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Department of Commerce and Economic Opportunity

Energy Efficient Affordable Housing Construction

Program Year 2 Evaluation Report

Presented to

Illinois Department of Commerce and Economic Opportunity

Commonwealth Edison Company

Ameren Illinois Utilities

March 1, 2011

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Section E. Executive Summary

The Illinois Department of Commerce and Economic Opportunity (DCEO) provides grants to non-profit and for-profit affordable housing developers to help offset additional costs for including energy efficient building practices in residential new construction and gut rehab. Supported by funding from a variety of sources, including the Illinois Energy Efficiency Trust Fund and the Energy Efficiency Portfolio Standard Fund, grants are funded through the Energy Efficient Affordable Housing Construction Program (EEAHC). The EEAHC program funds low income new construction and gut rehab projects.

The Program is well known and utilized in the affordable housing field. The EEAHC program has been providing grants for energy efficient upgrades since 1988. Groups such as the Illinois Housing Development Authority, Chicago Department of Housing, and the Community Investment Corporation, as well as project architects, encourage affordable housing developers to seek energy grants from this program.

Program applicants implement measures from the following list:

- Energy Star® refrigerator
- Interior and exterior fluorescent fixtures
- Efficient central air conditioner or heat pump (minimum 14 SEER)
- Thermal envelope improvements resulting in a reduction in required central AC or heat pump capacity
- Energy Star dishwasher
- Energy Star clothes washer
- Energy Star rated bathroom exhaust fan
- 90% AFUE furnace with efficient air handler
- Energy Star ceiling fan with lighting

E.1 Evaluation Objectives

The objectives of the PY2 Evaluation are to summarize and verify program impact and to provide recommendations to improve impact estimates and to maintain consistency with building codes and standards. The evaluation also intends to provide a comprehensive assessment of developments in program implementation, program standards, and tracking

systems, with a focus on the relationship of those elements to verifiable impact. The intent behind the PY2 evaluation is to:

- Document program accomplishments for PY2
- Continue to provide feedback and guidance regarding program tracking and verification policies,
- Update the PY1 review of program measures impact assumptions to incorporate newly available information and relevant changes in codes and standards, and
- Note current and pending changes to relevant portions of Energy Star standards and building energy codes that may affect measure impact in future program years
- Identify areas of impact uncertainty to guide PY3 evaluation activities.

E.2 Evaluation Methods

In order to meet the PY2 objectives, the Evaluation Team conducted the following activities:

- Review of verification and due diligence procedures
- Review of tracking systems and quality control
- Review of ex-ante impact assumptions
- Evaluation of program implementation issues and concerns

Evaluation results are based on electronic and hard copy program documentation as well as meetings with key program implementation staff.

E.3 Evaluation Findings

Program Accomplishments

The Program is administered across both ComEd and Ameren Illinois Utilities service territories. The programs' expectations[1] were to complete a total of 652 units over PY1 and PY2. The number of units that completed construction over PY1 and PY2 was 699, of which 495 were in PY2. Energy savings over the PY1 and PY2 period total 2,419 MWh—well in excess of expectations—and the demand reduction achieved is 0.7 MW.

[1] Source: *Template - Low Income new construction and gut rehab.pdf*

Table E-1. PY1 and PY2 Program Accomplishments[2]

Program Year	Ex-Post Accomplishments**		
	Completed Installations^	MWh	MW
PY1	204	430	0.3
PY2	495	1,989	0.4
Total (PY1 & PY2)	*699*	*2,419*	*0.7*
PY3	-	-	

^Sources: MS word and Excel files submitted to EM&V team:'PY2 Projects.doc' and 'retrofit master FY08 recommendations and project 2009.xlsx'
***Source: EM&V analysis.*

[2] Overall Program Expectations and Accomplishments reflect the total EEAHC Program, including both ComEd and Ameren Illinois Utilities service territories.

The funding of new projects is an indicator of the volume of upcoming project and unit installations. For this reason it is also an important metric of program accomplishments. Table E-2 below shows expected and actual accomplishments in terms of the number of units funded. The table shows the annual as well as cumulative project starts over the PY1 and PY2 period. The program project-starts were 1,328 units in PY2, exceeding the annual expectation by 241, and exceeding the cumulative expectation by 342 units.

Table E-2. Expected Project Starts versus Program Accomplishments[3]

Program Year	Expected* Funded Units	Actual Funded Units^	Annual Accomplishments Versus Expectations	Cumulative Accomplishments Versus Expectations
PY1	652	753	+101	+101
PY2	1,087	1,328	+241	+342
PY3	1,957	N/A	N/A	N/A

**Source: pdf file submitted to EM&V Team: 'Template - Low Income new construction and gut rehab.pdf"*
^Sources: MS word and Excel files submitted to EM&V team: 'PY2 Projects.doc' and 'retrofit master FY08 recommendations and project 2009.xlsx'

Impact Evaluation Findings

The EEAHC program allows participants to select from an array of measure choices and select what is appropriate given the particular circumstances of construction. As such, each project has a unique set of measures, and associated energy and demand savings. For this reason, the ex-post impact assessment is based on project specific data regarding the efficiency rating and measure counts of installed equipment.

In PY2 many projects included efficient heat pumps. This equipment produces electricity savings over both heating and cooling seasons. Moreover, there is energy savings associated with both building enveloped (reduced required capacity of equipment) as well as the energy efficiency of the equipment itself. These effects are included in the PY2 energy impact values and are primarily responsible for an ex-post kWh impact per unit (3,892 kWh) that is nearly twice that of the ex-ante per unit expectations (2,107 kWh). The program may consider assigning ex-ante impact for heat pump installations that reflect higher expected energy savings

[3] Overall Program Expectations and Accomplishments reflect the total EEAHC Program, including both ComEd and Ameren Illinois Utilities service territories.

values for both reduced required capacity and efficiency. Specifics regarding the heat pump measure and associated ex-ante and ex-post impacts are detailed below and in Section 3.4.

The PY1 Evaluation Report presented a review of ex-ante impact algorithms and assumptions. For the PY2 Evaluation, these were revisited to ensure consistency with current Energy Star calculators and were compared with applicable efficiency and building standards. These reviews resulted in a recommendation to reduce the PY2 impact related to reduced AC capacity for multi-family dwellings.

- The recommendation is to reduce the PY2 impact for multi-family dwellings from a 1 ton reduction per unit to a 0.56 ton reduction per dwelling unit.

It is recommended that this change be effective immediately, and applied to PY2 projects. Going forward, multi-family projects funded in PY1 and PY2 but not yet completed should also adopt this new impact estimate for reduced AC tonnage in multi-family structures.

Projects initiated in PY3 will be subject to the IECC 2009 building energy code. Engineering analysis performed in support of this evaluation indicates that for buildings subject to IECC Residential Code, (single family and small multi-family buildings) there is zero reduced AC tonnage when moving from IECC code to current EEAHC program standards. However, for buildings subject to IECC commercial code, there continues to be an impact of 0.56 reduced AC tons per dwelling unit.

- It is recommended that projects subject to IECC residential code and completed under the current EEAHC program standards, adopt a zero ex-ante impact for reduced AC tonnage for both single-family and small multi-family units.

- It is recommended that the program adopt an infiltration standard of 0.35 ACH, which conforms to ASHRAE 62.2.

- Projects subject to IECC commercial code can continue to claim 0.56 reduced tons of AC/HP capacity per unit under the current program standard.

- If a new 0.35 ACH standard is adopted by the program, it is recommended that reduced capacity impact be re-estimated in PY3 for building subject to commercial and residential IECC codes.

Table E-3 below summarizes ex-ante impact per unit, as well as the new recommended values for PY2 projects. Lighting values are presented on a per fixture basis. Actual ex-ante and ex-post figures are based on installed fixture counts. Similarly, the AC savings values reflect minimum qualifying equipment, but ex-post impact will reflect the actual efficiency of installed equipment. Energy Star clothes washers and ceiling fans are new measures in PY2. Reviews of energy star literature and calculators yielded estimates of kWh savings per appliance per year,

but identification of demand impact for clothes washers will be investigated as part of the PY3 evaluation. If this a positive demand impact is determined for clothes washers, retroactive credit will be applied to the program in PY3.

Table E-3. Ex-Ante and Recommended Per Unit Impact Values

Measure	Ex-Ante Values		Ex-Post Values	
	kWh/Unit	kW/Unit	kWh/Unit	kW/Unit
Indoor fluorescent lighting fixture (per fixture)*	87	0.01	87	0.01
Outdoor/common area fluorescent lighting fixture (per fixture)	133	0.02	133	0.02
90% AFUE furnace with efficient air handler	400	0.05	400	0.05
Energy Star rated bathroom exhaust fan	89	0.01	89	0.01
Energy Star refrigerator	95	0.01	95	0.01
Energy Star dishwasher	33	0.01	33	0.01
Energy Star clothes washer	-	-	24	-
Energy Star ceiling fan	-	-	54	0.01

** Ex-Ante values are based on 6 indoor and 2 outdoor fixtures. Ex-post values are based on the fixtures installed.*

Recommended ex-ante impact values for the HVAC measures (CAC, HP, and building envelope) are shown in Table E-4 below. As was done for this evaluation, it is recommended that ex-post impact associated with AC, HP and building envelope measures be developed using data regarding the specific equipment type, efficiency, building envelope specifications, building type, location and applicable building code. For planning purposes the program may consider using the values shown below. These values are based on minimum qualifying efficiencies and an average of the Energy Star calculator result for 5 Illinois cities. The capacity requirement reduction is based on the eQuest modeling performed in support of the engineering reviews presented in Section 3.4.

Table E-4. Recommended Ex-Ante Per Unit Impact Values for HVAC and Building Envelope Measures

Measure	HVAC Equipment	Building	Code	kWh/Unit**	kW/Unit**
Reduced required capacity	all	New SF	IECC 2009	0	0
Reduced required capacity	CAC	New SF	ASHAE 90.1 or similar	608	1.01
Reduced required capacity	CAC	New MF	ASHAE 90.1 or similar	340	0.57
Reduced required capacity	HP	New SF	ASHAE 90.1 or similar	3,399	1.01
Reduced required capacity	HP	New MF	ASHAE 90.1 or similar	1,937	0.57
Efficient AC	CAC	all	all	94	0.16
Efficient HP	HP	all	all	456	0.16

***Actual efficiency ratings and geographic placement data are used to estimate ex-post energy impact of efficient AC and heat pump equipment. Expected per unit savings assumes minimum qualifying efficiency (14 SEER).*

Program Accomplishments, ComEd Service Territory

Of the 495 installations completed through the EEAHC program, 417 were constructed within ComEd service territory in PY2. These were constructed within 6 building projects. Building projects and their impact information are provided in Table E-5 below. All 6 projects are new multi-family buildings. The associated ex-ante impact for PY2 is 879 MWh energy savings and 555 kW demand savings. The PY2 evaluation results yield total ex-post energy savings of 1,484 MWh and 346 kW for PY2. These ex-post impact results represent 169% of the ex-ante energy savings and 62% of demand savings. The difference between energy realization rate and the demand realization rate is due to the introduction of heat pump savings, which provides substantially increased energy savings but little change in expected summer demand impact. Lower than expected demand impact is also due to changes in expected reduced capacity requirement for air conditioning in multi-family units.

