DCEO
Energy Efficiency/Demand Response Plan
Plan Year 1 (6/1/2008-5/31/2009)
Evaluation Report:
Energy Efficient Affordable Housing Construction Program
ComEd Service Territory

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The Department of Commerce and Economic Opportunity

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Final Report

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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 Energy Efficiency Trust Fund[1] and the Energy Efficiency Portfolio Standard Fund, grants are funded through the Energy Efficient Affordable Housing Construction Program: a program that 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 must implement the full set of program measures, as follows:

- Energy Star® refrigerator
- Six interior fluorescent fixtures and 2 exterior fluorescent fixtures
- SEER 14 central air conditioner with programmable thermostat
- Reduce required central AC tonnage as a result of thermal envelope improvements
- Energy Star dishwasher
- Energy Star rated bathroom exhaust fan
- 90% AFUE furnace with efficient air handler

Evaluation Overview

The EEAHC program impact claim for the Program Year running June 2008 – May 2009 (PY1) is zero due to the fact that implemented activities have not been in place long enough to generate measured savings. However activities incented during PY1 will begin to generate impact in PY2 and PY3. The objective of the PY1 Evaluation is to assess the systems in place to implement the program and track accomplishments, as well as to examine methods of applying ex-ante impact claims.

The intent behind the PY1 evaluation is to:

- Provide early feedback and guidance regarding program tracking and verification policies,
- Recommend revisions to ex-ante impact assumptions that will improve impact estimates, and
- Identify areas of impact uncertainty to guide Program Year 2009 evaluation activities.

[1] Illinois's 1997 electric-industry restructuring legislation created separate public benefits funds that support renewable energy and residential energy efficiency. The efficiency fund is known as the Energy Efficiency Trust Fund. Electric utilities and alternative retail electric suppliers contribute annually a pro-rata share of a total amount of $3 million, based on the number of kilowatt-hours sold during the previous year.

Although this report identifies projected ex-ante impact claims, there remains some uncertainty regarding what the final content of those claims will be. Further, verification work planned for the PY2 evaluation will be critical to the assignment of final ex-post impact. Thus, until a claim has been filed and all of the planned evaluation activities relevant to that claim have been complete, no final ex-post evaluation impact figures will be published.

The recommended revisions to ex-ante impact assumptions identified in this report will be incorporated into evaluation adjustments made to the PY2 claim. The PY2 evaluation will integrate the algorithm review presented in this report with verification and baseline research conducted as part of the PY2 evaluation, to yield final ex-post adjustments to the PY2 claim.

In order to meet the PY1 objectives, the Evaluation performs 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 processes, implementation issues and concerns
- documentation of program theory and logic

Evaluation results are based on electronic and hard copy program documentation as well as three in-depth interviews conducted with key program implementation staff.

Program Accomplishments

The Program is administered across both ComEd and Ameren Illinois Utilities service territories. Goals are set for the overall program, including planned accomplishments in both service territories. The overall goals for number of dwellings constructed were met for PY1. The goal was to begin construction of 652 dwellings in PY1, and the actual number of dwellings that began construction in PY1 was 759. Due to the lag between construction and occupancy, about 75 percent of the kWh and kW savings associated with these installations is expected to accrue in PY3, and the remaining 25 percent are expected to begin generating impact in PY2.

There were 614 dwellings constructed through the EEAHC program *within ComEd service territory* in PY1. These were constructed within 11 building projects. One project is a new single-family project, one is a gut rehab project and the remaining 9 are new multi-family buildings. Among these, two multi-family projects were fully completed during PY1. The associated electricity savings is 2,210 kWh per dwelling and 1.491 kW demand savings per dwelling. PY1 projects have ex-ante impact of 353,600 kWh in PY2 and 1,003,340 kWh in PY3. The evaluation-based revised ex ante impact is 337,080 kWh in PY2 and 956,465 in PY3. Due to the lag between project initiation and occupancy, no impact is credited to the program for PY1.

Evaluation Findings

Verification, Due Diligence and Tracking System Review

The Evaluation findings show consistency in reporting and documentation between electronic and hard copy sources. Recommendations are made for improvements to the verification procedures, documentation, and program tracking in particular.

A fuel bill analysis verification of therm impact has been conducted for this program in past years. However, it is not currently being conducted for electricity measures, and there are no plans to implement

such a verification system. As part of this evaluation the fuel bill analysis technique for therm impact is reviewed and the feasibility of conducting a similar analysis for electricity impact is analyzed (see Section 3.1.3). It is not recommended that a fuel bill-based verification be instituted for this program to verify kWh impact. The results of the fuel bill analysis are difficult to interpret without matched data from similar nonparticipating buildings. Further, the results serve to verify only the measures related to the cooling costs, which make up 36 percent of overall program measure impact.

On-site verification of installed measures is regularly performed by program staff, but is not recorded in a central database. Detailed information regarding the appliance and lighting installations are also not recorded. It is recommended that formal verification procedures and guidelines be drafted and that they include standardized recording in a tracking database. Database tracking should keep a record of all on-site verification activities and findings, including dates of visits, measures verified, blower door test results and the make and model of efficient appliances installed. Grantee contact information should also be recorded centrally for each participating project.

Specification sheets provide the documentation of program-qualifying building standards and are required as part of the grant application. These specification sheets are site specific text documents and store all available details regarding the installed measures. Specification sheet guidelines could be tightened to exclude non-specific language, such as *"If supplied, refrigerators shall be ENERGY STAR® rated"*, and to ensure that lighting fixtures are Energy Star certified. Information contained in the specification sheets is currently stored as a 'pdf[2]' file in a central database. However, it would be useful to track these records in a database with standardized variables and records that can be more readily analyzed.

