit programs. Cost effectiveness is assessed through the use of the Total Resource Cost (TRC) test. The TRC test is defined in the Illinois Power Agency Act SB1592 as follows:

> *" 'Total resource cost test' or 'TRC test' means a standard that is met if, for an investment in energy efficiency or demand-response measures, the benefit-cost ratio is greater than one. The benefit-cost ratio is the ratio of the net present value of the total benefits of the program to the net*

present value of the total costs as calculated over the lifetime of the measures. A total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures, to the sum of all incremental costs of end-use measures that are implemented due to the program (including both utility and participant contributions), plus costs to administer, deliver, and evaluate each demand-side program, to quantify the net savings obtained by substituting the demand-side program for supply resources. In calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases."[13]

Table 3-11 summarizes the unique inputs used in a spreadsheet model to assess the TRC ratio for the Residential Retrofit Weatherization program in PY2. Most of the unique inputs come directly from the evaluation results presented previously in this report. Incentive costs come from the DCEO program tracking data. The participant contribution to incremental measure costs is zero for this program. Avoided costs for both demand and energy match what was used by ComEd in DSMore™ for assessing the TRC ratio of their own energy efficiency projects.

Table 3-11. Inputs to TRC Assessment for Residential Retrofit Weatherization Program

Item	ComEd	Ameren
Measure Life (varies by measure)	9 to 15 years	9 to 15 years
Annual Gross Energy Savings	5,475 MWh	2,939 MWh
Gross Coincident Peak Savings	0.625 MW	0.336 MW
Net-to-Gross Ratio	100%	100%
DCEO Administration Costs	$13,127	$4,260
DCEO Implementation Costs	$0	$0
DCEO Other Costs	$0	$0
DCEO Incentive Costs	$1,953,230	$769,945
Participant Contribution to Incremental Measure Costs	$0	$0

Based on these inputs, the TRC for this program is 2.02 for ComEd and 2.09 for Ameren and the program passes the TRC test.

Table 3-12 summarizes the unique inputs used in a spreadsheet model to assess the TRC ratio for the Residential Retrofit Home Improvement program in PY2. Most of the unique inputs

[13] Illinois Power Agency Act SB1592, pages 7-8.

come directly from the evaluation results presented previously in this report. Incentive costs come from the DCEO program tracking data. The participant contribution to incremental measure costs is zero for this program. Avoided costs for both demand and energy match what was used by ComEd in DSMore™ for assessing the TRC ratio of their own energy efficiency projects.

Table 3-12. Inputs to TRC Assessment for Residential Retrofit Home Improvement Program

Item	ComEd	Ameren
Measure Life (varies by measure)	9 to 20 years	9 to 20 years
Annual Gross Energy Savings	461 MWh	191 MWh
Gross Coincident Peak Savings	0.137 MW	0.072 MW
Net-to-Gross Ratio	100%	100%
DCEO Administration Costs	$19,690	$6,391
DCEO Implementation Costs	$0	$0
DCEO Other Costs	$0	$0
DCEO Incentive Costs	$924,585	$612,215
Participant Contribution to Incremental Measure Costs	$0	$0

Based on these inputs, the TRC for this program is 0.65 for ComEd and 0.38 for Ameren and the program does not pass the TRC test.

A shift of funding across the measures could raise the program TRC to a value greater than one. Environmental benefits have been quantified for CO_2 reductions using a value of $0.013875 per kWh.

Section 4. Conclusions and Recommendations

4.1 Conclusions

The primary objective of this report is an evaluation of gross and net impacts from the Weatherization and Home Improvement programs in PY2. Program evaluation work will continue for Program Year 3, providing the opportunity to refine and update the assessment.

The following conclusions highlight the major findings and recommendations presented in this Program Year 2 report.

4.1.1 Program Impacts

Weatherization Program

Table 4-1 presents the ex ante and ex post gross MWh savings for the Weatherization program. Table 4-2 presents the companion kW savings. The ex post energy savings and demand savings for the Weatherization program are the same as the ex ante energy savings and demand savings.

Table 4-1. Weatherization Program Ex Ante and Ex Post Gross MWh Savings

	Ex Ante			Ex Post		
Measure	kWh/Unit	Units	Total MWh	kWh/Unit	Units	Total MWh
Energy Star Refrigerator	550	3,108	1,709	550	3,108	1,709
CFL	38.25	173,595	6,640	38.25	173,595	6,640
Energy Star Bathroom Exhaust Fan	89	729	65	89	729	65
TOTAL			8,414			8,414

Table 4-2. Weatherization Program Ex Ante and Ex Post Gross kW Savings

	Ex Ante			Ex Post		
Measure	kW/Unit	Units	Total kW	kW/Unit	Units	Total kW
Energy Star Refrigerator	0.0628	3,108	195	0.0628	3,108	195
CFL	0.0044	173,595	764	0.0044	173,595	764
Energy Star Bathroom Exhaust Fan	0.0102	729	7	0.0102	729	7
TOTAL			966			966

Note: These tables only include the electric efficiency measures actually installed through the Weatherization program in PY2.

Home Improvement Program

Table 4-3 presents the ex ante and ex post gross MWh savings for the Home Improvement program. Table 4-4 presents the companion MW savings. For this program, the ex post savings are the same as the ex ante savings. For this program, the ex post demand savings are slightly lower than the ex ante demand savings.

Table 4-3. Home Improvement Program Ex Ante and Ex Post Gross MWh Savings

	Ex Ante			Ex Post		
Measure	kWh/Unit	Units	Total MWh	kWh/Unit	Units	Total MWh
Energy Star Refrigerator	550	617	339	550	512	339
Energy Star Fixture	54.80	1,717	94	54.80	979	94
Energy Star Bathroom Exhaust Fan	89	155	14	89	38	14
Energy Star Dishwasher	62	73	5	62	51	5
SEER 14 Central AC with programmable thermostat (new installation)	240	64	15	240	9	15
Energy Star Room AC	176	152	27	176	139	27
Reduce required tonnage as a result of thermal envelope improvements	216	282	61	216	133	61
90% AFUE furnace with EE air handler	400	108	43	400	41	43
CFL Installation	38.25	984	38	38.25	805	38
Ceiling Fan	88	346	30	88	193	30
TOTAL			666			666

Table 4-4. Home Improvement Program Ex Ante and Ex Post Gross kW Savings

	Ex Ante			Ex Post		
Measure	kW/Unit	Units	Total kW	kW/Unit	Units	Total kW
Energy Star Refrigerator	0.0628	617	39	0.0628	617	39
Energy Star Fixture	0.00626	1,717	11	0.00626	1,717	11
Energy Star Bathroom Exhaust Fan	0.0102	155	1.6	0.0102	155	1.6
Energy Star Dishwasher	0.0071	73	0.5	0.0071	73	0.5
SEER 14 Central AC with programmable thermostat (new installation)	0.2800	64	18	0.2800	64	18
Energy Star Room AC	0.2053	152	31	0.2053	152	31
Reduce required tonnage as a result of thermal envelope improvements	0.2520	282	71	0.2520	282	71
90% AFUE furnace with EE air handler	0.0457	108	5	0	108	0
CFL Installation	0.0044	984	4	0.0044	984	4
Ceiling Fan	0.1467	346	51	0.1467	346	51
TOTAL			232			227

Table 5-5 and Table 5-6 present the net savings impact contributions of ComEd and Ameren for the Weatherization and Home Improvement programs.

Table 5-5. ComEd and Ameren Net Savings for Low Income Weatherization

ComEd Low Income Weatherization Program PY2	MWh Savings		kW Savings	
	DCEO Claimed	Evaluation Verified	DCEO Claimed	Evaluation Verified
ComEd	5,475	5,475	628	628
Ameren	2,939	2,939	338	338
Total Savings	8,414	8,414	966	966

Table 5-6. ComEd and Ameren Net Savings for Low Income Home Improvement

ComEd Low Income Weatherization Program PY2	MWh Savings		kW Savings	
	DCEO Claimed	Evaluation Verified	DCEO Claimed	Evaluation Verified
ComEd	461	461	137	135
Ameren	205	205	95	92
Total Savings	666	666	232	227

4.1.2 Program Processes

The program's implementation strategy met many of the industry best practices for low income programs. Some key best practices for low income programs include:

- Partnering with existing entities serving the low income sector;
- Ensuring that participant contact information is captured;
- Including a full menu of household energy efficiency improvements;
- Smoothly providing incentives to partners to encourage participation;
- Designing a program that is easily understood by its intended targets;
- Conducting pre and post verification; and
- Providing timely responses to partner questions.

4.2 Recommendations

4.2.1 Impact Recommendations

Improve ex ante and ex post estimates of measure savings per unit. We recommend that both DCEO and the EM&V team make efforts to find measure savings data sources for areas closer to the Illinois region that are up-to-date. Some of these may come from evaluation work currently being done on other portfolio programs. If this information is not available, then continued use of the Energy Star calculators is the next best option. It is important that the most recent Energy Star calculators be used each year as these calculators are continually updated with the most recent studies.