Table E-5. kWh and kW Savings by Tracking Record, ComEd Service Territory

Project Name	Building Type	Total Units	Units PY2	Ex-Ante kWh	Ex-Ante kW	Ex-Post kWh	Ex-Post kW
Project 1	New MF	94	60	126,406	80	213269	72
Project 2	New MF	70	70	147474	93	145,487	52
Project 3	New MF	72	72	151,687	96	261,418	44
Project 4	New MF	16	16	33,708	21	57,009	14
Project 5	New MF	99	99	208,570	132	413,368	74
Project 6	New MF	100	100	210,676	133	393,474	90
Total		451	417	878,619	555	1,484,126	346
Realization Rate						*169%*	*62%*

Source: Ex ante: Excel and word files submitted by DCEO to EM&V Team, "Residential retrofit final 09.xls" and 'PY2 Projects.doc'
Ex post: EM&V analysis.

Program Accomplishments, Ameren Illinois Utilities Service Territory

Of the 495 installations completed through the EEAHC program, 78 were constructed within Ameren Illinois Utilities service territory in PY2. These were constructed within 3 building projects. Building projects and their impact information are provided in Table E-5 below. All 3 projects are new single-family buildings. The associated ex-ante impact for PY2 is 164 MWh energy savings and 104 kW demand savings. Ex-post impacts for PY2 total 505 MWh energy savings and 98 kW demand savings. These ex-post impact results represent 306% of the ex-ante energy savings and 95% of demand savings. The large energy realization rate is due to the installation of very efficient heat pumps and larger than expected efficient lighting installations. The difference between energy realization rate and the demand realization rate is due to the introduction of heat pump savings, which provides substantially increased energy savings but little change in expected summer demand impact.

Table E-6. kWh and kW Savings by Tracking Record, Ameren Illinois Utilities Service Territory

Project Name	Building Type	Total Units	Units PY2	Ex-Ante kWh	Ex-Ante kW	Ex-Post kWh	Ex-Post kW
Project 1	New SF	1	1	2,107	1.3	2,110	0.4
Project 2	New SF	70	70	147490	93.1	480,506	84.1
Project 3	New SF	30	7	14,749	9.3	21.882	13.7
Total		101	78	164,346	103.7	504,538	98.2
Realization Rate						306%	95%

Source for PY2 ex-post impact values: EM&V analysis. Source for participation records: Excel and word files submitted by DCEO to EM&V Team, "Residential retrofit final 09.xls" and 'PY2 Projects.doc'.

Verification, Due Diligence and Tracking System Review

There were no major changes to verification procedures or program tracking implemented during PY2. The most critical evaluation issue regarding verification and due diligence is not related to insufficient activities, but to documentation and program record keeping. A new program tracking system is currently under construction and is expected to address many of the following issues concerning documentation and record keeping.

- On-site verification of installed measures is regularly performed by program staff, but is not always recorded. Verification activity with a positive outcome is not documented, while negative outcomes are noted in letters that are stored in files.

The EM&V Team recommends that formal verification procedures and guidelines be drafted and that they include standardized recording of verification results in the new tracking database currently under construction.

Grant applicants are required to document compliance with program guidelines in a "specification sheet" that is provided with program application materials. Specification sheets provide some guidance on the measures installed, but do not provide enough information to determine which measures are installed or to assess the energy savings of the project. It is recommended that the new tracking database include the following key elements for each project, as applicable:

- Efficient appliances installed
- Efficient lighting fixture counts, indoor and outdoor
- Equipment type, capacity and efficiency of AC or Heat Pump equipment
- Electrical efficiency data of the air handler on the furnace
- Number of Ceiling Fans and the lamps installed

The program does not have a protocol developed for identifying building projects that meet the low income standard, instead relying on indicators such as project sponsorship by another low income grant provider. This may present a source of uncertainty regarding the verification of program qualifying status of grant applicants.

It is expected that with the completion of the new tracking database, the EM&V effort will be greatly enhanced by the construction of a program tracking system that is maintained and integral to program operations. It is expected to be a regularly updated database providing consistent and comprehensive program records in a standardized format.

Section 1. Introduction to the Program

1.1 Program Description

The Illinois Department of Commerce and Economic Opportunity (DCEO) provides grants to non-profit and for-profit affordable housing developers to help offset additional costs for incorporating energy efficient building practices in residential new construction. Supported by funding from a variety of sources, including the Illinois Energy Efficiency Trust Fund and the Energy Efficiency Portfolio Fund, grants are funded through the Energy Efficient Affordable Housing Construction Program (EEAHC)

The EEAHC program provides funds to affordable housing developers for both new construction and gut rehab projects. Funding is provided for individual measures; grantees are not required to accept the full set of efficiency measures for funding. The program's objectives are to identify and implement highly cost-effective low-income electric energy efficiency opportunities present only in gut-rehab and new construction projects.

The program has been in existence since 1988. Prior to 2008, the Energy Trust Fund was the only funding source for the EEAHC, covering both gas and electric energy efficiency measures. After 2008, the program was funded by two sources, the Energy Efficiency Trust Fund (now covering only gas measures) and the Energy Efficiency Portfolio Standard Fund (covering only electric measures).

1.1.1 Measures and Incentives

The energy efficient measures available to EEAHC participants in PY2 include Energy Star refrigerator, dishwasher, clothes washer, ceiling fans, fluorescent lighting fixtures, Energy Star bathroom exhaust fan, SEER 14 (minimum) CAC or Heat Pump, efficient furnace air handler, improved building envelope and resulting reduced AC tonnage. A participating project may install all of these measures, or a subset of these measures, depending upon the circumstances of the construction or rehab project. Typically, the same measures are installed in each unit of a single project. Grant amounts vary with the measures installed, the building type, and whether the project is new construction or gut rehab. Table 1-1 below summarizes the program standards as stated in the Guidelines Document, "EEAHC Guidelines June2009.pdf".

Table 1-1. Program Guideline Overview

Construction Element	Specification	
Insulation		
Sidewalls	R-21	Full Cavity Blown Insulation
Attic	R-49	
Foundation		
Slab on Grade	R-10	Full Slab & Perimeter
Basement	R-10	Exterior or Interior Foundation Insulation
Crawlspace Walls	R-10	Exterior or interior foundation wall insulation, or
Crawlspace Floor	R-21	
Windows	Double Glazed with low e coating (max U-value of 0.35)	
Air Sealing	All penetrations through shell sealed with caulk or foam	
Foundation	Seal drywall to framing members on exterior walls	
Foundation	Caulk base of drywall to subfloor	
Foundation	Completed units not to exceed 0.5 air changes/hour as measured with blower door	
Mechanical		
Furnace	Sealed combustion/direct vent, minimum 90% AFUE with an electronically commutated motor or equivalent advanced air handler	
Boiler	Sealed combustion/direct vent minimum 88% AFUE	
Water Heater	Sealed combustion/direct vent, minimum 62% EF and ENERGY STAR rated or sealed combustion/direct vent 88% for central water heater	
Air Conditioner	14 SEER minimum	
Duct Sealing	All duct joints (supply & return) sealed with duct mastic All ducts and pipes located in conditioned areas	

Construction Element	Specification
Ventilation	
Bathroom	Bathroom exhaust fans must be ENERGY STAR rated Bathroom exhaust fans must provide a minimum 75 CFM at 0.25" of static pressure Bathroom exhaust fans must have a sone rating no higher than 1.5 Bathroom exhaust fans must be controlled by a mechanical timer, fan-delay switch or other approved method
Kitchen	Kitchen exhaust fans must provide a minimum of 150 CFM
Exhaust Fans, all	All exhaust fans must vent to outside the building
Appliances	Refrigerators must be ENERGY STAR rated (if provided) Dishwashers must be ENERGY STAR rated (if provided) Clothes washers must be ENERGY STAR rated (if provided)
Lighting	Minimum of 6 interior fluorescent fixtures. All interior fixtures must be fluorescent in units with less than 6 interior fixtures. All common area and exterior lighting to be fluorescent or approved equivalent.

1.2 Evaluation Questions

The principal evaluation research questions addressed by this PY2 (June 2009 through May 2010) evaluation are listed below. Some of the researchable questions will also be addressed in the Program Years 3 (PY3) evaluation.

- What are the gross annual energy (kWh) and peak demand (kW) savings achieved by the program?
- Are the current engineering algorithms and tools for estimating gross energy savings accurate?
- Do the documentation of measures installed through the program support those referred to in the program standards?
- Are program standards aligned with applicable building codes and standards? Are the baseline assumptions reasonable?

Section 2. Evaluation Methods

This section describes the analytic methods and data collection activities implemented as part of the PY2 evaluation of the Energy Efficient Affordable Housing Construction program. Evaluation methods for Program Year 2 (spanning June 2009 through May 2010) leverage program documents and a variety of secondary sources and research. Data was assembled relating to program tracking, verification, implementation procedures and energy impact claims. Evaluation methods include the review of program data and documentation, stipulated savings algorithms, analysis of applicable building energy codes and building simulation modeling. Evaluation methods include the following components:

- Review and update summaries of projects initiated and completed through the program
- Review and comment on verification procedures and results.
- Review and comment on ex-ante impact claims algorithms and assumptions.
- Calculate energy and demand impact for each project arising from HVAC measures and building envelope using project-specific data relating to the building type, location, and HVAC equipment.
- Review of building codes and standards and evaluation of consistency with program standards.
- Identify key goals and program design and implementation issues.

2.1 Data Sources

Program verification procedures, tracking systems and savings claims are evaluated based on program data and documents provided by program management and implementation staff, as well as interviews with program staff. Specifically, the following data are collected and analyzed in support of this evaluation.

- Program tracking data
- Program standards documents
- Program application details of project 'specifications'
- Relevant engineering algorithms and ex-ante savings calculations
- Secondary sources such as:

- Building codes and standards (IECC 2009)
- Energy Star standards and calculators
- Engineering building simulation tools
- Engineering reference materials, including ASHRAE 90.1 and ARI Unitary Directory Source

Section 3. Program Level Results

This section details the evaluation results for PY2 (June 2009 through May 2010).

3.1 Verification and Due Diligence

Verification procedures are documented in the PY1 report. No major changes have been implemented in the interim. Key issues and related developments are summarized in this section. The reader should refer to the PY1 evaluation for additional details.

Grant applicants are required to document compliance with program guidelines in a "specification sheet" that is provided with program application materials. Just prior to the commencement of construction activities, the program implementer will review blueprints and other building documents to confirm consistency with program guidelines and the relevant *specification sheet*. As construction begins, the program implementer will almost always[4] visit the site at key points to inspect insulation levels and other key features of construction; the program implementer will also perform a blower door test at project completion. Up to this point, these visits have not been documented, unless a problem is identified. In the event that a problem is identified, a letter is sent to the program manager and is kept with the project file. Grant monies are withheld until the issue is resolved. However, going forward records of passed and failed verification activities are expected to be part of the new tracking database.