Ex-Ante Impact Algorithm Review

Based on the review of ex-ante impact algorithms and assumptions, a number of revisions to the values used in electricity savings calculations are recommended. Adjustments are recommended for all measures except bathroom exhaust fans and 90% AFUE furnace with efficient air handler. Table 1 summarizes recommendations for changes to ex-ante per-unit impact values based on a review of measure impact calculations.

[2] Portable Document Format.

Table 1: Algorithm Review Results

Program Measures	Ex-Ante kWh/unit	Ex-Ante kW/unit	Revised kWh/unit	Revised kW/unit
6 interior fluorescent fixtures & 2 exterior fluorescent fixtures	782	0.089	788	0.090
Reduce required tonnage as a result of thermal envelope improvements	432	0.72	608	1.01
90% AFUE furnace with efficient air handler	400	0.046	400	0.046
SEER 14 central air conditioner w/ programmable thermostat	366	0.61	93.75	0.16
Energy Star rated bathroom exhaust fan	89	0.01	89	0.01
Energy Star refrigerator	79	0.009	95	0.01
Energy Star dishwasher	62	0.007	33	0.006
Total Unit Savings	2,210	1.491	2,107	1.33

Source: file submitted by DCEO to EM&V Team Template – Low Income New Construction and Gut Rehab.pdf

Process Findings

Issues identified through process evaluation include challenges regarding the additional funding sources added to the program, and the subsequent need to split and track two funding sources. Program management is currently working on a method to best assess and allocate funds. These challenges, along with significant planned program growth, indicate it may be prudent to consider an increase in staff.

New funding from the Energy Efficiency Portfolio Fund broadened the qualifying criteria for grants. Whereas only non-profit builders previously qualified, grantees may now include for-profit builders,. The program needs to create protocols to ensure that the for-profit builders use the funds to build homes for low-income dwellers.

Current program design requires grantees to apply for funding and complete building construction within 12 months. This timeframe is incompatible with the time it takes to build these units and does not allow for unpredictable road blocks that may be inevitable. The program should continue with its efforts to move toward an expanded 24 month timeline.

1 INTRODUCTION TO PROGRAM

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. Supported by funding from a variety of sources, including Energy Efficiency Trust Fund and the Energy Efficiency Portfolio Fund, grants are funded through the Energy Efficient Affordable Housing Construction Program: a program that funds low income new construction and gut rehab projects.

1.1 Program Description

The Energy Efficient Affordable Housing Construction (EEAHC) program provides funds to affordable housing developers. Funding is not provided for individual measures; grantees must 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).

The required energy efficient measures for EEAHC participation include Energy Star refrigerator, interior and exterior fluorescent fixtures, Energy Star bathroom exhaust fan, Energy Star dishwasher, SEER 14 CAC with programmable thermostat, 90% AFUE furnace with efficient air handler, and finally, improved building envelope and resulting reduced AC tonnage. All of these measures must be installed for each unit of each participating building. The incentive per dwelling for these measures is $2,300.

1.2 Evaluation Questions

The principal evaluation research questions addressed by this Program Year 2008 (June 2008 through May 2009) evaluation include the following:

- What are the gross annual energy (kWh) and peak demand (kW) savings achieved by the program?
- How do these achievements compare with the goals?
- 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?
- How does the program design compare with implementation features, and how do these compare to national best practices?
- How effective are current marketing and outreach tools? What could be improved?

2 EVALUATION METHODS

2.1 Analytical Methods

Evaluation methods for Program Year one (spanning June 2008 through May 2009) leverage a variety of program data to assess tracking, verification, implementation and energy impact claims. A detailed characterization of program design, objectives, processes and implementation methods is assembled with input from program documentation materials as well as in-depth interviews conducted with key implementation staff.

Evaluation methods include the review of stipulated savings algorithms, using the Energy Star savings calculator, data from the Gas Appliance Manufacturer Association, and descriptions of baseline or pre-retrofit assumptions. In addition, the evaluation team assembled and reviewed a sample of applications, installation receipts and other paper files supporting program participation. Evaluation methods include the following components:

- Verify total tracking system ex-ante calculations. Review impact claims and compare with electronic and paper file documentation.
- Review and comment on verification procedures and results.
- Review and comment on ex-ante impact claims algorithms and assumptions
- Examine and compare hard copy application files to the tracking systems to inform tracking system assessment.
- Review and comment on electric fuel bill analysis process and results.
- Identify key goals and program design and implementation issues.
- Ensure marketing and outreach strategies, as well as other related program collateral, align with and clearly communicate program benefits.

2.2 Data Sources

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

- All tracking data and electronic project records.
- Relevant engineering algorithms and ex-ante savings calculations
- Existing impact-related metadata (fuel bill analysis, verification data, blower door tests, other DCEO low income evaluation SAE bill analysis results)
- A sample of paper files supporting program project applications, including hard copy applications, status reports, and other relevant supporting documents for a sample of projects.
- In-depth professional interviews with key implementation staff (See appendix for in-depth interview guides and interview records).
- Program marketing materials and related program collateral.

3 PROGRAM LEVEL RESULTS

This section details the impact and process evaluation results for program year one (June 2008 through May 2009).

3.1 Impact Assessment

This section presents the results of the Energy Efficient Affordable Housing Construction Program impact evaluation.