4.2.2 Process Recommendations

Provide contracts and grants in a timely manner to external partners and set expectations accordingly. We recommend that in the next year, DCEO make efforts to ensure that external parties receive their contracts and grants in a timely manner. At the same time we recommend

that DCEO set expectations with external partners about how long it will take for them to receive contracts and grant funding.

Require partners to submit participant data in one standard electronic format. We recommend that DCEO require partners to submit data either through a web-based system or in a standard electronic format. Currently, partners submit their reports in varying formats, with some partners submitting paper files and some electronic files. Compiling data in multiple formats increases administrative costs for DCEO and provides a barrier to effective program monitoring. DCEO is planning on implementing a common format for partners in PY3.

Simplify the program's presentation. We recommend that DCEO simplify the presentation of the measures incented and work with partners to improve understanding of measures. Combining two programs into one program that offers different measures depending on certain criteria has caused confusion in the market amongst partners, potential partners and evaluators alike. It is the intent of DCEO to modify the similar measures in PY3 so that cost and savings will be identical for both parts of the program. This will reduce the program to a one part structure that will avoid confusion.

Appoint a DCEO staff member to be responsible for the evaluation effort. DCEO and the evaluation team would benefit if DCEO had a staff member appointed to the evaluation effort. The staff member would be responsible for compiling the necessary evaluation material. This would avoid confusion over what material had already been provided and what material are needed. A DCEO staff member would also be more knowledgeable of the best person to reach for the needed information. This would avoid unnecessary confusion and frustration. The new program database may also help.

Section 5. Appendices

5.1 Process Data Collection Instruments

DCEO Residential Retrofit Energy Efficiency program

PY2009 Evaluation Depth Interview Questions for Program Staff

June 2010

[Determine up-front how the interview should best be conducted, i.e. talk about the programs together or each program separately]

Program Overview & Management

[This line of questions is intended to understand how the program is implemented, roles and responsibilities of each program organization and the goals/objectives for the program.]

1. Could you briefly describe the programs?
    a. Can you describe the history of the programs?
    b. How did the programs begin and why?
    c. Could you describe the goals and objectives for the programs?
    d. Did the programs meet their targets for 2009?

2. Can you describe who is involved in the programs' implementation?
    a. It is our understanding that each program provides supplemental funding to existing low income loan programs. Can you briefly describe the existing programs that receive additional funding through the EE Weatherization Program and Home Improvement programs?

3. Can you briefly describe how the program funds are given to the partner organizations?
    a. What is the process that these organizations go through to receive the Weatherization and Home Improvement grant funds?
    b. What is DCEO's role in each program?
    c. Who does DCEO directly interact with?
    d. Who do the organizations interact with? [e.g. directly with homeowners, renters and/or contractors/developers?]

4. Could you briefly summarize your specific role in the programs?
    a. What are your main responsibilities?
    b. How long have you been involved in the programs?

5. What kind of formal and informal communication is set up between DCEO and the organizations?
    a. How often do you communicate with them?
    b. How do you typically communicate with them? [PROBE FOR: regular meetings, calls, email, informal communication between set meetings, etc.]
    c. How well is the communication going?

6. Can you describe the marketing or promotional efforts to program partners done for PY2009?
    a. Who is responsible for it?
    b. How often did the efforts occur?
    c. Do you have any marketing materials that you can share?
    d. Are the programs marketed together?

7. Have you collaborated with other ComEd and/or Ameren home improvement and weatherization programs?
    a. Do you know if the partner organizations have collaborated with other ComEd and/or Ameren home improvement and weatherization programs?

8. Given that the program funds are funneled through pre-existing programs, how has the additional funding changed the way these pre-existing programs are implemented? Were these changes advantageous?
    a. What were some of the challenges that occurred in the implementation of the additional funding? How were they handled?

Program Databases & Documents

9. How do you track program data?
    a. Is it electronic or paper-based?

    b. How can we obtain tracking data and project records such as applications?

10. Are there any other program documents that you can share with us?
    a. Quarterly or monthly reports?
    b. Marketing plans for either program?
    c. Program guidelines for Home Improvement?

[Q11 APPLIES TO THE HOME IMPROVEMENT PROGRAM]

11. What are your systems for tracking customers who participate in the Low Income Home Improvement program? Are you in a position to share electronic lists of participants for this program for potential use in an impact study?

12. Is the data you receive required to be in a standardized format?

13. [**ASK IF Q12 IS YES**] Once you have the data what is the process to create your reports?

15. [**ASK IF Q12 IS NO**] How difficult would it be to require that the information be standardized?

QA/QC and Verification Procedures

As part of our evaluation, we'd like to report on the quality assurance and quality control procedures that are in place for the programs. Eventually we will ask for detailed information regarding any verification efforts for the evaluation including the actual algorithms used. Now we have a few questions just to understand what is happening for quality control.

[Q12 ONLY APPLIES TO THE WEATHERIZATION PROGRAM]

12. The Weatherization implementation plan states that "the existing programs include final inspections on every home to insure measures were installed properly." Can you walk me through the way in which inspections are done?
    a. Who implements them?
    b. Is it done on every home?
    c. When is it done?

[Q13 ONLY APPLIES TO THE HOME IMPROVEMENT PROGRAM]

13. The Home Improvement implementation plan states that "the lender or grantee will conduct their own inspections to insure measures have been installed properly. Field inspections will also be done on a random basis." Can you walk me through the ways in which inspections are done?
    a. Who implements them?
    b. How are the samples selected?
    c. How often is it done?

[Q14 APPLIES TO BOTH THE WEATHERIZATION AND HOME IMPROVEMENT PROGRAMS]

14. The Weatherization and Home Improvement implementation plans also state that the program includes "an annual fuel bill analysis for the first three years following implementation." Is that happening or still planned?
    a. Have you, or do you plan to, report on this analysis?

b. Do you already have something that outlines the approach and results of any verification efforts underway and can you share that will us?

15. Beyond the annual fuel bill analysis and inspections, are there other ways that you check the programs for quality control? [PROBE FOR: how other quality control procedures are conducted and why]

Program Partners

16. Let's focus for a minute on the partner organizations that seek additional funds from the programs. What do you perceive as their level of satisfaction with each of the programs? Why do you say that?

17. How do the organizations find out about each program?

18. What is their motivation to participate in each of the programs?

19. What role do you expect the program partners to fulfill? Do you think they are fulfilling that role?

20. What are the characteristics of the program partners who participate in the programs? Was this the group you expected to participate?

Program Strengths & Weaknesses

21. What do you see as the greatest strengths of each program?

22. What are some challenges to each program's success so far? [PROBE FOR: internal barriers such as application processes, management, implementation program design and external barriers in the marketplace]
    a. How are the challenges being addressed?

23. Are there any program issues that you would like to see explored through this evaluation?

Other Key Contacts

24. We are conducting up to 7 interviews with key staff at partner organizations, and we need to obtain a list of people involved and their contact information. Can you recommend staff for these interviews? Do you have contact information for these staff?

Partner Organizations - DCEO Residential Retrofit Energy Efficiency program
PY2009 Evaluation Depth Interview Questions
August 19, 2010

Program Overview & Management

[This line of questions is intended to understand how the program is implemented and the roles and responsibilities of each program organization.]

1. Could you briefly summarize your specific role in your organization?
    a. What are your main responsibilities?
    b. How long have you been involved in these programs?

2. What kind of formal and informal communication is set up between the DCEO and your organization?
    a. How often do you communicate with DCEO?
    b. How do you typically communicate with them? [PROBE FOR: regular meetings, calls, email, informal communication between set meetings, etc.]
    c. How well is the communication going?
    d. What do you typically communicate about?
    e. How quickly do they answer questions that you have?
    f. Does the DCEO provide you with any support to help with your involvement with these programs?
    g. Are there areas where you could use more support from the DCEO?

3. Other than the DCEO, who else does your organization interact with about these programs? [e.g. directly with homeowners, renters and/or contractors/developers?]

4. Has your organization collaborated with other ComEd and/or Ameren Residential Retrofit Energy Efficiency programs?

5. Given that the program funds are funneled through pre-existing programs, how has the additional funding changed the way these pre-existing programs are implemented?
    a. Were these changes advantageous?
    b. What were some of the challenges that occurred in the implementation of the additional funding? How were they handled?

Participation Process for Partner Organizations

1. How did your organization find out about these programs?

2. What was the process to apply to participate in this program?

3. What are the requirements that you need to fulfill in order to participate in the program? Do you have any trouble meeting these requirements?

4. How was the process of how to participate and the program requirements explained to you?
    a. Were participation process and program requirements easy to understand?

5. What is the process that you went through to receive these grant funds?
    a. Did this process operate smoothly?

6. Do you think builders and homeowners would likely implement these energy efficient measures without the programs' additional funds?

QA/QC and Verification Procedures

As part of our evaluation, we'd like to report on the quality assurance and quality control procedures that are in place for the programs. Now we have a few questions just to understand what is happening for quality control.