The program does not have a protocol developed for identifying building projects that meet the low income standard, instead relying on indicators such as project sponsorship by another low income grant provider. This may present a source of uncertainty regarding verification of the program qualifying status of grant applicants.

3.2 Summary of Program Accomplishments

The initial expectations for PY1 and PY2 were to complete a total of 652 units. The actual number of units that completed construction is in excess of these expectations, with 699 units completed over the PY1 and PY2 period; 495 of these were completed PY2. The expectations and accomplishments for this program for both ComEd and Ameren Illinois Utilities service territories combined are presented in Table 3-1 below.

[4] Field inspections are performed for most every project, except on occasion if they are geographically inconvenient. In these cases photos are sometimes sent in lieu of the on-site inspection.

Table 3-1. Savings Expectations versus Ex-Post Program Accomplishments[5]

Program Year	Expected Installations	Completed Installations^	MWh	MW
PY1	0	204	430	0.3
PY2	652	495	1,989	0.4
Total (PY1 & PY2)	652	699	2,419	0.7
PY3	1,087	-	-	-

**Source: pdf file submitted to EM&V Team: 'Template - Low Income new construction and gut rehab.pdf"*
^Sources: MS word and Excel files submitted to EM&V team: 'PY2 Projects.doc' and 'retrofit master FY08 recommendations and project 2009.xlsx'
***Source: EM&V analysis.*

The successful funding of new projects is an indicator of the volume of upcoming projects and unit installations. For this reason it is an important metric of program accomplishments. Table 3-2 below shows the annual expectations and accomplishments in terms of the number of units funded. The table shows the annual accomplishments versus expectations, as well as the cumulative accomplishments versus expectations over the PY1 and PY2 period. The program project-starts in PY2 were 1,328 units, exceeding annual expectations by 241 and cumulative expectations by 342 units.

Table 3-2. Expected Project Starts versus Program Accomplishments[6]

Program Year	Expected Funded Units	Actual Funded Units^	Annual Accomplishments Versus Expectations	Cumulative Accomplishments Versus Expectations
PY1	652	753	+101	+101
PY2	1,087	1,328	+241	+342
PY3	1,957	N/A	N/A	N/A

**Source: pdf file submitted to EM&V Team: 'Template - Low Income new construction and gut rehab.pdf"*
^Sources: MS word and Excel files submitted to EM&V team:'PY2 Projects.doc' and 'retrofit master FY08 recommendations and project 2009.xlsx'

[5] Overall Program Expectations and Accomplishments reflect the total EEAHC Program, including both ComEd and Ameren Illinois Utilities service territories.
[6] Overall Program Expectations and Accomplishments reflect the total EEAHC Program, including both ComEd and Ameren Illinois Utilities service territories.

3.3 *Participation and Impact Summary*

ComEd Service Territory

Of the 495 installations completed through the EEAHC program during PY2, 417 were constructed within ComEd service territory. These were constructed within 6 building projects. Building projects and their impact information are provided in Table 3-3 below. All 6 projects are new multi-family buildings. The associated ex-ante impact for PY2 is 1,484 MWh energy savings and 318 kW demand savings.

Ex-ante impact reviews completed during the PY2 evaluation cycle yield a change in the recommended impact values associated with the 'reduced AC tonnage' measure for multi-family structures. The impact review results[7] yield an expected reduction in capacity of 0.56 tons for new multi-family structures, rather than 1 ton.

Both efficient air conditioning equipment or efficient heat pump equipment qualify for the program. The installations of efficient heat pumps produce electricity savings during both heating and cooling seasons. Installed efficiency and equipment specification data are used to determine the ex-post kWh savings for efficient AC and heat pump equipment.

Although the program guidelines specify 6 indoor and 2 outdoor efficient lighting fixtures, often the installed fixture counts vary from these guidelines. Actual fixture counts are used to determine ex-post lighting energy and demand impact.

Ex-post energy and demand savings for projects completed ComEd service territory total 1,484 MWh and 346 kW for PY2, representing 169% of the ex-ante energy savings and 62% of ex-ante demand savings.

[7] See Section 3.4 for a full discussion.

Table 3-3. kWh and kW Savings by Tracking Record, ComEd Service Territory

Project Name	Building Type	Total Units	Units PY2	Ex-Ante kWh	Ex-Ante kW	Ex-Post kWh	Ex-Post kW
Project 1	New MF	94	60	126,420	80	213,369	72
Project 2	New MF	70	70	147490	93	145,487	52
Project 3	New MF	72	72	151,704	96	261.418	44
Project 4	New MF	16	16	33,712	21	57,009	14
Project 5	New MF	99	99	208,593	132	413,367	74
Project 6	New MF	100	100	210,676	133	393.474	90
Total		451	417	878,521	555	1,484,126	346
Realization Rate						169%	62%

Source for PY2 ex-post impact values: EM&V analysis. Source for participation records: Excel and word files submitted by DCEO to EM&V Team, "Residential retrofit final 09.xls" and 'PY2 Projects.doc'.

Ameren Illinois Utilities Service Territory

Of the 495 installations completed through the EEAHC program during PY2, 78 were constructed within Ameren Illinois Utilities service territory. These were constructed within 3 building projects. Building projects and their impact information are provided in Table 3-3 below. All 3 projects are new single-family buildings. The associated ex-ante impact for PY2 is 504 MWh energy savings and 98 kW demand savings.

Ex-ante impact reviews completed during the PY2 evaluation cycle yield a change in the recommended impact values associated with the 'reduced AC tonnage' measure for multi-family structures. The impact review results[8] yield an expected reduction in capacity of 0.56 tons for new multi-family structures, rather than 1 ton.

Both efficient air conditioning equipment or efficient heat pump equipment qualify for the program. The installations of efficient heat pumps produce electricity savings during both heating and cooling seasons. Installed efficiency and equipment specification data are used to determine the ex-post kWh savings for efficient AC and heat pump equipment.

[8] See Section 3.4 for a full discussion.

Although the program guidelines specify 6 indoor and 2 outdoor efficient lighting fixtures, often the installed fixture counts vary from these guidelines. Actual fixture counts are used to determine ex-post lighting energy and demand impact. Actual fixture counts for the Ameren Illinois utilities projects average 16.5 efficient fixtures per dwelling unit, well in excess of the ex-ante assumption of 8 per unit.

Ex-post energy and demand savings for projects completed Ameren Illinois service territory total 504 MWh and 98 kW for PY2, representing 306% of the ex-ante energy savings and 95% of ex-ante demand savings.

Table 3-4. kWh and kW Savings by Tracking Record, Ameren Illinois Utilities Service Territory

Project Name	Building Type	Total Units	Units PY2	Ex-Ante kWh	Ex-Ante kW	Ex-Post kWh	Ex-Post kW
Project 1	New SF	1	1	2,107	1.3	2,110	0.4
Project 2	New SF	70	70	147490	93.1	480,546	84.1
Project 3	New SF	30	7	14,749	9.3	21.882	13.7
Total		101	78	164,346	103.7	504,538	98.2
Realization Rate						306%	95%

Source for PY2 ex-post impact values: EM&V analysis. Source for participation records: Excel and word files submitted by DCEO to EM&V Team, "Residential retrofit final 09.xls" and 'PY2 Projects.doc'.

3.4 Ex-Ante Impact Review

There are seven measures available for electric savings incentives. The measures and their associated ex-ante energy and demand impacts are shown in Table 3-6 below. These ex-ante impact values are consistent with PY1 evaluation results.

The PY1 Evaluation Report presented a review of ex-ante impact algorithms and assumptions. For the PY2 Evaluation, algorithms and assumptions were revisited to ensure consistency with any changes in Energy Star calculators or other applicable efficiency and building standards. These reviews resulted in a recommendation to revise the impact related to a reduced required AC capacity, as well as to add a heat pump option to the list of measures. Efficient heat pumps provides electricity savings in both heating and cooling seasons, and are thereby associated with a notably higher energy savings. Demand savings is similar across the two, since demand savings is accrued only in the cooling season.

The Energy Star heat pump calculator was used to estimate energy savings associated with a 24,000 BTUH 14 SEER heat pump unit. The recommended ex-ante value is an average of the

Energy Star savings result across the 5 Energy Star cities in Illinois for which the calculator provides an estimate of savings.

The assumption of a full ton of reduced AC capacity per building unit was reviewed using applicable building codes and eQuest building simulation modeling. Results confirm the ex-ante impact assumptions for single family homes, but for large multi-family structures, the impact is measurably lower. Analysis of the 72 unit multi-family structure completed in PY2 using the applicable local building code and the program standards confirm a reduced tonnage value of 0.43 tons per unit. Similar analysis of a smaller 6-unit multi-family structure yields an impact of 0.69 reduced tons per dwelling unit. It is recommended that the program adopt ex-ante estimates for new multi-family structures in accordance with a 0.56 ton reduction, which is the average of results across the larger and smaller multi-family structures.

The same analysis was performed against the IECC 2009 residential code, adopted by the State of Illinois effective January 2010. Results show zero reduced AC tonnage when moving from IECC code to current program standards. It is recommended that either the reduced AC tonnage measure be eliminated from the portfolio, or that standards be tightened to produce savings relative to the building code. Projects funded in PY3 and subject to IECC codes should assume energy and demand savings of zero for the reduced AC tonnage measure. The EM&V team recommends adopting an infiltration standard of 0.35 ACH, which conforms to ASHRAE 62.2.

The recommended ex-ante values for HVAC measures (CAC and HP) and the reduced required capacity resulting from building envelop measures is summarized in Table 3-5 below. The recommended ex-ante values are a function of the installed equipment, the type of building constructed and the applicable building codes. Ex-post values are based on project-specific data relating to the building type, location, applicable codes and equipment installed.

Table 3-5. Recommended Ex-Ante Per Unit Impact Values for HVAC and Building Envelope Measures

Measure	AC / Heat Pump	Building	Code	Recommended Ex-ante	
				kWh/Unit	kWh/Unit
Reduced required capacity	all	New SF	IECC 2009	0	0
Reduced required capacity	CAC	New SF	ASHAE 90.1 or similar	608	1.01
Reduced required capacity	CAC	New MF	ASHAE 90.1 or similar	340	0.57
Reduced required capacity	HP	New SF	ASHAE 90.1 or similar	3,399	1.01
Reduced required capacity	HP	New MF	ASHAE 90.1 or similar	1,937	0.57
Efficient AC	CAC	all	all	94	0.16
Efficient HP	HP	all	all	456	0.16

Table 3-6 below summarizes the findings from the lighting and appliance engineering reviews. There are no recommended changes to the lighting and Energy Star appliance measures reviewed in PY1. Clothes washer and ceiling fan measures are reviewed for the first time, and the recommended ex-ante values are shown below. Demand savings associated with clothes washers is unavailable at this time but will be investigated in PY3.