3.1.1 Summary of Program Accomplishments

The goals for number of units installed were met for PY1. The goal was to install 652 units in 2008, and the actual number of units that began construction was 759. Because the project must be completed and tenants must be occupying the space before any energy savings can be realized, the energy savings for projects completed in PY1 are assumed to begin to accrue savings in the year following project completion. Therefore there were no savings goals for PY1. Only 27 percent of the units that began construction in PY1 are expected to be completed in time to begin accruing impact in PY2, while almost three-quarters of the units that began construction in PY1 are expected to begin accruing impact in PY3. The three year goals and PY1 accomplishments for this program for both ComEd and Ameren Illinois Utilities service territories *combined*, are presented in Table 2 below.

Table 2: Overall Program Goals Compared to PY 2008 Ex-Ante Accomplishments[3]

	Goals		PY1 Accomplishments	
Program Year	Installations	MWh impact	Installations	Ex-Ante MWh impact
PY1	652	0	759	0
PY2	1,087	1,095	-	451
PY3	1,957	2,921	-	1,227

Source: Excel file submitted by DCEO to EM&V Team, "Residential retrofit final 09.xls"

Participation Summary

Of the 759 installations through the EEAHC program, 614 were constructed *within ComEd service territory* in PY1. These were constructed within 11 building projects. Building projects and their impact information are provided in Table 3 below. One project is a new single-family project, one is a gut rehab project, and the remaining 9 are new multi-family buildings. The associated ex-ante electricity savings are 2,210 kWh per unit and 1.491 kW demand savings per unit. Evaluation-based revised impact estimates are 2,107 kWh and 1.33 kW per unit.

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

There is a time lag between project initiation, incentive distribution, and the occupancy of the new dwellings. For this reason program savings do not begin to accrue in the same year of recorded participation. PY1 projects have ex-ante impact of 353,600 kWh in PY2 and 1,003,340 kWh in PY3. Revised energy impact is 337,080 in PY2 and 956,465 in PY3.

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

Type	Units	Ex-Ante PY2 kWh	Ex-Ante PY3 kWh	Ex-Ante PY2 kW	Ex-Ante PY3 kW	Revised PY2 kWh	Revised PY3 kWh	Revised PY2 kW	Revised PY3 kW
New Multi-Family	71	0	156,910	0	106	0	149,579	0	95
New Multi-Family	94	75,140	132,600	51	89	71,630	126,405	45	79
New Multi-Family	81	179,010	0	121	0	170,647	0	108	0
New Multi-Family	41	90,610	0	61	0	86,377	0	54	0
New Multi-Family	72	0	159,120	0	107	0	151,686	0	95
New Multi-Family	60	0	132,600	0	89	0	126,405	0	79
New Multi-Family	70	0	154,700	0	104	0	147,473	0	93
New Multi-Family	16	0	35,360	0	24	0	33,708	0	21
New Multi-Family	99	0	218,790	0	148	0	208,568	0	132
New Single-Family	6	0	13,260	0	9	0	12,641	0	8
Gut Rehab	4	8,840	0	6	0	8,427	0	5	0
Total	614	353,600	1,003,340	239	676	337,080	956,465	213	603

Source: Excel file submitted by DCEO to EM&V Team, "Residential retrofit final 09.xls"

3.1.2 Ex-Ante Impact of Program Measures

There are seven required measures for each constructed unit in order to receive a grant through this program. The largest ex-ante kWh impact measure is fluorescent lighting, accounting for 35 percent of the total kWh savings. Thermal envelope improvements and the two HVAC measures each account for 17 to 20 percent of the total ex-ante kWh impact. The bathroom exhaust fan, the refrigerator, and the dishwasher combined account for the remaining 10 percent of the total kWh impact. The largest kW savings measure is thermal envelope improvements, which makes up 48 percent of total kW impact. The 14 SEER air conditioner measure accounts for another 41 percent of total kW impact. Table 4 below presents the ex-ante impact for these seven measures.

Table 4: Ex-Ante Impact by Measure Installed

Program Measures	Ex-Ante kWh/unit	Ex-Ante kW/unit
6 interior fluorescent fixtures & 2 exterior fluorescent fixtures	782	0.089
Reduce required tonnage as a result of thermal envelope improvements	432	0.720
90% AFUE furnace with efficient air handler	400	0.046
SEER 14 central air conditioner w/ programmable thermostat	366	0.610
Energy Star rated bathroom exhaust fan	89	0.010
Energy Star refrigerator	79	0.009
Energy Star dishwasher	62	0.007
Total Unit Savings	2,210	1.491

Source: file submitted by DCEO to EM&V Team Template – Low Income New Construction and Gut Rehab.pdf

3.1.3 Verification and Due Diligence

This section presents the evaluation findings of the verification procedures that are integral to program design and implementation, as well as those that were conducted as part of this evaluation.

Currently, the EEAHC program conducts annual gas fuel bill analysis on a selection of sites for the first three years following occupancy of units. Field inspections are scheduled before the sidewalls are closed in for insulation and before air sealing inspection. Another inspection is performed at the substantial completion stage, and at this time a Blower Door test is performed to measure air leakage.

The administration team for this program follows the planning and progress of each participating site. Building plan specifications are submitted to DCEO, which are reviewed along with blueprints to verify that the building plans align with program guidelines.

Building specifications are submitted with each application, and the site inspection results are kept by DCEO in site-specific files. However, there is no program-wide dataset describing the verification activities.