7. The Weatherization implementation plan states that "the existing programs include final inspections on every home to insure measures were installed properly." Can you walk me through the way in which inspections are done?
    a. Who implements them?
    b. Is it done on every home?
    c. When is it done?

8. The Home Improvement implementation plan states that "the lender or grantee will conduct their own inspections to insure measures have been installed properly. Field inspections will also be done on a random basis." Can you walk me through the ways in which inspections are done?
    d. Who implements them?
    e. How are the samples selected?
    f. How often is it done?

Program Databases & Documents

9. What are your systems for tracking customers who participate in the Residential Retrofit Energy Efficiency Program?
    a. Is it electronic or paper-based?

10. What information do you track about customers? For example, do you have participant account number, meter numbers, and measures installed?

11. Are you in a position to share electronic lists of participants for this program for potential use in an impact study?

Program Strengths & Weaknesses

12. What do you see as the greatest strengths of this program?

13. What are some challenges to each program's success so far? [PROBE FOR: internal barriers such as application processes, management, implementation program design and external barriers in the marketplace]
    b. How are the challenges being addressed?

14. Are there any program issues that you would like to see explored through this evaluation?

15. How would you sum up your experience with the program? Do you have any recommendations for improvement?

16. What is your overall level of satisfaction with the Residential Retrofit Energy Efficiency Program? Why do you say that?

5.2 Energy Star Calculators

These calculators show the assumptions and calculations used to create the ex ante estimates of savings.

Products that earn the ENERGY STAR prevent greenhouse gas emissions by meeting strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and the U.S. Department of Energy.
www.energystar.gov

CHANGE FOR THE BETTER WITH ENERGY STAR

Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Residential Refrigerator(s)

This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.

Enter your own values in the gray boxes or use our default values.

Number of units	1
Electricity Rate ($/kWh)	$ 0.101
Choose the type of refrigerator	3-Top Mount Freezer without through-the-door ice

	ENERGY STAR Qualified Unit	Conventional Unit
Initial cost per unit (estimated retail price)	$1,100	$1,070
Refrigerator Fresh Volume (ft^3)	18	18
Refrigerator Freezer Volume (ft^3)	5	5
Refrigerator Total Volume (ft^3)	23	23

Annual and Life Cycle Costs and Savings for 1 Residential Refrigerator(s)

	1 ENERGY STAR Qualified Unit(s)	1 Conventional Unit(s)	Savings with ENERGY STAR
Annual Operating Costs*			
Energy costs	$45	$101	$55
Total	**$45**	**$101**	**$55**
Life Cycle Costs*			
Energy costs	$453	$1,007	$554
Energy consumption (kWh)	*5,850*	*13,000*	*7,150*
Purchase Price for 1 unit(s)	$1,100	$1,070	-$30
Total	**$1,553**	**$2,077**	**$524**
Simple payback of initial additional cost (years)†			**0.5**

* *Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount*

† *A simple payback period of zero years means that the payback is immediate.*

Summary of Benefits for 1 Residential Refrigerator(s)

Initial cost difference	**$30**
Life cycle savings	**$554**
Net life cycle savings (life cycle savings - additional cost)	**$524**
Simple payback of additional cost (years)	**0.5**
Life cycle energy saved (kWh)	**7,150**
Life cycle air pollution reduction (lbs of CO_2)	**10,975**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**0.96**
Air pollution reduction equivalence (acres of forest)	**1.36**
Savings as a percent of retail price	**48%**

Assumptions for Residential Refrigerators			
Category	**Value**		**Data Source**
Power			
ENERGY STAR Qualified Unit			
Initial cost per unit	$1,100		DOE 2004
Refrigerator Fresh Volume	18	ft^3	DOE 2004
Refrigerator Freezer Volume	5	ft^3	DOE 2004
Adjusted Volume	26.15	ft^3	DOE 2004
Lifetime	13	years	DOE 2004
Annual Unit Energy Consumption			
For Selected Refrigerator Type	450	kWh	Calculated.
1-Manual Defrost Refrigerators	407	kWh	DOE 2004
2-Partial Automatic Defrost Refrigerators	407	kWh	DOE 2004
3-Top Mount Freezer without through-the-door ice	450	kWh	DOE 2004
4-Side Mount Freezer without through-the-door ice	541	kWh	DOE 2004
5-Bottom Mount Freezer without through-the-door ice	492	kWh	DOE 2004
6-Top Mount Freezer with through-the-door ice	529	kWh	DOE 2004
7-Side Mount Freezer with through-the-door ice	570	kWh	DOE 2004
Conventional Unit (New Unit)			
Initial cost per unit	$1,070		DOE 2004
Refrigerator Fresh Volume	18	ft^3	DOE 2004
Refrigerator Freezer Volume	5	ft^3	DOE 2004
Adjusted Volume	26.15	ft^3	DOE 2004
Lifetime	13	years	DOE 2004
Annual Unit Energy Consumption			
For Selected Refrigerator Type	1,000	kWh	Calculated.
1-Manual Defrost Refrigerators	479	kWh	DOE 2004
2-Partial Automatic Defrost Refrigerators	479	kWh	DOE 2004
3-Top Mount Freezer without through-the-door ice	1000	kWh	DOE 2004
4-Side Mount Freezer without through-the-door ice	636	kWh	DOE 2004
5-Bottom Mount Freezer without through-the-door ice	579	kWh	DOE 2004
6-Top Mount Freezer with through-the-door ice	623	kWh	DOE 2004
7-Side Mount Freezer with through-the-door ice	670	kWh	DOE 2004
Usage			
Number of operating hours per day	24	hours/day	DOE 2004
Number of operating days per year	365	days/year	DOE 2004
Number of operating hours per year	8,760	hours/year	Calculated.
Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Energy Prices			
2006 Commercial Electricity Price	$ 0.0912	$/kWh	EIA 2006
2006 Residential Electricity Price	$ 0.1008	$/kWh	EIA 2006
Carbon Emissions Factors			
Electricity Carbon Emission Factors	1.535	lbs CO_2/kWh	EPA 2006
CO_2 Equivalents			
Annual CO_2 sequestration per forested acre	8,066	lbs CO_2/year	EPA 2004
Annual CO_2 emissions for "average" passenger car	11,470	lbs CO_2/year	EPA 2004

For more information, please contact Bill McNary, D&R International, Contractor to the U.S. DOE, (301) 588-9387, bmcnary@drintl.com
Calculator last updated: 2/15/05
Constants updated 05/07

Products that earn the ENERGY STAR prevent greenhouse gas emissions by meeting strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and the U.S. Department of Energy.
www.energystar.gov

CHANGE FOR THE BETTER WITH ENERGY STAR

Life Cycle Cost Estimate for 12 ENERGY STAR Qualified Compact Fluoresecent Lamp(s)

This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.

Enter your own values in the gray boxes or use our default values.

Number of units	12
Electricity Rate ($/kWh)	$ 0.101
Hours used per day	3

	ENERGY STAR Qualified Unit	Conventional Unit
Initial cost per unit (estimated retail price)	$3.50	$0.50
Wattage (watts)	15 *	60
Lifetime (hours)	10,000	1,000

**ENERGY STAR wattage is calculated based on the wattage selected for the incandescent unit, user can entire an alternative value if desired*

Annual and Life Cycle Costs and Savings for 12 CFLs

	12 ENERGY STAR Qualified Units	12 Conventional Units	Savings with ENERGY STAR
Annual Operating Costs*			
Energy cost	$20	$79	$60
Energy consumption (kWh)	*194*	*788*	*594*
Maintenance cost	$0	$46	$46
Total	**$20**	**$125**	**$106**
Life Cycle Costs*			
Operating cost (energy and maintenance)	$147	$944	$797
Energy costs (lifetime)	$147	$598	$451
Energy consumption (kWh)	*1,773*	*7,200*	*5,427*
Maintenance costs (lifetime)	$0	$346	$346
Purchase price for 12 unit(s)	$42.00	$6.00	-$36.00
Total	**$189**	**$950**	**$761**
Simple payback of initial additional cost (years)†			**0.3**

** Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount rate of 4%. See "Assumptions" to change factors including the discount rate.*

† A simple payback period of zero years means that the payback is immediate.