Table 3-6. Ex-Ante Per Unit Impact Values

Measure	Ex-Ante (Single and Multi-Family)		Recommended Ex-Ante	
	kWh/Unit	kW/Unit	kWh/Unit	kW/Unit
6 interior fluorescent fixtures & 2 exterior fluorescent fixtures	788	0.09	788	0.09
90% AFUE furnace with efficient air handler	400	0.05	400	0.05
Energy Star rated bathroom exhaust fan	89	0.01	89	0.01
Energy Star refrigerator	95	0.01	95	0.01
Energy Star dishwasher	33	0.01	33	0.01
Energy Star clothes washer	-	-	23	-
Energy Star ceiling fan with lighting (per unit)	-	-	54	0.01

Engineering Reviews and Recommendations

An engineering review and recommendations are made below for each program measure and ex-ante savings value.

Energy Star Refrigerator

Impact assumptions

- Savings should be calculated based on existing national comparisons between standard and Energy Star certified appliances

Engineering reviews

Energy Star refrigerator ex-ante impact claims are 95 kWh per unit per year based on the Energy Star savings calculator. This calculation was reviewed and confirmed based on the current version of the calculator.

Recommendations

Based on this finding, we recommend making no change to the kWh impact claim of 95 kWh.

Fluorescent Lighting

Impact assumptions

- Savings should be calculated based on existing national comparisons between standard and Energy Star certified lighting
- Ex-post impact is credited based on actual indoor and outdoor fluorescent fixture counts.

Engineering reviews

A review of the Energy Star calculator confirmed no change relative to the findings presented in the PY1 engineering reviews. The expected value of 788 kWh per unit is based on an assumed minimum of 6 indoor fixtures (87 kWh per fixture) and 2 outdoor fixtures (133 kWh per fixture).

The IECC 2009 building code[9], incorporates an efficient lighting requirement. The code requires 50% of permanent fixtures be high efficiency. The EEAHC standards indicate a minimum of 6 interior fixtures be fluorescent. It is not readily apparent what changes the new code might have on the program fluorescent lighting measure impact. Understanding total lighting requirements, common area lighting requirements and baseline practices would help to inform such an assessment.

Recommendations

It is recommended that impact from fluorescent fixture installation continue to be credited at a rate of 133 kWh/0.02 kW per outdoor fixture and 87 kWh/0.01 kW per indoor fixture per year.

Evaluation activities in PY3 will address the potential effects of IECC 2009 code on the program fluorescent lighting measure impact. Evaluation activities will also investigate any potential impact differences arising from Energy Star certification versus non-energy star fluorescent fixtures.

Central Air Conditioning and Heat Pump

Impact Assumptions

- Impact should be calculated based on existing national comparisons between standard and Energy Star certified equipment

[9] Adopted in Illinois effective January 2010 for residential structures, and August 2009 for commercial structures.

- Air conditioning equipment installed within each incented unit has a 2 ton capacity and a minimum 14 SEER rating.

Engineering reviews

A review of the current CAC Energy Star calculator confirms no change to the reviews presented in PY1 report.

The energy savings figures are the result of the Energy Star Heat Pump Savings calculator, using a 24,000 BTU/hour capacity, and an assumed SEER of 14. Calculations were done for each of the five cities in Illinois for which the Energy Star calculator offers impact estimates. The city-specific energy impact estimates are similar across the five cities, varying by less than 20 kWh from the lowest 448 to the highest 465. An average was taken over the five city-specific results to yield the recommended value of 456 kWh.

The heat pump demand impact estimate should be a function of the cooling demand savings only. This issue requires additional study in PY3. In the meantime, as a reasonably conservative estimate, we recommend using the per unit CAC demand impact of 0.16 kW per unit.

Recommendations

It is recommended that the expected annual impact per CAC unit remain at 94 kWh, and 0.16 kW.

It is recommended that the expected annual impact per efficient heat pump be set to 456 kWh per unit energy savings, and 0.16 kW per unit demand savings.

The efficiency of installed heat pump and air conditioning units often exceeds the minimum requirement by a substantial margin. Ex-post impact for PY2 for both heat pump and air conditioning is based on actual efficiency data, as well as the actual project location.

Reduced Required AC Tonnage as a Result of Thermal Envelope Improvements

Impact assumptions

- Building envelope improvements lead to a reduction in AC tonnage from 3 tons to 2 tons per constructed dwelling unit.

Engineering reviews

The ex-ante claimed energy savings due to reduced AC tonnage resulting from building envelope improvements is 608 kWh per dwelling per year based on the Energy Star calculator and assuming a reduction from 3 tons to 2 tons. The savings specifically due to reduced AC

tonnage are calculated based on the assumption of meeting the EEAHC specifications of a 14 SEER rating and presume the use of a programmable thermostat.

This represents an average value from the 5 Illinois cities represented in the calculator. Annual energy savings range between 745 kWh (for Springfield IL) to 514 kWh (Rockford IL). Table 3-7 below shows the Energy Star based estimates of reduced tonnage across various major cities in Illinois.

Table 3-7. kWh Savings from Reduction in Required Tonnage by Metropolitan Area

City	kWh/year
Chicago	491
Springfield	745
Peoria	682
Rockford	514
Moline	598
Average	608

As discussed in PY1, this PY2 evaluation effort performed a more rigorous verification of baseline and the impact of this measure. The verification effort included assembling local building codes and performing detailed engineering analysis. Engineering analysis tools were used to assess the impact on required AC tonnage that results from the incremental changes in code that occur when moving from applicable building codes to the current program standard.

Required AC capacity was modeled using eQuest, an industry standard modeling software that uses DOE-2 as the simulation engine. The eQuest modeling of a 1,200 square foot, 2-story single family home with an unconditioned basement show that a one ton reduction is reasonable from an upgrade of a Chicago code built home to a home that meets the EEAHC program guidelines. However when the new statewide energy code (IECC) comes into effect as the baseline home, the one ton AC capacity reduction will no longer be a valid assumption. Table 3-8 shows the required AC capacity under four building construction scenarios, according to eQuest's auto-sizing feature.

The variable with the largest impact on AC capacity is infiltration. The Chicago Building Code has no building shell tightness requirement so a range is investigated from "typical" to "tight" building shell construction. Tightness varies from 1.0 air changes per hour (ACH) average

across all house types and vintages[10] to 0.6 ACH for a well sealed, newly constructed home[11]. The variation across this range yields almost a ton difference in required AC capacity, and hence, the reduction in AC capacity from a code built house to a house meeting EEAHC guidelines varies from 0.59 to 1.4 tons.

When the IECC code comes into effect as the baseline, the building shell tightness requirement will be reduced below the current EEAHC standard, to 0.42 ACH. Even though EEAHC requires more attic insulation than IECC, the tighter shell requirement of IECC causes the AC capacity of an IECC built home to be 0.13 tons less than that required in an EEAHC house.

Table 3-8. Required AC Capacity, Building Codes versus Program Standards, 1,200 Square Foot Single Family Dwelling

City	BTUH/sq ft	Tons	Attic	Basement	Walls	Infiltration [ACH]	Windows
Chicago Building Code (average shell)	37.3	3.73	R-30	R-30	R-13	1	double clear
Chicago Building Code (tight shell)	29.2	2.92	R-30	R-30	R-13	0.6	double clear
IECC 2009	22	2.20	R-38	R-30	R-13 + R-6 cont.	0.42[12]	double clear
EEAHC	23.3	2.33	R-49	R-30[13]	R-13 + R-7 cont.	0.5	double low e

The case of multi-story apartment buildings are significantly different from single family homes, especially when they are served by a central plant, such as is the case for one of the program projects completed in PY2. This project is a 72 unit multi-family structure served by a geothermal heat pump for heating and cooling. It was modeled with eQuest using the assumption that each of the 72 units in the building was 800 square feet. A baseline of a Chicago code built home with an average building shell and 1 ACH yields an AC capacity requirement

[10] Sherman and Matson, LBNL 39036 "Residential Ventilation and Energy Characteristics"
[11] http://cipco.apogee.net/res/reevair.asp
[12] The IECC 2009 standard is 7ACH50. The ACHnat equivalent of 7 ACH50 is 0.42 ACHnat. This is calculated for the Chicago area using an LBL factor of 16.65 determined using a climate factor of 18.5, height factor of 1.5, wind shielding correction factor of 1.0 and leakiness correction factor of 1.0.
[13] EEAHC program guidelines require R-19 in an unconditioned basement ceiling, however, such a house would not be allowed by the Chicago Building Code so the required insulation value of R-30 is used.

of 114.2 tons for the whole building. The same structure built to EEACH standards has required AC capacity of 83.4 tons, representing a total reduced AC capacity requirement of 31 tons, or 0.43 tons per dwelling unit. This is much lower than the assumed reduction of one ton per unit or a 72 ton reduction for such a building.

A 6 unit apartment building was also modeled relative to Chicago code, to provide an idea of how smaller multi-family structures would behave. The outcome was a reduction of 0.69 tons of AC capacity per dwelling unit.

Table 3-9 below shows the required AC capacity for a 72 unit multi-family structure that meets the Chicago building code as well as the same structure built to program standards. The change in required AC capacity is 31 tons, or 0.43 tons per unit. The table also shows AC capacity requirements for a six unit multi-family structures, built to local building code and built to EEAHC program standards. The result for the smaller structure is somewhat higher, at 0.69 tons per dwelling unit.

Table 3-9. Required AC Capacity, Large and Small Multi-Family Structures, Chicago Building Code Versus Program Standards

Building Code	Units	Square Ft	BTUH/Sq ft	Tons	Attic	Basement	Walls	Infiltration [ACH]
Chicago Building Code	72	57,600	23.8	114.2	R-30	R-30	R-13	1
EEAHC	72	57,600	17.4	83.5	R-49	R-30	R-13 + R-7 cont.	0.5
AC Capacity Reduction Total of 30.7 Tons, or 0.43 Tons per dwelling unit								
Chicago Building Code	6	4800	28.5	11.4	R-30	R-30	R-13	double clear
EEAHC	6	4800	18.1	7.2	R-49	R-30	R-13 + R-7 cont.	double low e
AC Capacity Reduction Total of 4.2 Tons, or 0.69 Tons per dwelling unit								

Reduced required heat pump capacity due to thermal envelope improvements

The installation of efficient heat pump will provide reduced tonnage impact through both the heating and the cooling season, increasing the energy savings associated with reduced tonnage. In order to estimate the impact associated with reduced capacity requirement for heat pump, the assumption of a reduced capacity requirement of 1 ton per single family unit and 0.56 tons per multi-family unit is used. The Energy Star calculator for air source heat pumps produces an expected impact of 3,399 kWh per single family unit and 1,937 kWh per multi-family unit. Demand impact is borrowed from the AC impact values (1.01 kW and 0.57 kW for single family and multi-family, respectively). Demand impact is borrowed from AC calculations to better reflect demand reduction in the cooling season only. A better estimate of demand impact from air source heat pump will be considered in the PY3 report. Note that ex-post impact for PY2 heat pumps is based on engineering calculations using actual equipment type, efficiency rating and location.

Recommendations

Based on a review of the current Energy Star Calculator as well as the engineering analysis completed with eQuest, it is recommended that the EEAHC program continue to claim 608 kWh per unit, and 1.01 kW for single family dwellings that are part of projects initiated during PY1 or PY2. That is, these impacts are applicable to single family projects that were *not subject to the IECC code*.