Fuel Bill Verification Review

While the focus of this evaluation is on the electric measures funded by ComEd and Ameren Illinois Utilities, the EEAHC program has been operating since 1988 with grants funded elsewhere that support gas savings measures. In past years, staff of EEAHC have conducted fuel bill-based verification for claimed therm savings. No similar fuel bill verification is currently implemented for electric savings measures, and there are no plans to develop such a model.

The method previously used to establish gas savings with fuel bills is summarized below:

1. For each participating site, the gas consumption records are assembled for a full year.
2. The daily baseload (cooking, hot water) consumption is determined by averaging over summer usage, when the heating system is not engaged.

3. The heating season is determined with gas meter readings – typically this starts in October and ends in March.
4. Heating degree days are calculated over the full heating season.
5. Total gas consumption during the heating season period is computed, and from this value estimated daily baseload consumption is subtracted. Note daily baseload consumption is assumed constant year round.
6. Total gas consumption (Btus) is divided by building square footage and then by heating degree days to yield a heating index.

The results are used to estimate a heating cost per unit per year, and to generate a heating index that is normalized for weather and building size and can be compared across years and between buildings.

This gas fuel bill analysis approach likely overestimates heating costs. Water heating and cooking gas usage is likely higher than the assumed year-round value in the winter due to lower water intake temperatures and a general tendency to use stoves more intensively during the winter.

The presence of unoccupied units may lead to an underestimate of fuel costs for heating and should be removed from the premise level billing dataset.

In order to evaluate savings, energy consumption in buildings with energy efficient technologies installed should be compared to consumption for similar nonparticipating buildings. On one occasion several years ago two similar buildings were gut rehabbed at the same time—one through the EEAHC program and one with standard practices. After both rehab projects were complete, run-time meters were installed on the boilers in both buildings to measure the energy savings. Of course, opportunities like this do not arise regularly. In the absence of appropriate comparisons to similar nonparticipating buildings, fuel bill analysis results can be difficult to interpret.

It is possible to put together a similar bill-based approach to estimate AC usage and the cooling expense per dwelling over a calendar year. However, this approach is not recommended for two reasons. First, the result, by itself, does not verify energy savings. Similar to the heating case, an estimate of cooling kWh consumption does not directly verify savings versus a baseline unless the analysis includes nonparticipating buildings of similar vintage and use for comparison. Second, conducting this analysis would serve to verify savings from only the building envelope and efficient AC measures, leaving most of the program savings unverified, and thus does not warrant the expense.

Hard Copy Application Review

One hard copy application, consisting of four documents, was received and reviewed. The first document contained a brief summary of project description, project tasks, and reporting/monitoring requirements and stated the number of units being installed and the amount of grant money awarded. The second document presented a breakdown of the awarded grant money and stated the number of units and square footage of the units. The third document included some of the information contained in the tracking database, such as address, number of units, utility, construction start date, and the developer information. The last document contained contact information for grant manager, auditor, report delivery schedule, detailed application including spec sheet, legal language, and the programs terms and conditions. All of the data contained within the hard copy data was consistent with the electronic tracking database.

Application Specification Sheet Review[4]

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. These were assessed against the program standards and impact calculation assumptions. A summary of what was found is provided in Table 5 below.

Table 5: Program Measures vs. Installed Measures

Measure	Count
1.) Energy Star Refrigerator	
If supplied, refrigerators shall be ENERGY STAR rated.	11
2.) Six interior FL fixtures & 2 exterior FL fixtures	
All hard-wired lights in each unit shall be fluorescent fixtures. All common area lighting shall be fluorescent.	5
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
A minimum of six fluorescent lighting fixtures shall be installed in high use areas of the home.	2
3.) SEER 14 central air conditioner w/ programmable thermostat	
Heating and cooling shall be provided by a geothermal system.	4
Air conditioners shall have a minimum SEER value of 14.	3
If air conditioning is provided, it shall be have a minimum SEER value of 14 and be ENERGY STAR rated.	1
VRF heat pump system shall have a minimum SEER rating of 14.	1
Air conditioners shall have a minimum SEER rating of 15.	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
4.) Reduce required tonnage as a result of thermal envelope improvements Cooling capacity reduced from 36,000 Btuh (3 tons) to 24,000 Btuh (2 tons) as a result of the following envelope improvements: • Improve sidewall insulation to R21 from R10 • Improve roof cavity insulation to R44 from R30 (includes use of Energy Star compliant roofing when appropriate) • Improve windows from standard double-glazed to double-glazed low-E with a solar heat gain coefficient no higher than 0.55	
Exterior wall insulation	
R15	1
R21	9
R24	1
Attic/Roof insulation	
R44	8
R49	3
Conditioned wall insulation	
R13	8
R15	1
R21	2

[4] The "Specification Sheet Review" comments on all specification sheets provided, including those in both Ameren Illinois Utilities and ComEd service territories.