Summary of Benefits for 12 CFLs

Initial cost difference	**$36**
Life cycle savings	**$797**
Net life cycle savings (life cycle savings - additional cost)	**$761**
Simple payback of additional cost (years)	**0.3**
Life cycle energy saved (kWh)	**5,427**
Life cycle air pollution reduction (lbs of CO_2)	**8,330**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**0.73**
Air pollution reduction equivalence (acres of forest)	**1.03**
Savings as a percent of retail price	**1812%**

Assumptions for CFLs

Category	Value		Data Source
Power			
ENERGY STAR Qualified Unit			
Initial Cost per Unit	$3.50		Industry Data 2006
Wattage	10	watts	EPA 2007
	15	watts	EPA 2007
	18	watts	EPA 2007
	25	watts	EPA 2007
	37	watts	EPA 2007
Bulb Life	6,000	hours	EPA 2007
	8,000	hours	EPA 2007
	10,000	hours	EPA 2007
	12,000	hours	EPA 2007
Lifetime			
For 6,000 hour CFL	5	years	calculated
For 8,000 hour CFL	7	years	calculated
For 10,000 hour CFL	9	years	calculated
For 12,000 hour CFL	11	years	calculated
Conventional Unit			
Initial Cost per Unit	$0.50		Industry Data 2007
Wattage	40	watts	EPA 2007
	60	watts	EPA 2007
	75	watts	EPA 2007
	100	watts	EPA 2007
	150	watts	EPA 2007
Bulb Life	750	hours	EPA 2007
	1,000	hours	EPA 2007
Lifetime			
For 750 hour incadescent bulb	0.7	years	calculated
For 1,000 hour incadescent bulb	0.9	years	calculated
Maintenance			
Labor cost (per hour)	$20		EPA 2004
Installation labor hours	0.15	hours	Assumption
Usage			
Hours used per day	3	hours/day	EPA 2007
Number of days per year	365	days/year	Assumption
CFL annual bulb replacements			
6,000 hours	0.18	bulbs/year	Calculated
8,000 hours	0.14	bulbs/year	Calculated
10,000 hours	0.11	bulbs/year	Calculated
12,000 hours	0.09	bulbs/year	Calculated
Incandescent annual bulb replacements			
750 hours	1.46	bulbs/year	Calculated
1,000 hours	1.10	bulbs/year	Calculated
Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Energy Prices			
2006 Commercial Electricity Price	0.0912	$/kWh	EPA 2006
2006 Residential Electricity Price	0.1008	$/kWh	EPA 2006
Carbon Emissions Factors			
Electricity Carbon Emission Factors	1.535	lbs CO_2/kWh	EPA 2006
CO_2 Equivalents			
Annual CO_2 sequestration per forested acre	8,066	lbs CO_2/year	EPA 2004
Annual CO_2 emissions for "average" passenger car	11,470	lbs CO_2/year	EPA 2004

For questions or comments, please send your email to: Escalcs@cadmusgroup.com
Constants Update 05/07
Calculator Updated 06/07

Products that earn the ENERGY STAR prevent greenhouse gas emissions by meeting strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and the U.S. Department of Energy.
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CHANGE FOR THE BETTER WITH ENERGY STAR

Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Central Air Conditioner(s)

This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.

Enter your own values in the gray boxes or use our default values.

Choose your city from the menu at right: IL-Chicago

Enter your own values in the gray boxes or use our default values.

Number of units	1
Electric Rate ($/kWh)	$0.113

	ENERGY STAR Qualified Unit	Conventional Unit
Initial Cost per Unit (estimated retail price with installation)**	$3,413	$2,857
Seasonal Energy Efficiency Ratio (SEER) rating	14.0	9.0
Cooling Capacity of Air Conditioner (Btu/hr)	3 ton	3 ton
Use with programmable Thermostat (Yes/No)	Yes	No

Annual and Life Cycle Costs and Savings for 1 Central Air Conditioner(s)

	1 ENERGY STAR Qualified Units	1 Conventional Units	Savings with ENERGY STAR
Annual Operating Costs*			
Energy cost	$166	$308	$142
Energy consumption (kWh)	*1,475*	*2,732*	1,257
Maintenance cost	$0	$0	$0
Total	**$166**	**$308**	**$142**
Life Cycle Costs*			
Operating costs (energy and maintenance)	$1,756	$3,252	$1,496
Energy costs	$1,756	$3,252	$1,496
Maintenance costs	$0	$0	$0
Purchase price for 1 unit(s)	$3,413	$2,857	-$556
Total	**$5,169**	**$6,109**	**$940**
		Simple payback of initial additional cost (years)†	**3.9**

** Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount rate of 4%. See "Assumptions" to change factors including the discount rate.*

† *A simple payback period of zero years means that the payback is immediate.*

Summary of Benefits for 1 Central Air Conditioner(s)

Initial cost difference	**$556**
Life cycle savings	**$1,496**
Net life cycle savings (life cycle savings - additional cost)	**$940**
Simple payback of additional cost (years)	**3.9**
Life cycle energy saved (kWh)	**17,594**
Life cycle air pollution reduction (lbs of CO_2)	**27,095**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**2**
Air pollution reduction equivalence (acres of forest)	**3**
Savings as a percent of retail price	**28%**

Assumptions for Central Air Conditioners			
Category	**Value**		**Data Source**
Power			
ENERGY STAR Qualified Unit			
Initial Cost Per Unit			
2.5 ton	$3,252		DEER Database 2008
3 ton	$3,413		DEER Database 2008
3.5 ton	$3,574		DEER Database 2008
4 ton	$3,735		DEER Database 2008
5 ton	$4,057		DEER Database 2008
Seasonal Energy Efficiency Ratio(SEER) rating	14.5		EPA 2009
Cooling Capacity of Air Conditioner (Btu/hr)	36,000	Btu/hr	Calculated
Lifetime	14	years	EPA 2006
Conventional Unit			
Initial Cost Per Unit			
2.5 ton	$2,696		DEER Database 2008
3 ton	$2,857		DEER Database 2008
3.5 ton	$3,018		DEER Database 2008
4 ton	$3,179		DEER Database 2008
5 ton	$3,501		DEER Database 2008
Seasonal Energy Efficiency Ratio(SEER) rating	13		EPA 2007
Cooling Capacity of Air Conditioner (Btu/hr)	36,000	Btu/hr	Calculated
Lifetime	14	years	EPA 2006
Maintenance			
Labor cost (per hour)	$20		EPA 2004
Labor time (hours)	0		EPA 2004
Usage			
Full-Load Cooling Hours			
Full-Load Cooling Hours for Selected Location	#REF!		ARI Unitary Directory, August 1, 1992 - January 31, 1993
Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Programable Thermostat Discount Rate	16%		LBNL 2007 (Based on minimum estimated savings)
Energy and Water Prices			
Commercial Electricity Price	$0.1030	$/kWh	Energy Information Administration, Annual Energy Outlook 2009 (Early Release) edition. (converted from 2007 to 2008 dollars).
Residential Electricity Price	$0.1127	$/kWh	Energy Information Administration, Annual Energy Outlook 2009 (Early Release) edition. (converted from 2007 to 2008 dollars).
Carbon Dioxide Emissions Factors			
Electricity Carbon Emission Factor	1.54	lbs CO_2/kWh	EPA's Climate Change Action Plan (CCAP) number for 2009.
CO_2 Equivalents			
Annual CO_2 sequestration per forested acre	9,700	lbs CO_2/year	EPA's Greenhouse Gas Equivalencies Calculator. http://www.epa.gov/cleanenergy/energy-resources/calculator.html
Annual CO_2 emissions for "average" passenger car	12,037	lbs CO_2/year	EPA's Greenhouse Gas Equivalencies Calculator. http://www.epa.gov/cleanenergy/energy-resources/calculator.html
Usage			
Full-Load Cooling Hours			
IL-Chicago	683		EPA 2002
IL-Moline	830		EPA 2002
IL-Peoria	948		EPA 2002
IL-Rockford	714		EPA 2002
IL-Springfield	1,036		EPA 2002
For questions or comments, please send your email to:	Escalcs@cadmusgroup.com		
Calculator last updated: 04/09			

Products that earn the ENERGY STAR prevent greenhouse gas emissions by meeting strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and the U.S. Department of Energy.
www.energystar.gov

CHANGE FOR THE BETTER WITH ENERGY STAR

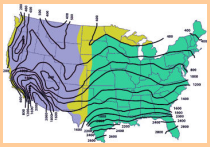
Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Central Air Conditioner(s)

This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.

Enter your own values in the gray box using the map.

Full-Load Cooling Hours for Selected Location	600

Follow the link and click on your location to display your cooling load hours, enter this value in the box on the left.



Enter your own values in the gray boxes or use our default values.