The EEAHC program should adjust the shell tightness requirement for the next program year, where IECC will be the baseline, or they should discontinue the AC capacity reduction impact claim for newly funded projects.

The EEAHC program should revise their AC capacity reduction assumption for apartment buildings to 0.56 tons per dwelling unit. This recommendation reflects the average reduction across the large 72 unit building and the smaller 6 unit building. Large multi-family buildings are subject to the commercial IECC code, which does not have as stringent a shell tightness requirement as the residential code. It is expected that new multi-family building projects will continue to accrue savings of 0.56 tons per dwelling regardless of new code requirements.

A summary of recommended ex-ante impact for reduced required CAC/HP capacity are provided in Table 3-5, which details expected energy and demand values based on building type, equipment type, and applicable building codes.

Energy Star Dishwasher

Impact Assumptions

- Impact should be calculated based on existing national comparisons between standard and Energy Star certified appliances
- A household runs 215 dishwasher loads each year, according to the Energy Star calculator
- Current market averages for dishwasher energy use should be used for savings comparisons instead of minimum efficiency standards

Engineering Reviews

A review of the current Energy Star calculator confirms there are no changes to findings presented in the PY1 report values.

Recommendations

It is recommended that the expected impact for dishwashers funded in PY2 remain at 33 kWh per year, and 0.004 kW.

Bathroom Exhaust Fans

Impact assumptions

- Savings should be calculated based on existing national comparisons between standard and Energy Star certified appliances
- Bathroom exhaust fans operate 2 hours per day on average
- Standard bathroom exhaust fans are 150 W, and efficient bathroom exhaust fans are 28 W

Engineering reviews

Efficient bathroom exhaust fans ex-ante impact claim is 89 kWh per year. The EEAHC impact algorithm assumptions include 2 hours of operation a day, and a change in wattage from 150 for standard to 28 for efficient. The assumed operating hours and the assumption of a 28 watt fan are reasonable.

A review of the current Energy Star standards for bathroom exhaust fans confirmed that they remain at 1.4 CFM per watt for fans between 10-89 CFM and 2.8 CFM per watt for fans 90 CFM and above, the same values used in the PY1 calculation.

The specifications provided by the program participants in 5 of 6 projects state the exhaust fans shall be rated no less than 75 CFM. A 75 CFM fan that meets the minimum Energy Star requirement of 1.4 CFM per watt draws 54 watts. A 90 CFM fan that meets the minimum Energy Star requirement of 2.8 CFM per watt draws 32 watts. However, a review of Energy Star qualifying fans shows that the average 80 CFM fan goes beyond these minimum requirements and draws 24.2 watts. These values corroborate the 28 watt assumption for efficient fans.

It is worth noting that as it is currently stated, the specification in the EEAHC guidelines that bathroom exhaust fans "shall be rated no less than 75 CFM" does not provide sufficient specificity for the wattage of efficient fans. This makes it difficult to confirm or deny the existing savings claim, as wattage is a critical component of the calculation.

It is also worth noting that the requirement of 75 cfm for bathroom fans and 150 cfm for kitchen fans exceeds the ASHRAE 62.2 requirement of 50 cfm in bathrooms and 100 cfm in kitchens. This is an energy penalty in terms of electrical fan energy as well as heating and cooling load. Some of the excess ventilation is required to fulfill ASHRAE 62.2's Whole Building Ventilation requirement of 60 cfm for a 4-5 bedroom house less than 1500 square feet or 45 cfm for a similar 2-3 bedroom house. A 1000 square foot house meeting the EEADC tightness requirement of 0.5 ACHnat would be able to claim 23 cfm infiltration credit toward the whole house ventilation requirement, reducing it to 22 cfm for a 2-3 bedroom house and 37 cfm for a 4-5 bedroom house. This could be met by the bath fans alone (a 4-5 bedroom house would likely have 2 bathrooms doubling the bath fan excess air and a larger footprint increasing the infiltration credit.) We recommend reducing the required kitchen exhaust fan flow to 100 cfm.

Additional updates to this calculation in PY3 may include analysis of hours of use for bathroom fans and analysis of the distribution of fan sizes in residential bathrooms. According to a paper that cites unpublished data from Lawrence Berkeley National Lab, average residential fan use in the U.S. is 350 hours per year, or approximately 1 hour per day. Also, approximately 38% of residential bathroom fans are less than or equal to 75 CFM, while 62% are greater than 75 CFM. This data will be taken into account in the PY3 impact analysis. In addition, interviews with contractors in Program Year 3 will provide additional data points on fan sizes. The fact that EEAHC guidelines specify the use of fan timers will also be evaluated in determining the time of use value for efficient fans in the program.

Recommendations

The recommended impact value for bathroom exhaust fans remains at 89 kWh per year.

It is also recommended that the EEAHC guideline for bathroom exhaust fans be revised to include a specific size and wattage range for efficient fans.

90% AFUE Furnace with Efficient Air Handler

Impact assumptions

- An Electricity Use Ratio (see below) of 6 represents baseline energy usage for furnaces

Engineering reviews

The ex-ante per unit claimed impact from installation of 90%AFUE Furnace with efficient air handler is 400 kWh per year.

Program standards require that installed furnaces be designated as an electrically efficient furnace by the Gas Appliance Manufacturers Association (GAMA). A GAMA certified energy efficient air handler will consume less than 2% of the total energy used by the furnace during a typical heating season. While there is no minimum efficiency standard provided in these same terms, ranges in kWh consumption from fans within a set heating capacity can easily yield this magnitude of impact.

As noted above, direct address of air handler efficiency in relation to this requirement is not included in the specification documentation for sites, and many of the heating systems are electric (5 of 17) or geothermal (4 of 17).

Often the air handler energy rating is expressed in Eae, a measure of absolute energy consumption of the air handler. The Eae is not a relative measure. The larger the unit for heating purposes, the larger the Eae will be. This makes the Eae statistic hard to compare across units.

A review of the literature finds a publication addressing the potential energy savings of efficient air handlers by ACEEE[14] . The publication calculates savings for heating and separately for cooling from efficient air handlers, which they define through a statistic called "EUR", or Electricity Use Ratio. Although the EUR is not commonly published it can be readily calculated from the furnace capacity and Eae. The EUR is the ratio of the annual electricity use divided by the furnace capacity expressed in thousands of Btuh (kBtuh). The publication finds what is termed a natural delineation of EUR at a value of 6, with efficiency air handlers defined as those with an EUR of less than or equal to 6.

The report finds the average savings for air handlers with EUR less than 6 across all capacities to be 511 kWh per year. Savings for furnaces with capacity at the lower end (between 26 and 76 kBtuh) range between 351 and 440 kWh per year. The report also publishes an average kWh per year associated with efficient furnace fans and motors equal to 500 kWh per year, and regional

[14] Saving Energy with Efficient Residential Air Handlers. by Harvey M. Sachs and Sandy Smith, April 2003

specific values for New England at 679 kWh per year, and Wisconsin at 742 kWh per year. Savings for the cooling season are also reported, and could be invoked if the system installed is used for both heating and cooling.

The publication states, "We suspect that almost all furnaces for which EUR < 6 have advanced motors, but that some furnaces with EUR greater than 6 also have ECM systems, but in combination with very high internal status pressures that require higher wattages to move enough air."

Recommendations

Since the ex-ante impact assumptions are in line with the smaller capacity impact estimates published in the ACEEE study, no change is recommended to the ex-ante impact assumptions.

The EEAHC might consider adopting the EUR in measure specifications and recording, as it represents a measure of the Eae in relation to capacity.

Energy Star Clothes Washer

Impact assumptions

- Savings should be calculated based on existing national comparisons between standard and Energy Star certified appliances.
- A household will run 392 loads per year, or 7.5 loads per week.

Engineering reviews

Energy Star clothes washers are a newly introduced measure in PY2. A review of the Energy Star clothes washer calculator shows an annual impact of 23.8 kWh for an efficient clothes washer. This impact reflects gas fueled water heating and gas fueled clothes dryer, consistent with predominant fuel types for these appliances in Illinois.

In some cases participating multi-family buildings may install somewhat fewer clothes washers than the number of dwelling units. If these are installed in common areas, the impact should reflect 23.8 kWh per dwelling, since the impact is based on the number of wash loads and this is a function of occupancy. However, if the washers are installed within a subset of units, the impact should reflect the number of units in which washers were installed.

A peak demand impact for clothes washers is unavailable at this time. This issue will be investigated as part of the PY3 evaluation. Note that if a positive demand impact is identified for clothes washers an adjustment factor will be added to PY3 impact results to account for PY2 projects with clothes washers that were not credited for demand impact in PY2.

Recommendations

Based on this finding, we recommend an impact of 23.8 kWh per dwelling unit serviced by washers.

Energy Star Ceiling Fan with Lighting

Impact assumptions

- Savings should be calculated based on existing national comparisons between standard and Energy Star certified appliances

Engineering reviews

Energy Star ceiling fans are a newly introduced measure in PY2. Energy savings from this measure arises from the efficient fan motor and efficient lighting technology.

The Energy Star calculator for efficient ceiling fans provides estimates of the hours per day the fan is run at high, medium and low speed (40%, 40%, 20%, respectively). The operating hours estimates are provided regionally; an estimate of 2.8 hours per day is provided for the East North Central area. The Energy Star calculator also provides expected wattage for standard efficiency and energy star certified fans at each speed. Using this information annual kWh savings associated with an upgrade from a standard efficiency fan to an Energy Star fan is estimated at 3.03 kWh per year.

The ceiling fans come with efficient lighting. The Energy Star calculator assumes the efficient lighting will be a 20 watt bulb replacing a 60 watt standard, and running 3.5 hours per day for 365 days per year. The assumption of a single bulb per fixture is used for the calculation.

Since the impact is largely driven by the lighting, the demand impact for the ceiling fan measure is estimated by applying the demand to energy ratio for the efficient lighting measure discussed above, which yields 0.006 kW per ceiling fan fixture.

Further investigation confirming the correct baseline, and related implications on the assumed impact for ceiling fans in low income new construction and gut rehab, will be investigated as part of the PY3 evaluation.

Recommendations

Based on this finding, we recommend an energy impact of 30.3 kWh per ceiling fan per year, and a demand impact of 0.006 kW per fixture per year.

3.5 *Ex-Post Impact Assessment, ComEd Service Territory*

Table 3-10 below presents the number of installed units in each project. None of the projects included efficient dishwashers. The clothes washer column notes the number of clothes washers as well as the number of dwelling units served by the washers. Since clothes washer impact is dependent upon usage, the number of dwelling units served by the washers is used to derive the clothes washer savings. The efficient AC/ heat pump column notes the type of unit installed as well as the number of units served by the system. The lighting column notes the actual number of fixtures installed. All of the completed units received impact credit for reduced required capacity associated with the building envelope improvements.