Table 5: Program Measures vs. Installed Measures (Continued)

Measure	Count
Windows	
maximum U-value of 0.35, low-E double glazed	8
maximum U-value of 0.35, low-E double glazed, SHGC shall not exceed 0.55	1
maximum U-value of 0.40, low-E double glazed	1
maximum U-value of 0.48, low-E double glazed	1
All completed homes must have not more than 5.0 air changes per hour at 50 pascals as measured with a blower door.	11
5.) Energy Star dishwasher	
If supplied, dishwashers shall be Energy Star rated.	11
6.) Energy Star rated bathroom exhaust fan (impact based on Energy Star rated fan at 90 CFM and 28 watts)	
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
A continuous central exhaust system shall be utilized to vent all bathrooms. Ventilation shall provide a minimum 75 CFM.	3
Ventilation shall be provided to patient rooms using outside air conditioned with a heat recovery system utilizing general exhaust from the building.	1
7.) 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
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
Furnace shall have a minimum AFUE rating of 90% and shall be direct vent sealed combustion, unless an electric furnace is used.	1
Furnaces shall have a minimum AFUE rating of 90% and shall be direct vent sealed combustion units.	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
Heating and cooling shall be provided by a geothermal system.	1
Primary heating and cooling is being done with a geothermal system. 2. Boilers shall be direct vent sealed combustion with a minimum efficiency of 88%.	2
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

The supplied specification sheets made no mention of the capacity of the units installed, which are assumed to be one ton smaller per unit than a baseline construction method would yield. Specific information regarding the capacity of installed units would be required to verify this assumption.

The largest kWh impact is from the lighting measure. It is worth noting that all of the specification sheets documented the installation of interior fluorescent fixtures. None of the specification sheets documented the installation of the 2 exterior fluorescent fixtures required as part of the program, although they do mention common area lighting. Energy Star provides a certification for residential fluorescent fixtures. Specification sheets should confirm that each installed lighting fixture is not only fluorescent, but certified by Energy Star.

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 part of the program, Energy Star rated refrigerators and dishwashers are to be installed in each unit. However, all of the specification sheets stated "if supplied" they would be Energy Star rated. It is not clear from the information received whether these items were or are going to be installed.

The electrical efficiency of the air handler on the furnace system is not directly addressed in the specification documents. Efficiency of the air handlers for both electrical and gas powered heating systems should be addressed directly in the specification documents. In addition, the ratings for air handlers may 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.

Specification Sheet Content versus Program Requirements

Specification sheets were reviewed to document compliance with program guidelines. It is observed that no one site had all the required measures installed. The problem may lie in a failure to eliminate from funding consideration projects that don't meet qualifications, or it may lie in a mismatch between the required qualifications and industry standards, or it may lie in inadequately designed or filled out specification sheets. It will require field verification to document whether the required measures were installed as planned. For example, most site specification documents did not address the requirements for a timer switch on bathroom exhaust fans. It could be they are not planned to be installed, or that they were installed and just left out of the specification document.

The EEAHC requirements appear to target single family or small multi-family structures. As can be seen in Table 6 the structure that comes closest to meeting all the requirements is a single family structure (Shelby County). Some of these projects may be residential but their construction appears to border on commercial standards with possible central plant heating and ventilation systems, such as Mercy Housing in Chicago and the Hospice of North East Illinois.

Table 6: Specifications versus Program Requirements

Site Name	Energy Star Refrig.	Fluorescent Lighting Fixtures	Energy Star Bathroom Fan	Energy Star Dish Washer	SEER 14 CAC	90% AFUE Furnace	Bldg Envelope Improve
TRP	Yes	Yes	ES NSW	Yes	Yes	Yes	Yes
NEI Hospice	Yes	Hard	No Spec	Yes	Yes	No Gas Heat	Yes
Mt Sinai	Yes	Yes	ES NSW	Yes	Yes	Yes	Yes
Postigo	Yes	Yes	ES NSW	Yes	Yes	Yes	Yes
Mercy	Yes	Hard	Central NSW	Yes	Yes	Yes	Yes
Shelby Cty	Yes	Yes	ES NSW	Yes	Yes	Yes	Yes
NHS	Yes	Hard	ES NSW	Yes	Yes	Yes	Yes
Homestead	Yes	Yes	ES NSW	Yes	Yes	Qualify(1)	Yes
TRP Morgon	Yes	Hard	Central NSW	Yes	Yes	Yes	Yes
IFF	Yes	Yes	Yes	Yes	No	No	Yes
Bluestem	Yes	Yes	ES NSW	Yes	Yes	Qualify(2)	Yes

Explanation of table nomenclature

Yes	The specifications appear to have met the requirements of the EEAHC program
Hard	The specifications for lighting require that hard-wired permanent fixtures be fluorescent.
ES NSW	The specifications require the planned use of Energy Star bathroom exhaust fans, but do not document the time switches that are installed as required by EEAHC program guidelines.
Central NSW	The type of residential facility built is a multi-unit structure with all exhaust provided by a central fan. This is a common technique in condominiums and apartment buildings. It is questionable whether this meets the requirements of the EEAHC program or is an energy efficient solution. A central system is less often able to vary its main fan CFM or speed with duct static pressure. However, if there is a damper which opens and closes by an owner controlled timer switch, the resulting change in duct static pressure would slow or speed up the main fan, decreasing energy use. Such a system is energy efficient even if it is not Energy Star.
No spec	The documentation shows the project had no specifications to install this energy measure.
No Gas Heat	This site used a heat pump system instead of gas furnace for heating.
No	It is unclear whether the in wall AC/heat unit meets EEAHC requirements. It's difficult to achieve the EEAHC requirements with an in wall unit, but if the site was designed to use those then is it up to EEAHC to adjust accordingly. That is, if the program accepts these systems in residential sites then corresponding minimum energy efficiency standard should be set. .
Qualify(1)	This system located in the Champaign-Urbana area is a ground source based heating and cooling system. The system in and of itself may meet program requirements but the question is, was there also a heat backup system to provide added heat to the heat source loop? With the climate in the area it may be difficult to obtain enough heat from a ground source system. Was an additional source of boiler heat added? If so, did it meet the EEAHC requirements for heating boilers?
Qualify(2)	The spec calls first for electric furnaces with gas allowable as a substitute. The EEAHC requirements, however, are based on gas fired furnaces. The EEAHC requirements in spirit could be met by an electric furnace if there are units which incorporate energy efficient fans and controls that meet the same requirements as gas furnaces. Both systems share the same equipment for moving heated air. The question is what agency would be the certifying agency as to if the electric furnaces meet the same requirements as gas furnaces. Would AHRI for example have such a certification? If so, then perhaps EEAHC requirements should be adjusted to incorporate this. If electric furnaces did not qualify at all, then this site's furnaces, if finally installed as electric, would not have met program qualifications.