Number of units	1
Electric Rate ($/kWh)	$0.101

	ENERGY STAR Qualified Unit	Conventional Unit
Initial Cost per Unit (estimated retail price with installation)	$3,800	$3,300
Seasonal Energy Efficiency Ratio (SEER) rating	16	9
Cooling Capacity of Air Conditioner (Btu/hr)	24,000	36,000
Use with programmable Thermostat (Yes/No)	Yes	No

Annual and Life Cycle Costs and Savings for 1 Central Air Conditioner(s)

	1 ENERGY STAR Qualified Units	1 Conventional Units	Savings with ENERGY STAR
Annual Operating Costs*			
Energy cost	$76	$242	$166
Energy consumption (kWh)	*756*	*2,400*	1,644
Maintenance cost	$0	$0	$0
Total	**$76**	**$242**	**$166**
Life Cycle Costs*			
Operating costs (energy and maintenance)	$805	$2,555	$1,750
Energy costs	$805	$2,555	$1,750
Energy consumption (kWh)	*10,584*	*33,600*	*23,016*
Maintenance costs	$0	$0	$0
Purchase price for 1 unit(s)	$3,800	$3,300	-$500
Total	**$4,605**	**$5,855**	**$1,250**
		Simple payback of initial additional cost (years)†	**3.0**

** Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount rate of 4%. See "Assumptions" to change factors including the discount rate.*

† *A simple payback period of zero years means that the payback is immediate.*

Summary of Benefits for 1 Central Air Conditioner(s)

Initial cost difference	**$500**
Life cycle savings	**$1,750**
Net life cycle savings (life cycle savings - additional cost)	**$1,250**
Simple payback of additional cost (years)	**3.0**
Life cycle energy saved (kWh)	**23,016**
Life cycle air pollution reduction (lbs of CO_2)	**35,330**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**3**
Air pollution reduction equivalence (acres of forest)	**4**
Savings as a percent of retail price	**33%**

Assumptions for Central Air Conditioners			
Category	**Value**		**Data Source**
Power			
ENERGY STAR Qualified Unit			
Initial Cost Per Unit	$3,800		Industry Data 2007
Seasonal Energy Efficiency Ratio(SEER) rating	14		EPA 2007
Cooling Capacity of Air Conditioner (Btu/hr)	36,000	Btu/hr	EPA 2004
Use with programmable Thermostat (Yes/No)	No		Cadmus Assumption 05-07
Lifetime	14	years	EPA 2006
Conventional Unit			
Initial Cost Per Unit	$3,300		Industry Data 2007
Seasonal Energy Efficiency Ratio(SEER) rating	9		EPA 2007
Cooling Capacity of Air Conditioner (Btu/hr)	36,000	Btu/hr	EPA 2004
Use with programmable Thermostat (Yes/No)	No		EPA 2004
Lifetime	14	years	EPA 2006
Maintenance			
Labor cost (per hour)	$20		EPA 2004
Labor time (hours)	0		EPA 2004
Usage			
Full-Load Cooling Hours			
Full-Load Cooling Hours for Selected Location	600		ARI Unitary Directory, August 1, 1992 - January 31, 1993
Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Programable Thermostat Discount Rate	16%		LBNL 2005 (Based on minimum estimated savings)
Energy and Water Prices			
Commercial Electricity Price	$0.0912	$/kWh	EIA 2006
Residential Electricity Price	$0.1008	$/kWh	EIA 2006
Carbon Dioxide Emissions Factors			
Electricity Carbon Emission Factor	1.535	lbs CO_2/kWh	EPA 2006
CO_2 Equivalents			
Annual CO_2 sequestration per forested acre	8,066	lbs CO_2/year	EPA 2006
Annual CO_2 emissions for "average" passenger car	11,470	lbs CO_2/year	EPA 2006
For questions or comments, please send your email to Escalcs@cadmusgroup.com			
Calculator last updated: 6/07			
Constants updated 05/07			

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CHANGE FOR THE BETTER WITH ENERGY STAR

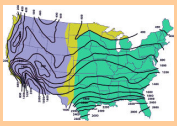
Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Room Air Conditioner(s)

This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.

Enter your own value in the gray box using the map.

Full-Load Cooling Hours for Selected Location	600

Follow the link and click on your location to display your cooling load hours, enter this value in the box on



Enter your own values in the gray boxes or use our default values.

Number of units	1
Electricity Rate ($/kWh)	$0.101
Cooling Capacity of Air Conditioner (Btu/hr)	8,000 - 13,999

	ENERGY STAR	Conventional Unit
Initial Cost per Unit (estimated retail price)	$300	$300
Energy Efficiency Ratio (EER)	11.5	8.8

Annual and Life Cycle Costs and Savings for 1 Room Air Conditioner(s)

	1 ENERGY STAR	1 Conventional	Savings with
Annual Operating Costs*			
Energy cost	$58	$76	$18
Energy consumption (kWh)	*574*	*750*	*176*
Maintenance cost	$0	$0	$0
Total	**$58**	**$76**	**$18**
Life Cycle Costs*			
Operating costs (energy and maintenance)	$578	$755	$177
Energy costs	$578	$755	$177
Energy consumption (kWh)	*7,461*	*9,750*	*2,289*
Maintenance costs	$0	$0	$0
Purchase price for 1 unit(s)	$300	$300	$0
Total	**$878**	**$1,055**	**$177**
Simple payback of initial additional cost (years)†			**0.0**

* *Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount rate of 4%. See "Assumptions" to change factors including the discount rate.*

† *A simple payback period of zero years means that the payback is immediate.*

Summary of Benefits for 1 Room Air Conditioner(s)

Initial cost difference	**$0**
Life cycle savings	**$177**
Net life cycle savings (life cycle savings - additional cost)	**$177**
Simple payback of additional cost (years)	**0.0**
Life cycle energy saved (kWh)	**2,289**
Life cycle air pollution reduction (lbs of CO_2)	**3,514**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**0**
Air pollution reduction equivalence (acres of forest)	**0**
Savings as a percent of retail price	**59%**

Assumptions for Room Air Conditioners

Category	Value		Data Source
Power			
ENERGY STAR Qualified Unit			
Initial Cost Per Unit	$300		Industry Data 2006
Energy Efficiency Ratio (EER)			
< 6000	10.7		DOE 2005
6,000 - 10000	10.8		DOE 2005
14,000 - 19,999	10.7		DOE 2005
≥ 20000	9.4		DOE 2005
Cooling Capacity of Air Conditioner (Btu/hr)	≤ 7,999	Btu/hr	DOE 2005
Cooling Capacity of Air Conditioner (Btu/hr)	8,000 - 13,999	Btu/hr	DOE 2005
Cooling Capacity of Air Conditioner (Btu/hr)	14,000 - 19,999	Btu/hr	DOE 2005
Cooling Capacity of Air Conditioner (Btu/hr)	≥ 20000	Btu/hr	DOE 2005
Lifetime	13	years	EPA 2006
Conventional Unit (Manufactured After 1994)			
Initial Cost Per Unit	$300		Industry Data 2006
Energy Efficiency Ratio (EER)			
< 6000	9.7		DOE 2005
10,000	9.8		DOE 2005
14,000 - 19,999	7.7		DOE 2005
≥ 20000	8.5		DOE 2005
Cooling Capacity of Air Conditioner (Btu/hr)	≤ 7,999	Btu/hr	DOE 2005
Cooling Capacity of Air Conditioner (Btu/hr)	8,000 - 13,999	Btu/hr	DOE 2005
Cooling Capacity of Air Conditioner (Btu/hr)	14,000 - 19,999	Btu/hr	DOE 2005
Cooling Capacity of Air Conditioner (Btu/hr)	≥ 20000	Btu/hr	DOE 2005
Lifetime	13	years	EPA 2006
Maintenance			
Labor cost (per hour)	$20		EPA 2004
Labor time (hours)	0		EPA 2004
Usage			
Full-Load Cooling Hours			
Full-Load Cooling Hours for Selected Location	600		ARI Unitary Directory, August 1, 1992 - January 31, 1993
Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Energy Prices			
Commercial Electricity Price	$0.0912	$/kWh	EIA 2006
Residential Electricity Price	$0.1008	$/kWh	EIA 2006
Carbon Dioxide Emissions Factors			
Electricity Carbon Emission Factor	1.535	lbs CO_2/kWh	EPA 2006
CO_2 Equivalents			
Annual CO_2 sequestration per forested acre	8,066	lbs CO_2/year	EPA 2006
Annual CO_2 emissions for "average" passenger car	11,470	lbs CO_2/year	EPA 2006

For questions or comments, please send your email to:	Escalcs@cadmusgroup.com	
Constants updated: 5/07		
Last updated: 7/07		

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CHANGE FOR THE BETTER WITH ENERGY STAR

Life Cycle Cost Estimate for 10 ENERGY STAR Qualified Lighting Fixture(s)

This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.

Enter your own values in the gray boxes or use our default values.

		ENERGY STAR Unit Cost	Conventional Unit Cost
Electricity Rate ($/kWh)	$0.101		
Indoor Lighting Fixtures	8	$65.00	$40.00
Outdoor Lighting Fixtures	2	$40.00	$40.00

Annual and Life Cycle Costs and Savings for 10 Light Fixture(s)

	10 ENERGY STAR Qualified Unit(s)	10 Conventional Unit(s)	Savings with ENERGY STAR
Annual Operating Costs*			
Energy cost	$42	$109	$67
Maintenance cost	$0	$0	$0
Total	**$42**	**$109**	**$67**
Life Cycle Costs*			
Life cycle operating cost (energy + maintenance)	$575	$1,479	$904
Purchase price for 10 unit(s)	$600	$400	-$200
Total	**$1,175**	**$1,879**	**$704**
		Simple payback of initial additional cost (years)†	**3.0**

** Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount rate of 4%. See "Assumptions" to change factors including the discount rate.*

† A simple payback period of zero years means that the payback is immediate.