Table 3-10. Installed Measures (Counts) by Project, ComEd Service Territory

Project	Refrig-erator	Dish Washer	Clothes washer	Air Handler	Bathroom Fan	AC/HP	Indoor/ Outdoor lighting	Reduced AC/HP Capacity	Ceiling Fan
Project A	72	0	0	0	0	HP/72 units	782/120	72	0
Project B	99	0	0	0	0	HP/99 units	693/258	99	0
Project C	70	0	20 serving 70 units	20	70	0	630/130	70	0
Project D	100	0	100	0	100	HP/100	1,270/107	100	100
Project E	16	0	0	0	16	HP/16	96/48	16	16
Project F	60	0	9 serving 27 units	60	60	CAC/60 units	1,559/60	60	0
Total	417	0	129 serving 197 units	80	246	425	5112/822	417	116

Table 3-11 below shows the energy (kWh) savings per project by measure category. The largest energy savings arise from reduced required AC/ heat pump capacity and efficient lighting. Together these two measure categories make up about 75% of the total kWh savings.

Table 3-11. Energy Impact by Measure and Project, ComEd Service Territory

Project	Refrig-erator	Dish Washer	Clothes washer	Air Handler	Bathroom Fan	Efficient AC/HP	lighting	Reduced AC/HP Capacity	Ceiling Fan
Project A	6,840	0	0	0	6,408	39,124	83,994	131,495	0
Project B	9,405	0	0	0	0	169,875	85,833	148,255	0
Project C	6,650	0	1,666	28,000	0	0	72,100	37,071	0
Project D	9,500	0	2,380	0	8,900	49,800	124,721	192,763	5,410
Project E	1520	0	0	0	1424	7,416	14,736	31,048	866
Project F	5700	0	643	24,000	5340	4,541	143,640	29,506	0
Total	39615	0	4,689	52,000	15,664	270,757	525,024	570,102	6,276

Table 3-12 below shows the total demand (kW) impact associated with each project by measure. The largest contributor to demand savings is from reduced AC/ heat pump capacity and efficient AC/HP. These two measures make up 79% of total PY2 demand reduction associated with projects in ComEd service territory.

Table 3-12. Demand Impact by Measure and Project, ComEd Service Territory

Project	Refrig-erator	Dish Washer	Air Handler	Bathroom Fan	AC/HP	Lighting	Reduced AC/HP Capacity	Ceiling Fan
Project A	0.7	0.0	0.0	0.0	7.8	9.6	26.1	-
Project B	1.0	0.0	0.0	0.0	33.7	9.8	29.4	-
Project C	0.7	0.0	3.5	0.0	0.0	8.2	39.9	-
Project D	1.0	0.0	0	1.0	16.0	14.2	57.0	0.6
Project E	0.2	0	0	0.2	2.6	1.7	9.1	0.1
Project F	0.6	0	0	3.0	7.7	11.0	49.0	0
Total	4.2	0	6.5	1.8	67.7	54.6	181.5	0.7

Either efficient air conditioners or heat pumps may be installed through the program. Four of the 6 projects sponsored by ComEd included the installation of heat pumps. Two of the projects included geothermal heat pumps. The energy impact associated with these two heat pump installations was modeled by the Evaluation Team using engineering principles and reference materials. The modeled heat pump impact yields a cooling demand impact, from which the demand savings is estimated (with a 70% factor). The air source heat pump and the Variable Refrigerant Flow heat pump systems impact was estimated using the Energy Star Air Source Heat Pump savings calculator. A conservative default value is used for demand estimates for these two projects. Specifically the heat pump demand impact is assumed equal to CAC demand impact for a 14 SEER unit. Heat pump demand impact will be investigated further in PY3.

Table 3-13. Air Conditioning and Heat Pump Impact Detail

Project Name	Equipment Description	CAC/HP Efficiency Rating	Source of Impact Estimates	CAC/HP kWh impact per unit	CAC/HP kW Impact per unit	Reduced Capacity kWh Impact per unit	Reduced Capacity kW Impact per unit
Project A	Geothermal Heat Pump	12-14 EER	Modeled	543	0.1	1,826	0.4
Project B	Geothermal Heat Pump	14.4-17.3 EER	Modeled	1,716	0.3	1,498	0.3
Project D	Air Source Heat Pump	15 SEER	ES HP calculator (Chicago/ Rockford)	498	0.2	1,928	0.6
Project E	VRF Heat Pump	14 SEER	ES HP calculator (Chicago/ Rockford)	464	0.2	1,941	0.6
Project F	PTAC	10.5 EER	Not efficient	-	-	530	0.6
Project F	CAC	14 SEER	ES CAC calculator	76	0.1	492	0.8
Average per Unit				649	0.2	1,367	0.5

3.6 Ex-Post Impact Assessment, Ameren Illinois Utilities Service Territory

Table 3-14 below presents the number of installed units in each project. One of the projects included efficient dishwashers. The clothes washer column notes the number of clothes washers as well as the number of dwelling units served by the washers. Since clothes washer impact is dependent upon usage, the number of dwelling units served by the washers is used to derive the clothes washer savings. The efficient AC/ heat pump column notes the type of unit installed as well as the number of units served by the system. The lighting column notes the actual number of fixtures installed.

Table 3-14. Installed Measures (Counts) by Project, Ameren Illinois Utilities Service Territory

Project	Refrig-erator	Dish Washer	Clothes washer	Air Handler	Bathroom Fan	AC/HP	Indoor/ Outdoor lighting	Reduced AC Capacity	Ceiling Fan
Project A	1	0	0	1	1	0	12/2	0	4
Project B	70	70	0	0	70	HP/70 units	1050/140	70	140
Project C	7	0	3 serving 3 units	7	7	CAC/7 units	61/23	7	14
Total	78	70	3 serving 3 units	8	78	77	1123/165	77	158

Table 3-15 below shows the energy (kWh) savings per project by measure category. The largest contributor to energy savings is from reduced AC/ heat pump capacity and efficient AC/HP. Together these two measure categories make up about 70% of the total kWh savings.

Table 3-15. Energy Impact by Measure and Project, Ameren Illinois Utilities Service Territory

Project	Refrig-erator	Dish Washer	Clothes washer	Air Handler	Bathroom Fan	Efficient AC/HP	lighting	Reduced AC/HP Capacity	Ceiling Fan
Project A	95	0	0	400	89	0	1,310	0	216
Project B	6,650	2310	1,666	0	6,230	197,798	109,970	148,348	0
Project C	6,65	231	71	28,00	623	1,759	8,381	6,595	757
Total	7,410	2,541	1,737	3,200	6,942	199,556	119,661	154,943	8,548

Table 3-16 below shows the total demand (kW) impact associated with each project by measure. The largest contributor to demand savings is from reduced AC/ heat pump capacity and efficient AC/HP. These two measures make up 82% of total PY2 demand reduction associated with projects in Ameren Illinois Utilities service territory.

Table 3-16. Demand Impact by Measure and Project, Ameren Illinois Utilities Service Territory

Project	Refrig-erator	Dish Washer	Air Handler	Bathroom Fan	AC/HP	Lighting	Reduced AC/HP Capacity	Ceiling Fan
Project A	0.0	0.0	0.1	0.0	7.8	0.1	0.0	0.0
Project B	0.7	0.7	0.0	0.7	33.7	12.6	29.4	0.9
Project C	0.1	0.1	0.4	0.1	0.0	1.0	11.0	0.1
Total	0.8	0.8	0.4	0.8	40.5	13.7	40.4	1.0

Either efficient air conditioners or heat pumps may be installed through the program. The largest Ameren Illinois Utilities project included the installation of geothermal heat pumps with a 16 to 24 EER rating. The impact from this heat pump installation was modeled by the Evaluation Team using engineering principles and reference materials. The modeled heat pump impact yields a total potential cooling demand impact, from which the demand savings is estimated (with a 70% factor).

Table 3-17. Air Conditioning and Heat Pump Impact Detail

Project	Equipment Description	CAC/HP Efficiency Rating	Source of Impact Estimates	CAC/HP kWh impact per unit	CAC/HP kW Impact per unit	Reduced Capacity kWh Impact per unit	Reduced Capacity kW Impact per unit
Project A	None	-	-	-	-	-	-
Project B	Geothermal Heat Pump	16-24 EER	Modeled	2,825	0.6	2,119	0.4
Project C	CAC	15 SEER	ES CAC calculator (Springfield MO)	251	0.2	942	1.6
Average per Unit				2,558	0.5	1,986	0.5

3.7 Application Specification Sheet Review

3.7.1 Specification Sheet Summary

Specification sheets are a required component of the grant application. The sheets are used to verify that the building plans will conform to program standards. Specification sheets were provided for 11 sites in PY1, and an additional 6 are analyzed for the PY2 evaluation. These are summarized in the 2nd and 3rd columns of Table 3-18 below.

Table 3-18 Specification Sheet Content

Measure and Specification	PY1 Sample	PY2 Sample
Energy Star Refrigerator		
If supplied, refrigerators shall be ENERGY STAR rated.	11	6
Lighting: 6 Interior and 2 Exterior Fluorescent Fixtures		
All hard-wired lights in each unit shall be fluorescent fixtures. All common area lighting shall be fluorescent.	5	2
A minimum of six fluorescent lighting fixtures shall be installed in high use areas of the home. All common area lighting shall be fluorescent.	4	3
A minimum of six fluorescent lighting fixtures shall be installed in high use areas of the home.	2	1
Air Conditioning: SEER 14 Central Air Conditioner		
Heating and cooling shall be provided by a geothermal system	4	2
Air conditioners shall have a minimum SEER value of 14	3	2
If air conditioning is provided, it shall be have a minimum SEER value of 14 and be ENERGY STAR rated.	1	1
VRF heat pump system shall have a minimum SEER rating of 14.	1	1
Air conditioners shall have a minimum SEER rating of 15.	1	0
Primary heating and cooling is being done with packaged terminal air conditioning units (PTAC). Units shall have a minimum EER value of 10.5	1	0
Through-the-wall air conditioning units shall be Energy Star® rated with a minimum 10.0 EER.	0	0
Reduced AC Tonnage: as a result of thermal envelope improvements		
Exterior wall insulation		
R15	1	0
R21	9	6
R24	1	0
Attic/Roof insulation		
R44	8	5
R49	3	1
Conditioned wall insulation		
R13	8	6
R15	1	0
R21	2	0
Windows		
maximum U-value of 0.34, low-E double glazed	8	1
maximum U-value of 0.35	0	0
maximum U-value of 0.35, low-E double glazed	0	5
maximum U-value of 0.35, low-E double glazed, SHGC shall not exceed 0.55	1	0
maximum U-value of 0.40, low-E double glazed	1	0
maximum U-value of 0.47, low-E double glazed	0	0
maximum U-value of 0.48, low-E double glazed	1	0
Air Infiltration		
All completed homes must have not more than 5.0 air changes per hour at 50 pascals as measured with a blower door.	11	6