All projects for which specification sheets were submitted, with the exceptions of the Shelby County Community Services sites and the Postigo LLC site in Waukegan, are large multi-unit residential developments. Large multi-family developments may be required to follow the commercial section of the IECC per Illinois state code in the future.

Having a large multistory structure does not rule out following EEAHC Program Guidelines. The TRP Resurrection project on Morgan St. in Chicago is a several story apartment building per the TRP website. The only area it misses in the DCEO requirements appears to be in that it uses a central ventilation system for bathroom exhaust, which by its nature excludes use of Energy Star exhaust fans.

If an on-site verification and impact evaluation is to be done for some of these projects, it should be conducted not strictly as a residential evaluation but may need to invoke commercial structure standards and methods as well. Different techniques would be required at different sites. The construction techniques and building layout for larger structures would entail modeling the building in E-quest or similar building models as one large structure as opposed to smaller individual structures. Many apartments might have an outside wall exposure only on one wall, similar to an office area.

Large multi-family structures may require both a sample of individual apartments inside the building and assessment of the overall energy envelope of the building.

A summation of building types is presented in Table 7 below. Information was obtained from development company web sites, news releases and Goggle Earth.

Table 7: Participating Building Type Summary

TRP (The Resurrection Project)	Apartment Building
Hospice of Northeastern Illinois	Combined apartment bldg and medical facility
Mt. Sinai Development Corp	Individual homes (possible townhomes)
Postigo LLC	Exact nature unknown, probably small apt. bldg
Mercy Housing Lakefront	Multistory Apartment Bldg
Shelby County Community Services	Individual home
Neighborhood Housing Services	Townhomes
Homestead Corp of Champaign-Urbana	Townhomes
TRP (The Resurrection Project) Morgan Street	Multistory Apartment Bldg
IFF Countryside	Multistory Apartment Bldg
Bluestem Housing Partners	Townhomes

3.1.4 Program Tracking System Review

Tracking of this program is currently largely in site specific paper or electronic 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 currently available in electronic format structured in a flat file or relational database is limited to the following elements:

- 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
- PY 09 ComEd/Ameren Illinois Utilities kWh
- PY 09 ComEd/Ameren Illinois Utilities EEPS
- Actual PY 09 ComEd/Ameren Illinois Utilities EEPS

All of the documents we received seem to be from information collected prior to construction. It is important to also have a record of the actual measures installed during construction to see that the program guidelines are being met.

As part of the electronic tracking database, there are a few items that would be helpful to include in the future to aid in a more comprehensive evaluation.

- Make and model numbers for the appliance measures (collected at the time of inspection).
- Number of fluorescent fixtures actually installed.
- Actual insulation R-values installed.
- Notes from site inspections, including dates of visits, all measures verified

3.1.5 Gross Impact Claims Review

This section presents a review of ex-ante savings calculations as presented in DCEO documents.

An engineering review is presented for the potential energy savings calculations presented in DCEO documents for the EEAHC program.

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 79 kWh per unit per year based an older version of the Energy Star savings calculator.

The current Energy Star refrigeration savings calculator[5] does not confirm the ex-ante impact claim. The current tool shows that an upgrade from a standard to Energy Star refrigerator saves 95 kWh per year with life cycle savings (12 year life cycle) of 1142 kWh.

Recommendations

Based on this finding, we recommend increasing the kWh impact claim from 79 to 95 kWh. Invoking the ex-ante demand to energy ratio, this corresponds to 0.01 kW.

Fluorescent Lighting

Impact assumptions

- Savings should be calculated based on existing national comparisons between standard and Energy Star certified appliances
- As specified in the EEAHC program requirements, six interior fluorescent fixtures and two exterior fluorescent fixtures are used in each unit

Engineering reviews

EEAHC program requirements specify that six interior fluorescent fixtures and two exterior fluorescent fixtures are to be used in each newly constructed home. The associated ex-ante impact claim is 782 kWh per year. Program impact claim documentation states these values are based on the Energy Star savings calculator.

The Energy Star savings calculator[6] confirms ex-ante savings claims, with a slightly higher result at 788 kWh per year. These calculations are based on lights installed in high use areas, which is consistent with notes provided on the specification sheets that are submitted with the application. Although outdoor lighting fixtures are often not noted in the specification sheets, common area lighting is noted to be fluorescent.

For the indoor lighting savings calculation, the Energy Star calculator assumes the equivalent of just under 28 watts per fixture of fluorescent lighting. Energy Star provides a certification for residential light fixtures that requires minimum lumens per watt that range from 50 to 70, depending on the size and total wattage of the fixture. Assuming 60 lumens per watt, this translates into 10,080 lumens. The standard assumption for lighting requirements is 15 lumens per square foot. Thus, this lighting installation would serve 670 square feet of living space. This amount of high use area is reasonable and consistent with the typical size of homes constructed through the program, which is approximately 1,000 square feet.