Summary of Benefits for 10 Light Fixture(s)

Initial cost difference	**$200**
Life cycle savings	**$904**
Net life cycle savings (life cycle savings - additional cost)	**$704**
Simple payback of additional cost (years)	**3.0**
Life cycle energy saved (kWh)	**13,200**
Life cycle air pollution reduction (lbs of CO_2)	**20,262**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**1.77**
Air pollution reduction equivalence (acres of forest)	**2.51**
Savings as a percent of retail price	**176%**

Assumptions for Residential Lighting Fixtures			
Category	**Value**		**Data Source**
Power			
ENERGY STAR Qualified Unit			
Indoor Lighting Fixtures unit energy consumption			
High use (3+ hr/day)	35	kWh/yr	EPA 2007
Initial Cost	$65.00		Industry Data 2007
Outdoor Lighting Fixtures unit energy consumption	70	kWh/yr	EPA 2007
Initial Cost	$40.00		Industry Data 2007
Conventional Unit			
Indoor Lighting Fixtures unit energy consumption			
High use (3+ hr/day)	100	kWh/yr	EPA 2007
Initial Cost	$40.00		Industry Data 2007
Outdoor Lighting Fixtures unit energy consumption	140	kWh/yr	EPA 2007
Initial Cost	$40.00		Industry Data 2007
Usage			
Fixture Lifetime	20	years	EPA 2007
Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Energy Prices			
Commercial Electricity Price	0.0912	$/kWh	EIA 2006
Residential Electricity Price	0.1008	$/kWh	EIA 2006
Carbon Emissions Factors			
Electricity Carbon Emission Factor	1.535	lbs CO_2/kWh	EPA 2006
CO_2 Equivalents			
Annual CO_2 sequestration per forested acre	8,066	lbs CO_2/year	EIA 2004
Annual CO_2 emissions for "average" passenger car	11,470	lbs CO_2/year	EIA 2004

Last updated: 7/07
Constants updated: 5/07
If you have any questions, please contact: ESCalcs@cadmusgroup.com.

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CHANGE FOR THE BETTER WITH ENERGY STAR

Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Dishwasher(s)

This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.

Enter your own values in the gray boxes or use our default values.

Number of units	1
Electric Rate ($/kWh)	$0.101
Water Rate ($/1000 gallons)	$4.158
Gas Rate ($/therm)	$0.880
Number of Cycles (Loads) per Week	7
Type of Water Heating	Gas Water Heating

	ENERGY STAR Qualified Unit	Conventional Unit
Initial Cost per Unit (estimated retail price)	$545	$645
Energy Factor (EF)	0.65	0.46
Unit Electricity Consumption (kWh/year)	149	211
Unit Water Consumption (gal/year)	1,456	2,184

Annual and Life Cycle Costs and Savings for 1 Dishwasher(s)

	1 ENERGY STAR Qualified Unit(s)	1 Conventional Unit(s)	Savings with ENERGY STAR
Annual Operating Costs*			
Electricity cost	$15	$21	$6
Electricity consumption (kWh)	*149*	*211*	*2*
Water cost	$6	$9	$3
Water consumption (gal)	*1,456*	*2,184*	*728*
Gas cost	$20	$28	$8
Gas consumption (therm)	*23*	*32*	*9*
Maintenance cost	$0	$0	$0
Total	**$41**	**$59**	**$18**
Life Cycle Costs*			
Operating costs (electricity, water, and maintenance)	$361	$515	$154
Electricity costs	$132	$186	$55
Water costs	$53	$80	$27
Gas costs	$176	$249	$73
Maintenance costs	$0	$0	$0
Purchase price for 1 unit(s)	$545	$645	$100
Total	**$906**	**$1,160**	**$254**
Simple payback of initial additional cost (years)†			**0.0**

** Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount rate of 4%. See "Assumptions" to change factors including the discount rate.*

† A simple payback period of zero years means that the payback is immediate.

Summary of Benefits for 1 Dishwasher(s)

Initial cost difference	**-$100**
Life cycle savings	**$154**
Net life cycle savings (life cycle savings - additional cost)	**$254**
Simple payback of additional cost (years)	**0.0**
Life cycle electricity saved (kWh)	**681**
Life cycle air pollution reduction (lbs of CO_2)	**1,045**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**0**
Air pollution reduction equivalence (acres of forest)	**0**
Savings as a percent of retail price	**47%**

Assumptions for Dishwashers			
Category	**Value**		**Data Source**
Power & Water			
ENERGY STAR Qualified Unit			
Initial Cost Per Unit	$545		Industry Research 2007
Energy Factor	0.65		DOE 2007
Lifetime	11	years	DOE 2007
Water Consumption per Cycle	4	gallons/cy	DOE 2007
Annual Unit Water Consumption	1,456	gallons/yr	Calculated
Electric Water Heating			
Electricity Consumption per Cycle	1.54	kWh/Cycle	Calculated
Unit Electricity Consumption (UEC)	560	kWh/yr	Calculated
Gas Water Heating			
Percent improvement	0		Calculated
Electricity Consumption per Cycle	0.41	kWh/cy	EPA 2006
Unit Electricity Consumption	149	kWh/yr	Calculated
Gas Consumption per Cycle	0.063	Therms/cy	EPA 2006
Unit Gas Consumption	23	Therms/yr	Calculated
Conventional Unit			
Initial Cost Per Unit	$545		Assume same price as ENE
Energy Factor	0.46		DOE 2007
Lifetime	11	years	DOE 2007
Water Consumption per Cycle	6	gallons/cy	DOE 2007
Annual Unit Water Consumption	2,184	gallons/yr	Calculated
Electric Water Heating			
Electric Consumption per Cycle	2.17	kWh/Cycle	Calculated
Unit Electricity Consumption	791	kWh	Calculated
Gas Water Heating			
Percent improvement	0		Calculated
Electric Consumption per Cycle	0.58	kWh/Cycle	EPA 2006
Unit Electricity Consumption	211	kWh	Calculated
Gas Consumption per Cycle	0.089	Therms/Cycle	EPA 2006
Unit Gas Consumption	32	Therms	Calculated
Maintenance			
Labor cost (per hour)	$20		EPA 2004
Labor time (hours)	0		EPA 2004
Usage			
Average number of cycles per year (CPY)	364	Cycles/year	Calculated
Number of Cycles per week (CPW)	4	Cycles/week	EPA 2006
Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Energy and Water Prices			
Commercial Electricity Price	$0.091	$/kWh	EIA 2006
Residential Electricity Price	$0.101	$/kWh	EIA 2006
Water Rate per 1000 Gallons	$4.158	$/1000 gal	DOE 2004
Commercial Gas Price	$1.07	$/therm	EIA 2006
Residential Gas Price	$1.25	$/therm	EIA 2006
Carbon Dioxide Emissions Factors			
Electricity Carbon Emission Factors	1.535	lbs CO_2/kWh	EPA 2006
Carbon Dioxide Equivalents			
Annual CO_2 sequestration per forested acre	8,066	lbs CO_2/year	EPA 2004
Annual CO_2 emissions for "average" passenger car	11,470	lbs CO_2/year	EPA 2004
For questions or comments, please send your email to Escalcs@cadmusgroup.com			
Last updated: 8/07			

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CHANGE FOR THE BETTER WITH ENERGY STAR

Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Central Air Conditioner(s)

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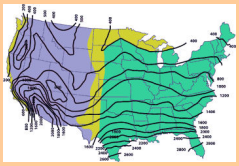
Enter your own values in the gray box using the map.

Full-Load Cooling Hours for Selected Location	600

Follow the link and click on your location to display your cooling load hours, enter this value in the box on the left.



Enter your own values in the gray boxes or use our default values.

Number of units	1
Electric Rate ($/kWh)	$0.101

	ENERGY STAR Qualified Unit	Conventional Unit
Initial Cost per Unit (estimated retail price with installation)	$3,500	$3,300
Seasonal Energy Efficiency Ratio (SEER) rating	14	13
Cooling Capacity of Air Conditioner (Btu/hr)	36,000	36,000
Use with programmable Thermostat (Yes/No)	Yes	No

Annual and Life Cycle Costs and Savings for 1 Central Air Conditioner(s)

	1 ENERGY STAR Qualified Units	1 Conventional Units	Savings with ENERGY STAR
Annual Operating Costs*			
Energy cost	$131	$167	$37
Energy consumption (kWh)	*1,296*	*1,662*	366
Maintenance cost	$0	$0	$0
Total	**$131**	**$167**	**$37**
Life Cycle Costs*			
Operating costs (energy and maintenance)	$1,380	$1,769	$389
Energy costs	$1,380	$1,769	$389
Energy consumption (kWh)	*18,144*	*23,262*	*5,118*
Maintenance costs	$0	$0	$0
Purchase price for 1 unit(s)	$3,500	$3,300	-$200
Total	**$4,880**	**$5,069**	**$189**
		Simple payback of initial additional cost (years)†	**5.4**

** Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount rate of 4%. See "Assumptions" to change factors including the discount rate.*