Measure and Specification	PY1 Sample	PY2 Sample
Energy Star Dishwasher		
If supplied, dishwashers shall be Energy Star rated.	11	6
Energy Star Bathroom Exhaust Fan		
All bathroom(s) to be equipped with exhaust fans that are Energy Star rated. Fans shall be rated no less than 75 CFM at 0.25" of static pressure. Bathroom fans shall have a sone rating no higher than 1.5 and shall be vented directly outdoors.	7	4
A continuous central exhaust system shall be utilized to vent all bathrooms and kitchens. Alternately, all bathrooms to be equipped with ENERGY STAR® rated exhaust fans vented directly outdoors. Bathroom fans shall have a sone rating no higher than 1.5	0	0
A continuous central exhaust system shall be utilized to vent all bathrooms. Ventilation shall provide a minimum 75 CFM.	3	1
Ventilation shall be provided to patient rooms using outside air conditioned with a heat recovery system utilizing general exhaust from the building	1	1
A mechanical timer shall be used for the fan if the fan is controlled separately from the light. A fan-delay timer shall be used if the fan and ceiling light are controlled together.	8	4
90% AFUE Furnace with Efficient Air Handler		
Patient rooms shall be conditioned with a Variable Refrigerant Flow (VRF) heat pump system with a minimum SEER rating of 14.0.	1	1
All furnaces are electric. If gas or propane-fired furnaces are substituted, they shall have a minimum AFUE rating of 90% and shall be direct vent sealed combustion units.	2	0
Furnace shall have a minimum AFUE rating of 90% and shall be direct vent sealed combustion, unless an electric furnace is used.	1	1
Furnaces shall have a minimum AFUE rating of 90% and shall be direct vent sealed combustion units.	2	2
A geothermal system may be utilized for primary heating and cooling. Alternately, boilers used for heating (either primary or back-up for the geothermal system) shall be direct vent sealed combustion with a minimum efficiency of 88%.	1	0
Heating and cooling shall be provided by a geothermal system.	1	1
Boilers shall be direct vent sealed combustion with a minimum efficiency of 88%.	0	0
Primary heating and cooling is being done with a geothermal system. Boilers shall be direct vent sealed combustion with a minimum efficiency of 88%.	2	1
Primary heating and cooling is being done with packaged terminal air conditioning units (PTAC). Units shall have a minimum EER value of 10.5.	1	0

There has been some notable and positive changes to the content of the program specification sheets between PY1 and PY2. The bathroom fan timer specification, however, has improved since PY1, as now 4 of the 6 sites did specify "A mechanical timer shall be used for the fan if the fan is controlled separately from the light. A fan-delay timer shall be used if the fan and ceiling light are controlled together. ", meeting the EEAHC requirement. Also, a change has been

instituted that going forward the efficient appliance specifications will state positively whether they will be provided or not.

The sampled specification sheets do not specify the capacity or efficiency of the units installed. Specific information regarding the capacity and efficiency of installed units would be useful to verify the reduced AC capacity measure, as well as to support impact estimates reflective of installed efficiency rather than minimum qualifying efficiency[15].

The largest kWh impact is from the lighting measure. The specification sheets often specify fluorescent fixtures but not Energy Star certified fluorescent fixtures. It is unclear whether this distinction is material to the impact of the lighting measures. The issue will be investigated further in the PY3 evaluation. Manufacturer information for a sample of installed lighting fixtures will be requested, and relevant manufacturer data will be used to ascertain efficiency relative to similar Energy Star certified fixtures.

The largest kW impact is from the thermal envelope improvements. A large portion of the specification sheets were dedicated to this measure and covered topics such as insulation, air sealing and drywall improvements. All of the specification sheets stated "All completed homes must have not more than 5.0 air changes per hour at 50 pascals as measured with a blower door." As discussed in more detail in Section 3.4 Ex-Ante Impact Review, the air infiltration standards fall below the IECC 2009 residential code, which specifies a minimum air infiltration of 0.42 air changes per hour (ACH).

The electrical efficiency of the air handler on the furnace system is not directly addressed in the specification documents. It would be beneficial if the efficiency of the air handlers were addressed in the specification documents. Ideally, the ratings for air handlers would be specified in the EAE rating which reflects the absolute electrical energy used by the unit. During any type of verification or certification of install, procedures should be in place to verify that the furnace is not only 90% AFUE but also electrical energy efficient certified.

Half of the projects for which specification sheets were submitted are large multi-unit residential developments. As of August 18, 2009, large multi-family developments may be required to follow the commercial section of the 2009 International Energy Conservation Code (IECC) per Illinois state code if the buildings are more than three stories in height.

Additionally, as of January 29, 2010, Illinois state code requires that residential buildings (buildings that are detached one- and two-family dwellings and buildings that contain three or

[15] In support of the impact assessment presented in this report, efficiency information was provided by DCEO in separate documents.

more dwelling units and are three stories or less in height above grade) comply with the residential section of the 2009 International Energy Conservation Code (IECC).

3.8 Program Tracking System Review

Tracking of this program is kept in site-specific paper or electronic pdf files. Data structured in a flat file or relational database format that provide records for all participants in a single file is a valuable asset to any energy efficiency program, and is particularly useful for M&E activities. The data submitted in summary electronic format in support of this evaluation consisted of a list constructed in MS Word that contained the following:

- For projects completed during PY2:
- The name of project
- The date of completion
- The number of dwelling units included
- The building type (single-family, multi-family or rehab)
- For projects funded during PY2:
- The name of project
- The date of project funding
- The number of dwelling units included
- The building type (single-family, multi-family or rehab)

The contents of the tracking data submitted in support of the PY2 evaluation is substantially less comprehensive than what was provided in support of the PY1 evaluation. The Evaluation Team received tracking with the following contents for PY1:

- Building Type (Single Family, Multi Family, Rehab)
- Non-Profit Grantee (Participant Business Name)
- Project Name
- Project Location, City, Zip
- Total Grant Amount
- Grant Amount Paid for by Trust Fund/ComEd/Ameren Illinois Utilities
- Total Square Footage
- Number of Units
- Flag for whether the mean income is more or less than 150% of poverty line
- Estimated Project Start Date
- Flag indicating whether project is Scheduled to be Completed by May 2009
- Flag indicating whether project is Scheduled to be Completed by May 2010
- Project kWh Savings
- PY1 ComEd/Ameren Illinois Utilities kWh
- PY1 ComEd/Ameren Illinois Utilities EEPS

- Actual PY1 ComEd/Ameren Illinois Utilities EEPS

All of the tracking documents provided to the Evaluation Team relate to information collected prior to construction. It is recommended that the program maintain records of verification activities and outcomes to provide additional verification that the program guidelines are being met. This is particularly critical given the current program implementation which allows for exceptions to the prescribed measure bundle. Documentation of such exceptions, reasons behind each allowance, and most importantly, the resulting agreed upon change to ex-ante impact claims are essential to impact evaluation and verification efforts. The absence of such records, or the inability to provide such records to the Evaluation Team, creates uncertainty in resulting program impacts. In particular, impact values generated without this information are likely to be higher than actual accomplishments.

The EM&V effort would be greatly enhanced by the construction of a program tracking system, designed to provide consistent and comprehensive database records of program participation, accomplishments and verification. It is strongly recommended that the program develop and maintain a participant tracking system and that it reflect the following elements:

- Name of Project
- Unique Project ID
- Project address and building type
- Service territory of building
- Number of dwelling units and number of buildings
- Square footage
- Rehab or new construction designation
- Name of developer and/or grant applicant
- Contact information for developer/grant applicant
- Date of funding approval
- Date construction began
- Date construction was completed, or partially complete (if the latter, number of units)
- Details regarding any exceptions to the standard measure bundle
- Ex-ante impact for the project
- Sources and quantities of funding
- Measure data
    - Lighting: number of indoor fixtures and number of outdoor/common area fixtures
    - Efficient AC: type of air conditioning and associated SEER rating, capacity of air conditioning
    - Appliances: Quantity and type, For dishwasher and clothes washer, note water heating fuel type
- Verification data: Site inspection detail (dates, scope and outcome)

3.9 Cost Effectiveness Review

This section addresses the cost effectiveness of the EEAHC program. 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."*[16]

Table 3-19 summarizes the unique inputs used in a spreadsheet model to assess the TRC ratio for the EEAHC 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.

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

Table 3-19. Inputs to TRC Assessment for EEAHC Program

Item	ComEd	Ameren
Measure Life	20 years	20 years
Participants	417	78
Annual Gross Energy Savings	1,484 MWh	505 MWh
Gross Coincident Peak Savings	0.346 MW	0.0982 MW
Net-to-Gross Ratio	100%	100%
DCEO Administration Costs	$0	$0
DCEO Implementation Costs	$0	$0
DCEO Other Costs	$0	$0
DCEO Incentive Costs	$1,431,622	$254,475
Participant Contribution to Incremental Measure Costs	$0	$0

Based on these inputs, the TRC for this program is 2.12 for ComEd and 3.03 for Ameren and the program passes the TRC test.

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 EEAHC program completed electrically efficient construction of 417 low income dwellings in ComEd service territory during PY2, generating 1,484 MWh of energy savings, and 345 kW of demand reduction. These accomplishments represent 169% and 62% of the ex-ante energy and demand impact, respectively. Differences between ex-ante and ex-post impact are due to the installation of heat pumps which accrue energy savings over both heating and cooling seasons for both efficiency level and the reduced capacity requirement associated with the building envelop measures. In addition, there were larger than expected lighting installations in many of the projects.

The program as a whole –including ComEd and Ameren Illinois Utilities service territories— completed construction of 495 program funded dwelling units during PY2, and 699 units over the combined PY1 and PY2 periods. The associated energy savings totals 2,419 MWh and 0.4 MW. These accomplishments are well in excess of expectations.

4.2 Recommendations

Impact recommendations

- Efficient heat pumps accrue savings over both cooling and heating seasons, and are associated with a greater ex-ante impact expectation. The program may consider adjusting ex-ante impact for heat pump installations in accordance with the Energy Star heat pump savings calculator.

- Similarly, reduced tonnage has different expected impact for heat pump installations than for CAC installations. The program may consider adopting ex-ante impacts in accordance with the figures presented in Table E-4.

- The program should revise the impact associated AC capacity reduction for multi-family structures from 1 ton per unit to 0.56 tons per dwelling unit for PY2, consistent with engineering analysis results presented in Section 3.4 and Table E-4.

- Projects funded in PY3 and subject to residential IECC 2009 building energy code should not claim reduced AC (or heat pump) capacity savings, unless a stricter shell tightness guideline is invoked by the program.

Verification recommendations

- It is recommended that the program guidelines incorporate information and requirements regarding incentives for efficient ceiling fans.
- Additional detail regarding capacity and efficiency of installed AC equipment should be added to the specification sheet requirements or the tracking database.
- It is recommended that DCEO include information on the electrical efficiency of the furnace tem air handler be directly referenced in the specification documents or detailed in the tracking system. DCEO may also consider requiring an EUR[17] of 6 or less for this measure.
- It is recommended that verification activities and results be documented in the new tracking database.
- It is recommended that the program guideline for bathroom exhaust fans be revised to include a specific size and wattage range for efficient fans. As it is currently stated, the specification in the guidelines that bathroom exhaust fans "shall be rated no less than 75 CFM" does not provide sufficient specificity for the wattage of efficient fans.