Recommendations

It is recommended that impact from fluorescent fixture installation be revised from 782 kWh per year electricity savings and 0.089 kW demand reduction to 788 kWh electricity savings per year and .090 kW demand reduction.

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[5] http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators.

[6] http://www.energystar.gov/index.cfm?c=fixtures.pr_light_fixtures

Central Air Conditioning

Impact Assumptions

- Impact should be calculated based on existing national comparisons between standard and Energy Star certified appliances
- Central Air Conditioning is installed within each incented unit, has a 2 ton capacity and a minimum 14 SEER rating

Engineering reviews

The savings claimed for efficient air conditioning units are 366 kWh per year per dwelling based on the Energy Star savings calculator. Efficient units are specified as a minimum of 14 SEER with programmable thermostat.

The current Federal standard for Air Conditioning efficiency is 13 SEER. Program standards assume a two ton unit for each dwelling. The Energy Star Calculator shows that moving from a 13 SEER unit to a 14 SEER unit with 2.5[7] tons of capacity for the city of Springfield IL, yields 143 kWh impact per year. To compensate for smaller capacity of program units, a proportional downward adjustment[8] of 0.8 is applied, yielding 115 kWh per year per unit. Springfield Illinois yields the highest impact of the 5 cities available in the Energy Star Calculator. The average across all five cities is 93.75 kWh. Results for each of the 5 cities are shown in Table 8 below.

Table 8. Annual Energy Savings Estimates for Efficient Central AC (14 SEER) Relative to a 13 SEER Baseline

City	kWh per year
Chicago	76
Springfield	115
Peoria	105
Rockford	79
Moline	92
Average	**93.75**

[7] A 2.0 ton capacity is not an available specification for the calculator.

[8] Proportional adjustment is the ratio of the assumed capacity of 2.0 tons and the calculator assumed capacity of 2.5

Recommendations

It is recommended that EEAHC base expected impact on the Energy Star Calculator invoking a 13 SEER baseline which yields annual impact per unit of 93.75 kWh, and 0.16 kW.

Reduced Required AC Tonnage as a Result of Thermal Envelope Improvements

Impact assumptions

- Impact should be calculated based on existing national comparisons between standard and Energy Star certified appliances
- Building envelope improvements lead to a reduction in AC tonnage from 3 tons to 2 tons.

Engineering reviews

The ex-ante claimed energy savings due to reduced AC tonnage resulting from building envelope improvements is 432 kWh per dwelling per year based on an assumed reduction from 3 tons to 2 tons. The reduced tonnage results from the following:

- improve sidewall insulation to R21 from R10
- improve roof cavity insulation to R44 from R30 (includes use of ENERGY STAR compliant roofing when appropriate)
- improve windows from standard double-glazed to double-glazed low-E with a solar heat gain coefficient no higher than 0.55

The current Energy Star calculator reflects a change in capacity from 3 to 2 tons results in annual energy savings between 745 kWh (for Springfield IL) to 514 kWh (Rockford IL). Indeed, EEAHC figures are on the conservative end of this spectrum. Table 9 below shows the Energy Star based estimates of reduced tonnage across various major cities in Illinois.

Table 9: kWh Savings from Reduction in Required Tonnage by Metropolitan Area

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

The DCEO Low Income Energy Efficient Direct Install Retrofit Program guidelines claim that improvements to the building envelope reduce required AC capacity by a full ton. Similarly, building envelope improvements for the EEAHC program, which are relative to baseline construction practices and codes, have a similar claimed impact. Little detail regarding the basis for these claims is provided in the program ex-ante savings calculation documents.

Basic calculations using online tools[9] show that moving from un-insulated space to insulated (wall and ceiling) space results in approximately a one ton reduction in required AC tonnage, for a 1,200 square foot dwelling. However, quite a few building specification assumptions are required to produce this estimate that may or may not reflect actual circumstances in participating buildings.

Recommendations

Based on the expected impact of reduced tonnage predicted by the Energy Star Calculator, it is recommended that the EEAHC program begin claiming 608 kWh per unit, and 1.01 kW. At the same time, as stated above, said reduction in required capacity should be verified, to the extent feasible, with PY2 Evaluation activities.

Further baseline research and on-site engineering analysis of participating sites are recommended to verify the measure ex-ante claim of a one ton reduction in required AC tonnage due to thermal envelope improvements. This research should be supported with good baseline data for comparison.

Energy Star Dishwashers

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

The ex-ante impact claim for installing an Energy Star dishwasher is 62 kWh per year. This ex-ante value was originally based on the Energy Star calculator.

Currently, the Federal energy standard for dishwashers specifies an Energy Factor (EF) of at least 0.46 for standard-size dishwashers. For estimating the annual energy use of dishwashers, it is assumed that a household runs 215 dishwasher loads each year. Thus, the minimum compliant dishwasher would use 467 kWh/year, not including standby losses for control electronics which are typically 2 watts (~17 kWh/yr)[11]. *Energy Star* dishwashers are required to have a maximum energy use of 324 kWh/year and 5.8 gallons per cycle for standard models, yielding an expected savings of 140 kWh per year over the minimally efficient unit[10].

[9] http://www.consumerreports.org/cro/appliances/heating-cooling-and-air/air-conditioners/sizing-worksheet/index.htm

[10] The Federal standard for dishwashers will change as of January 1, 2010. The Federal standard will change from an energy factor of .46 to a new standard of no more than 355 kWh per year for a standard size dishwasher. This reduces the spread between Federal Standard and Energy Star to just 31 kWh per year beginning January 1, 2010.