† *A simple payback period of zero years means that the payback is immediate.*

Assumptions for Central Air Conditioners			
Category	**Value**		**Data Source**
Power			
ENERGY STAR Qualified Unit			
Initial Cost Per Unit	$3,500		Industry Data 2007
Seasonal Energy Efficiency Ratio(SEER) rating	14		EPA 2007
Cooling Capacity of Air Conditioner (Btu/hr)	36,000	Btu/hr	EPA 2004
Use with programmable Thermostat (Yes/No)	No		Cadmus Assumption 05-07
Lifetime	14	years	EPA 2006
Conventional Unit			
Initial Cost Per Unit	$3,300		Industry Data 2007
Seasonal Energy Efficiency Ratio(SEER) rating	13		EPA 2007
Cooling Capacity of Air Conditioner (Btu/hr)	36,000	Btu/hr	EPA 2004
Use with programmable Thermostat (Yes/No)	No		EPA 2004
Lifetime	14	years	EPA 2006
Maintenance			
Labor cost (per hour)	$20		EPA 2004
Labor time (hours)	0		EPA 2004
Usage			
Full-Load Cooling Hours			
Full-Load Cooling Hours for Selected Location	600		ARI Unitary Directory, August 1, 1992 - January 31, 1993
Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Programable Thermostat Discount Rate	16%		LBNL 2005 (Based on minimum estimated savings)
Energy and Water Prices			
Commercial Electricity Price	$0.0912	$/kWh	EIA 2006
Residential Electricity Price	$0.1008	$/kWh	EIA 2006
Carbon Dioxide Emissions Factors			
Electricity Carbon Emission Factor	1.535	lbs CO_2/kWh	EPA 2006
CO_2 Equivalents			
Annual CO_2 sequestration per forested acre	8,066	lbs CO_2/year	EPA 2006
Annual CO_2 emissions for "average" passenger car	11,470	lbs CO_2/year	EPA 2006
For questions or comments, please send your email to Escalcs@cadmusgroup.com			
Calculator last updated: 6/07			
Constants updated 05/07			

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CHANGE FOR THE BETTER WITH ENERGY STAR

Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Ceiling Fan(s) with Lighting

This energy savings calculator was developed by the U.S. EPA and U.S. DOE and is provided for estimating purposes only. Actual energy savings may vary based on use and other factors.

Enter your own values in the gray boxes or use our default values.

Number of units	1
Electricity Rate ($/kWh)	$0.103
Percent of Time Spent at Low Speed	40%
Percent of Time Spent at Medium Speed	40%
Percent of Time Spent at High Speed	20%
Choose your location from the drop-down menu	East North Central

	ENERGY STAR Qualified Unit	Conventional Unit
Initial Cost per Unit (estimated retail price)	$276	$190
Cost per Replacement Bulb	$3.50	$0.50
Number of Bulbs per Fixture	3	3
Wattage per Bulb	20	60

Annual and Life Cycle Costs and Savings for 1 Ceiling Fan(s) with Lighting

	1 ENERGY STAR Qualified Unit(s)	1 Conventional Unit(s)	Savings with ENERGY STAR
Annual Operating Costs*			
Energy cost	$11	$27	$16
Maintenance cost	$2	$13	$11
Total	**$14**	**$41**	**$27**
Life Cycle Costs*			
Operating costs (energy and maintenance)	$111	$330	$219
Energy cost	$91	$222	$131
Maintenance cost	$20	$109	$89
Purchase price for 1 unit(s)	$276	$190	-$86
Total	**$387**	**$520**	**$133**
Simple payback of initial additional cost (years)†			**3.2**

** Annual costs exclude the initial purchase price. All costs, except initial cost, are discounted over the products' lifetime using a real discount rate of 4%. See "Assumptions" to change factors including the discount rate.*

† A simple payback period of zero years means that the payback is immediate.

Summary of Benefits for 1 Ceiling Fan(s) with Lighting

Initial cost difference	**$86**
Life cycle savings	**$219**
Net life cycle savings (life cycle savings - additional cost)	**$133**
Simple payback of additional cost (years)	**3.2**
Life cycle energy saved (kWh)	**1,563**
Life cycle air pollution reduction (lbs of CO_2)	**2,408**
Air pollution reduction equivalence (number of cars removed from the road for a year)	**0.2**
Air pollution reduction equivalence (acres of forest)	**0.2**
Savings as a percent of retail price	**48%**

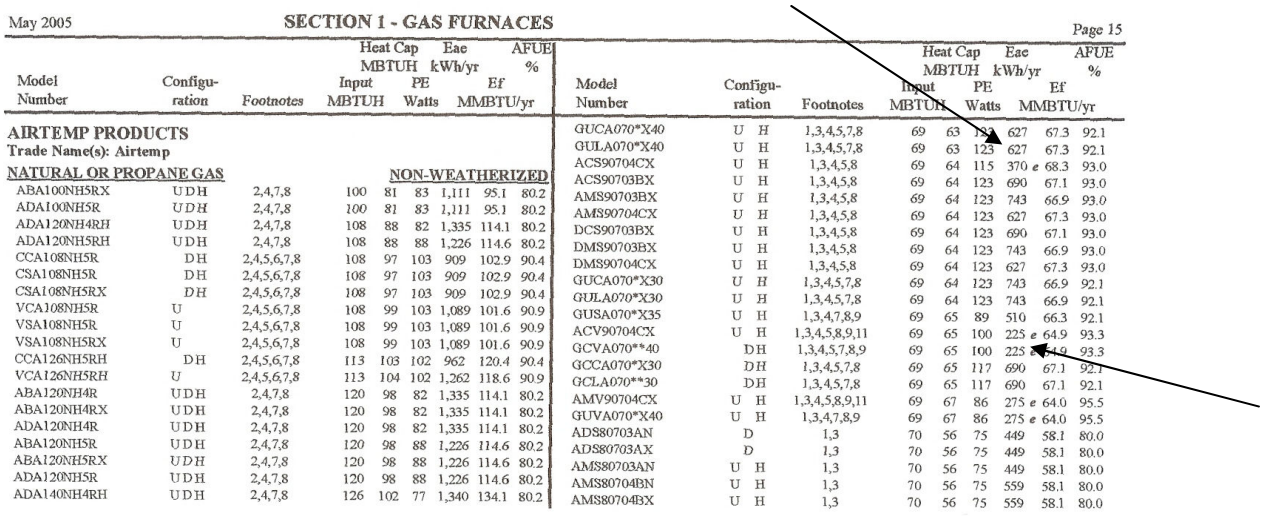
Assumptions for Ceiling Fans with Lighting			
Category	**Value**		**Data Source**
Power			
ENERGY STAR Qualified Unit			
Initial Cost Per Unit	$276		Industry Data 2007
Power			
Ceiling Fan Wattage			
Low Speed	11.7	watts	LBNL 2007
Medium Speed	31.4	watts	LBNL 2007
High Speed	71.5	watts	LBNL 2007
Bulb Wattage	20	watts	LBNL 2007
Lighting Wattage per Selected Fixture	60	watts	Calculated
Lifetime			
Fan	10	years	LBNL 2007
Bulb	10,000	hours	LBNL 2007
Number of Bulbs per Fixture	3	bulbs	Assumption
Number of Bulbs Replaced Annually per Selected Fixture	0.4	bulbs	Calculated
Cost per Replacement Bulb	$3.50		Industry Data 2007
Annual Bulb Replacement Cost per Selected Fixture	$1.34		Calculated
Conventional Unit			
Initial Cost Per Unit	$190		Industry Data 2007
Power			
Ceiling Fan Wattage			
Low Speed	15.2	watts	LBNL 2007
Medium Speed	34.8	watts	LBNL 2007
High Speed	72.5	watts	LBNL 2007
Bulb Wattage	60	watts	LBNL 2007
Lighting Wattage for Selected Fixture	180	watts	Calculated
Lifetime			
Fan	10	years	LBNL 2007
Bulb	1,000	hours	LBNL 2007
Number of Bulbs per Fixture	3	bulbs	Assumption. Assumed to have the same number of bulbs as the ENERGY STAR qualified fixture.
Number of Bulbs Replaced Annually per Selected Fixture	3.8	bulbs	Calculated
Cost per Replacement Bulb	$0.50		Industry Data 2007
Annual Bulb Replacement Cost per Selected Fixture	$1.92		Calculated
Maintenance			
Labor cost (per hour)	$20		EPA 2004
Labor time (hours)	0.15		Assumption
Usage			
Days Used per Year	365	days/year	Assumption.
Percent of Time Spent at Low Speed	40%		LBNL 2007
Percent of Time Spent at Medium Speed	40%		LBNL 2007
Percent of Time Spent at High Speed	20%		LBNL 2007
Daily Fan and Lighting "On Hours"	Fan	Light	
For Selected Location	2.8	3.5	LBNL 2007
National Average	6.2	3.3	LBNL 2007
New England	1.6	4.0	LBNL 2007
Mid Atlantic	3.2	3.5	LBNL 2007
South Atlantic	9.6	3.0	LBNL 2007
East North Central	2.8	3.5	LBNL 2007
East South Central	8.0	3.0	LBNL 2007
West North Central	4.0	4.0	LBNL 2007
West South Central	8.8	3.0	LBNL 2007
Mountain	5.6	3.5	LBNL 2007
Pacific	2.8	4.0	LBNL 2007