Tracking system recommendations

The EEAHC program is in the process of developing a central tracking database. This effort is expected to substantially improve the EM&V process and minimize the record keeping and data transfer burden held by administrators.

It is recommended that the tracking system content and development process be coordinated with the EM&V team review to ensure the content will support evaluation efforts and that the process of developing and maintaining the new system is working effectively for all participants. In particular, the new tracking system is expected to be constructed and maintained as a supportive and integral component of regular program operations.

- It is recommended that the new tracking system database be constructed with standardized variables that can be manipulated with database tools, such as SAS or MS ACCESS.

[17] EUR stands for Electricity Use Ratio and is calculated as the ratio of the annual electricity use (Eae) divided by the furnace capacity in thousands of Btuh (kBtuh). (http://www.mass.gov/Eoeea/docs/dpu/gas/08-119/31109negfra12.pdf)

- It is recommended the new tracking system hold records of participation and verification activities, and the specific measures associated with each project.

Recommendations for alignment with codes and standards

As of January 29, 2010, Illinois state code requires that residential buildings (buildings that are detached one- and two-family dwellings and buildings that contain three or more dwelling units and are three stories or less in height above grade) comply with the residential section of the 2009 International Energy Conservation Code (IECC).

- The EEAHC program should consider adjusting the shell tightness requirement for new grant application in the next program year, where IECC residential will be the baseline for some projects. The Evaluation Team suggests a requirement of 0.35 ACH, which complies with ASHRAE 62.2.

- It is recommended that the program create protocols to ensure that all builders use the supplied funds to build homes for low-income dwellers.

- It is recommended that the program create an updated program standards document that specifies the low income protocols, measure specific funding levels, and other minimum electric measure and project requirements for participation.

Recommendations for Evaluation, Measurement and Verification

It is recommended that the PY3 evaluation apply engineering principals and detailed information regarding building projects to produce customized impacts associated with the efficient HVAC and building envelope measures.

It is recommended that further research be conducted regarding new IECC 2009 commercial code lighting requirements, as well as national lighting efficiency requirements. The potential implications of these regulations on program standards and associated energy and demand impact are critical to adopting appropriate and timely program design adjustments.

The demand impact associated with efficient clothes washers also requires identification and research in PY3.

Section 5. Appendices

5.1 Comparison of EEAHC Program Guidelines to IECC 2009 code

The state of Illinois recently enacted legislation to create a statewide energy efficiency code for commercial and residential structures. The state regulation now declares that the International Energy Conservation Code 2009 version (IECC 2009) is adopted as the state building efficiency code for residential and commercial buildings. The new regulation was effective as of August 2009 for commercial buildings, and January 2010 for residential buildings.

The EEAHC grant recipients are single and multi-family residential structures and thus will generally be covered by the residential regulations, except for cases of multi-family apartment buildings with more than three stories which will be directly covered by the commercial regulation. The new code raises the baseline for the impact of EEAHC measures to the extent that it requires more energy efficient measures than the previously existing code.

A comparison was done between the EEAHC program standards, a local building code (Chicago) and the IECC 2009 code. Building codes are jurisdictive on the city and county level, so there are multiple building codes that apply in within the ComEd and Ameren Illinois Utilities Service territories. A thorough investigation into all of the applicable building codes is beyond the scope of this evaluation, and most likely, the thermal building shell requirements are similar in all the codes. The Chicago Building Code is used as a representative building code in the analysis that follows.

The IECC divides Illinois into two separate climate zones. Those are zone 5A in the north and zone 4A in the south. Chicago lies in zone 5A.

Table 5-1 below shows principal cities in Illinois and corresponding climate zones.

Table 5-1. Major Cities and Corresponding Climate Zones

City	kWh/year
Cairo	4A
Carbondale	4A
Champaign/Urbana	5A
Chicago Area	5A
Decatur	5A
DeKalb	5A
East St Louis	4A
Effingham	4A
Galena	5A
Peoria	5A
Quad Cities Area	5A
Rockford	5A
Shelby Co area	5A
Springfield	5A

A comparison between the DCEO EEAHC specifications and the IECC 2009 code is presented in Table 5-2 below.

Table 5-2. DCEO Program Specifications Versus IECC 2009 Code: Residential Building Envelope Requirements

Structure Area	Chicago Building Code (Climate Zone 5)	IECC Climate Zone 4 Requirements	IECC Climate Zone 5 Requirements	DCEO Specifications	Comment
Sidewall, wood frame	R-13	R-13	R-20 or R-13+R-5 sheathing	R-21	Baseline increase Note (1)
Sidewall, brick or concrete	R-9.5 continuous insulation	R-5/R-10	R-13/R-17	R-21	Note (1)
Attic	R-30	R-38	R-38	R-49	Baseline increase
Foundation/Slab on Grade	unheated NR, heated R-10	R-10	R-10	R-10	Note (2)
Basement wall	NR unheated,				
R-9.5 heated	R-10/R-13	R-10/R-13	R-10	Note (3)	
Crawl space wall	NR	R-10/R-13	R-10/R-13	R-10	Note (3)
Crawl space ceiling	R-30	R-19	R-30	R-21	No change in baseline, Note (4)
Windows	U-0.35	U-0.35	U-0.35	U-0.35	No change in baseline
Ceiling with no attic	R-20 continuous insulation above deck	R-38	R-38	R-49	Baseline increase, Note (5)
Infiltration	NR	7 ACH_{50}	7 ACH_{50}	0.5 ACH_{nat}	Baseline increase, Note (6)

1) IECC raises the baseline for wood frame walls by R-5 if the insulation is continuous on the outside of the wall, or by R-7 if not. It raises the baseline in the case of brick or concrete walls by R-13 (since continuous R-9.5 insulation is equivalent to R-17 with thermal bridging.) Additionally, DCEO exceeds the IECC requirements assuming wood frame

construction is used. If brick or concrete block is used (mass wall) then the second R value must be placed on the interior. DCEO requires R-21 on the inside, which exceeds the IECC code for zone 4, but is less rigorous for zone 5a where IECC requires a total of R-30 split between inside and outside of mass wall. Note that for rehab projects EEAHC requires R-19 on the inside wall.

2) In the case of unheated slabs IECC raises the baseline from no insulation to R-10. There is no change in the case of heated slabs. DCEO meets IECC requirements except it is unclear on the depth of insulation as is directed in IECC.

3) Again, the baseline is increased in the case of unheated basements where there was no existing insulation requirement, however, in the case of heated basements, there is essentially no change in the requirement as the Chicago code requires R-9.5 continuous and IECC requires R-10 continuous or R-13 with thermal bridging (which actually yields a lower effective value of R-7). Crawlspaces are by definition unheated hence no requirement. DCEO specifies requirements of continuous R-10 for basement/crawlspace wall sheathing insulation, but IECC requires R-13.

4) IECC requires R-30 in zone 5 as opposed to the DCEO which requires only R-21. IECC does however allow an exception to go as low as R-19, if the floor/crawlspace ceiling framing will not allow R-30 to be installed.

5) The baseline increase to R-38 from R-20 continuous is difficult to quantify because the R-38 value assumes batts in a joist bay.

6) The ACHnat equivalent of 7 ACH50 is 0.42 ACHnat. This is calculated for the Chicago area using an LBL factor of 16.65 determined using a climate factor of 18.5, height factor of 1.5, wind shielding correction factor of 1.0 and leakiness correction factor of 1.0.

Table 5-3 below summarizes the major appliance or mechanical requirements and differences between IECC requirements and the current DCEO EEAHC specifications. The Chicago Mechanical Code was not compared to IECC because it is not available online. Most of the IECC requirements are equivalent to the Federal minimum requirement so the baseline could not have been any lower under the existing code. Therefore, the impact associated with the mechanical measures are unaffected by the adoption of IECC as the new code. The only exception is lighting, where IECC requires fluorescent fixtures, and it is likely that there was no such requirement in the pre-existing code.

Table 5-3. DCEO Program Specifications Versus IECC 2009 Code: Residential Appliance and Mechanical Requirements

Appliance or Mechanical	IECC Requirements	DCEO EEAHC Specifications	Comment
Interior Fluorescent fixtures	50% of permanent fixtures must be high efficiency lighting	6 interior fixtures. If less than 6 then all must be high efficiency lighting	DCEO exceeds IECC
Exterior and common area lamps	Not covered specifically	All must be fluorescent hardwired fixtures or equivalent per application document but only two required per other documents	DCEO exceeds IECC
Gas Furnace	Prevailing minimum federal efficiency (78% AFUE at writing)	90% AFUE, sealed combustion, direct vent, electronic motor	Note (7)
Boiler	Prevailing minimum federal efficiency (80% AFUE at writing)	88% AFUE, sealed combustion, direct vent,	Note (7)
Water Heater	Prevailing minimum federal efficiency. None stated in Federal standards however.	62% EF and Energy Star rated	Note (8)
Air Conditioner/Heat pump	Subject to the International Residential Code (IRC) sizing and efficiency standards, programmable thermostat required	SEER 14 except for moderate rehabs, single family remodeling, and direct install program where it is SEER 16, programmable thermostat required	Note (9)
Air distribution ducts	R-6 except when located in attic, R-8 insulation in attic, sealing per IRC, tightness verification required in residential if ducts are in unconditioned	No insulation standard, All ducting in building thermal envelope, seal with mastic	Note (10)
Bathroom exhaust fans	Not Covered in IECC, maybe in IRC, any exhaust opening must have a damper	Energy Star, 75 CFM at 0.25 inch static on timer switch	Note (11)
Kitchen exhaust fan	Not Covered in IECC, maybe in IRC, any exhaust opening must have a damper	75 CFM, no Energy Star rating required	Note (11)
Refrigerator, dishwasher, clothes washer	Domestic appliances not covered	All, if provided by the install and renovation contractor, must be Energy Star rated	DCEO exceeds IECC

7) The DCEO exceeds the IECC in gas furnace efficiency requirements, as well as for hydronic heating boilers.

8) The IECC states that the water heater should meet or exceed Federal standards in place. We were unable, however, to find such a standard. DCEO requires a 62% EF and Energy Star certification. All Energy Star efficient gas storage water heaters will have an EF of 62% or greater. In September of 2010 the standard will change to 67%.

9) The IECC does not specifically call for a minimum SEER for AC. It instead references its sister document, the International Residential Code (IRC). The IRC contains instructions for properly sizing an AC unit. It takes into consideration that SEER alone does not guarantee energy efficiency. An over or under sized unit may also waste energy with short cycling or continuous operation. Both require programmable thermostats.

10) The DCEO guidelines state that all ducts must be inside the building thermal envelope. The IECC does allow ducts outside the conditioned space but they must be insulated as stated in Table 12.

11) The one point here is the IECC requires any exhaust fan have a mechanical or gravity damper at its exterior exit. This is not mentioned In the DCEO document but it should be part of the requirements. Outside leaking drafting in through exhaust fans represent a significant energy loss. Energy Star rated kitchen stove hoods are available and perhaps it should also be a requirement of the DCEO program.