Discount Rate			
Commercial and Residential Discount Rate (real)	4%		A real discount rate of 4 percent is assumed, which is roughly equivalent to the nominal discount rate of 7 percent (4 percent real discount rate + 3 percent inflation rate).
Energy and Water Prices			
Commercial Electricity Price	$0.1030	$/kWh	Energy Information Administration, Annual Energy Outlook 2009 (Early Release) edition. (converted from 2007 to 2008 dollars).
Residential Electricity Price	$0.1127	$/kWh	Energy Information Administration, Annual Energy Outlook 2009 (Early Release) edition. (converted from 2007 to 2008 dollars).
Carbon Dioxide Emissions Factors			
Electricity Carbon Emission Factors	1.54	lbs CO_2/kWh	Energy Information Administration, Annual Energy Outlook 2009 (Early Release) edition. (converted from 2007 to 2008 dollars).
CO_2 Equivalents			
Annual CO_2 sequestration per forested acre	9,700	lbs CO_2/acre-yr	EPA's Greenhouse Gas Equivalencies Calculator. http://www.epa.gov/cleanenergy/energy-resources/calculator.html
Annual CO_2 emissions for "average" passenger car	12,037	lbs CO_2/acre-yr	EPA's Greenhouse Gas Equivalencies Calculator. http://www.epa.gov/cleanenergy/energy-resources/calculator.html
For questions or comments, please send your email to:	Escalcs@cadmusgroup.com		
Calculator last updated: 04/09			

5.3 Other Measure sources

5.4 Furnace Data from Gas Appliance Manufacturers Association (GAMA)

This data was used for the ex ante estimate of savings.



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Model Number	Configuration	Footnotes	Heat Cap MBTUH Input MBTUH	Eae kWh/yr PE Watts	AFUE % Ef MMBTU/yr	
AIRTEMP PRODUCTS						
Trade Name(s): Airtemp						
NATURAL OR PROPANE GAS					**NON-WEATHERIZED**	
ABA100NH5RX	U D H	2,4,7,8	100	81 83 1,111	95.1	80.2
ADA100NH5R	U D H	2,4,7,8	100	81 83 1,111	95.1	80.2
ADA120NH4RH	U D H	2,4,7,8	108	88 82 1,335	114.1	80.2
ADA120NH5RH	U D H	2,4,7,8	108	88 88 1,226	114.6	80.2
CCA108NH5R	D H	2,4,5,6,7,8	108	97 103 909	102.9	90.4
CSA108NH5R	D H	2,4,5,6,7,8	108	97 103 909	102.9	90.4
CSA108NH5RX	D H	2,4,5,6,7,8	108	97 103 909	102.9	90.4
VCA108NH5R	U	2,4,5,6,7,8	108	99 103 1,089	101.6	90.9
VSA108NH5R	U	2,4,5,6,7,8	108	99 103 1,089	101.6	90.9
VSA108NH5RX	U	2,4,5,6,7,8	108	99 103 1,089	101.6	90.9
CCA126NH5RH	D H	2,4,5,6,7,8	113	103 102 962	120.4	90.4
VCA126NH5RH	U	2,4,5,6,7,8	113	104 102 1,262	118.6	90.9
ABA120NH4R	U D H	2,4,7,8	120	98 82 1,335	114.1	80.2
ABA120NH4RX	U D H	2,4,7,8	120	98 82 1,335	114.1	80.2
ADA120NH4R	U D H	2,4,7,8	120	98 82 1,335	114.1	80.2
ABA120NH5R	U D H	2,4,7,8	120	98 88 1,226	114.6	80.2
ABA120NH5RX	U D H	2,4,7,8	120	98 88 1,226	114.6	80.2
ADA120NH5R	U D H	2,4,7,8	120	98 88 1,226	114.6	80.2
ADA140NH4RH	U D H	2,4,7,8	126	102 77 1,340	134.1	80.2

Model Number	Configuration	Footnotes	Heat Cap MBTUH Input MBTUH	Eae kWh/yr PE Watts	AFUE % Ef MMBTU/yr	
GUCA070*X40	U H	1,3,4,5,7,8	69	63 123	627	67.3 92.1
GULA070*X40	U H	1,3,4,5,7,8	69	63 123	627	67.3 92.1
ACS90704CX	U H	1,3,4,5,8	69	64 115	370 e	68.3 93.0
ACS90703BX	U H	1,3,4,5,8	69	64 123	690	67.1 93.0
AMS90703BX	U H	1,3,4,5,8	69	64 123	743	66.9 93.0
AMS90704CX	U H	1,3,4,5,8	69	64 123	627	67.3 93.0
DCS90703BX	U H	1,3,4,5,8	69	64 123	690	67.1 93.0
DMS90703BX	U H	1,3,4,5,8	69	64 123	743	66.9 93.0
DMS90704CX	U H	1,3,4,5,8	69	64 123	627	67.3 93.0
GUCA070*X30	U H	1,3,4,5,7,8	69	64 123	743	66.9 92.1
GULA070*X30	U H	1,3,4,5,7,8	69	64 123	743	66.9 92.1
GUSA070*X35	U H	1,3,4,7,8,9	69	65 89	510	66.3 92.1
ACV90704CX	U H	1,3,4,5,8,9,11	69	65 100	225 e	64.9 93.3
GCVA070**40	D H	1,3,4,5,7,8,9	69	65 100	225 e	64.9 93.3
GCCA070*X30	D H	1,3,4,5,7,8	69	65 117	690	67.1 92.1
GCLA070**30	D H	1,3,4,5,7,8	69	65 117	690	67.1 92.1
AMV90704CX	U H	1,3,4,5,8,9,11	69	67 86	275 e	64.0 95.5
GUVA070*X40	U H	1,3,4,7,8,9	69	67 86	275 e	64.0 95.5
ADS80703AN	D	1,3	70	56 75	449	58.1 80.0
ADS80703AX	D	1,3	70	56 75	449	58.1 80.0
AMS80703AN	U H	1,3	70	56 75	449	58.1 80.0
AMS80704BN	U H	1,3	70	56 75	559	58.1 80.0
AMS80704BX	U H	1,3	70	56 75	559	58.1 80.0

Ceiling Fan savings estimates from EVT TRM User Manual No. 2009-54

Ceiling Fan with ENERGY STAR Light Fixture

Measure Number: IV-F-1-b (Efficient Products Program, Ceiling Fan End Use)
Version Date & Revision History
Draft date: Portfolio No. 29
Effective date: 1/1/04
End date: TBD
Referenced Documents: a) ceilingfans.xls; b) Calwell and Horwitz (2001). "Ceiling Fans: Fulfilling the Energy Efficiency Promise". *Home Energy*. Jan/Feb. c) Caldwell and Horowitz. Unpublished memo circulated through CEE.

Description
This measure described energy savings associated with the use of integrated or attachable ENERGY STAR lighting fixture to an interior residential ceiling fan. If equipped with a light kit, then either fitted with an ENERGY STAR rated fixture or included with ENERGY STAR bulbs equal to the number of light sockets, as well as have separate fan and light switching. Energy savings are claimed only for the kWh savings attributable to lighting.

Algorithms

Energy Savings
From lighting:
$\Delta kWh = 180\ kWh$[386]

Demand Savings
From lighting:
$\Delta kW = 0.145$[387]

Where:
ΔkWh = gross customer annual kWh savings for the measure
ΔkW = gross customer connected load kW savings for the measure

Baseline Efficiencies – New or Replacement
The baseline condition for fans with light kits assumes four sockets fitted with 60 watt incandescent bulbs. Based on information from manufacturer data and the Horowitz/Calwell article in the Jan/Feb 2001 issue of Home Energy magazine.

High Efficiency
Energy Star fans with light kits assumes 2-D or circline Energy Star lamp totaling 60 watts. Conditions are based on information from manufacturer data and the Horowitz/Calwell article in the Jan/Feb 2001 issue of Home Energy magazine.

Operating Hours
Lighting: 1241 hours / year

Loadshape
Residential: Loadshape, #1 - Residential Indoor Lighting

Persistence
The persistence factor is assumed to be one.

Lifetimes
20 years, equivalent to the EVT estimate for lifetime of interior fluorescent fixture.
Analysis period is the same as the lifetime.

Measure Cost
The incremental cost for this measure is $50[388].

Incentive Level
The incentive level for this measure is $15.

O&M Cost Adjustments
There is an annual savings of $12.48 related to operation and maintenance cost adjustment for this measure.

Fossil Fuel Descriptions
There are no fossil-fuel algorithms or default values for this measure.

Water Descriptions

There are no water algorithms or default values for this measure.