As of July 1 2011, Energy Star will again change its minimum standard for dishwashers, bringing it to a maximum of 307 kWh per year. The difference between minimally efficient and Energy Star will then be 53 kWh per year

However, there are few dishwashers available today that function at minimum efficiency standards[11]. Most dishwashers have an energy factor of 0.57 or higher with corresponding annual consumption of about 375 kWh per year or lower. Generally speaking, modern dishwashers vary substantially in their energy use. Many Energy Star dishwashers substantially exceed the minimum Energy Star standards. In fact, a survey of 453 new dishwashers (both Energy Star and Standard) completed in 2008[12] yielded an average energy factor of 0.67, slightly exceeding the minimum Energy Star requirement. Consistent with these market findings, the current Energy Star dishwasher savings calculator invokes current market averages instead of minimum efficiency standards. The Energy Star calculator assumptions rely on average energy factors calculated for all qualifying dishwashers and all nonqualifying dishwashers. Predicted savings is dependent on the type of water heating equipment. With electric water heating, the calculator predicts savings of 74 kWh per year. With gas water heating, the savings is predicted to be 33 kWh per year. Gas is the predominant fuel source for water heating in the EEAHC program delivery area.

Recommendations

It is recommended that the expected impact for dishwashers funded in PY1 be revised to 33 kWh per year, and 0.004 kW[13].

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.

[11] "How Energy Efficient are Modern Dishwashers? " Authors, David E. Hoak, Danny S. Parker and Andreas H. Hermelink, Original Publication Proceedings of ACEEE 2008 Summer Study on Energy Efficiency in Buildings, American Council for an Energy Efficient Economy, Washington, DC, August 2008. Florida Solar Energy Center website: http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1772-08.pdf

[12] "How Energy Efficient are Modern Dishwashers? " Authors, David E. Hoak, Danny S. Parker and Andreas H. Hermelink, Original Publication Proceedings of ACEEE 2008 Summer Study on Energy Efficiency in Buildings, American Council for an Energy Efficient Economy, Washington, DC, August 2008. Florida Solar Energy Center website: http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1772-08.pdf

[13] It is also recommended that the claim for Energy Star dishwashers be revised for PY2 to reflect the new Federal Standard that will take effect January 1, 2010.The claim should again be revised when Energy Star minimum, standards change in 2011.

The EEAHC ex-ante 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. The minimum wattage rating for an Energy Star listed fan at 90 CFM is 32 watts, 4 watts higher than the 28 watt assumption.

However, the specifications provided by the program participants in 10 of 11 projects state the exhaust fans shall be rated no less than 75 CFM. The Energy Star requirements for bathroom exhaust fans between 10-89 CFM are 1.4 CFM[14] per watt, which yields annual energy (at 2 hours per day) of 54 watts. However, A review of Energy Star qualifying fans shows that the average CFM per watt for 80 CFM fans is 3.3 CFM per watt, which yields 27 watts, nearly identical to the ex-ante measure assumptions.

Recommendations

No change to ex-ante claimed impact for bathroom exhaust fans is recommended.

[Further research into the average operating hours of bathroom exhaust fans is also recommended.]

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 (4 of 11) or geothermal (3 of 11).

Often the air handler energy rating is expressed in Eae[15], which is not a relative measure, the larger the unit for heating purposes the larger the Eae. 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[16]. The publication calculates savings for heating and separately for cooling from

[14] http://www.energystar.gov/index.cfm?c=vent_fans.pr_crit_vent_fans

[15] Average Annual Auxiliary Electrical Consumption

[16] Saving Energy with Efficient Residential Air Handlers. by Harvey M. Sachs and Sandy Smith, April 2003, (http://www.aceee.org/pubs/a033full.pdf)

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 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. However, further verification data and market research of baseline will be conducted as part of the PY2 evaluation.

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

3.2 Process Evaluation

This section provides a summary of the process-related findings for the June 2008 - May 2009 Program Year (PY1). The evaluation efforts for the EEAHC Program for this year are design to be a "kick-off" effort to identify the key goals and program design and implementation issues, while future program year efforts will delve deeper into a full process assessment. The third year program effort will include more interviews and offer expanded analysis including comparing the program to best practices, synthesizing staff and participant feedback, and providing recommendations for improvements.

As part of this "kick-off" effort, Opinion Dynamics conducted depth interviews with the three most influential and informed program personnel and reviewed the program implementation plan and application package. These interviews were conducted with the technical contractor for the program (Domus PLUS), the DCEO program manager and the DCEO division manager between June and September 2009. During the interviews, we explored the program's processes and roles of program staff, with a focus on indentifying key goals and program design and implementation issues.

3.2.1 Program Theory

Program Goals and Design

The program provides incentives to affordable housing builders and developers in an effort to help offset the incremental cost of installing energy efficient measures. Incorporating energy efficiency into low-

income housing developments is not perceived as a standard practice. It is believed that builders and developers would not install energy efficient measures without the incentives as they are primarily motivated to keep their building material costs low. In this respect, the program helps overcome this cost barrier in the marketplace and encourages the adoption of energy efficient measures in affordable housing projects.

"What was going on is that in an effort to keep construction costs low, developers kept all of the energy efficiency measures out of the buildings. So consequently ended up with buildings that had affordable rents, but the people couldn't afford the fuel bills."

Stimulating the adoption of energy efficient measures in the affordable housing sector has multiple desired outcomes including:

- Improved energy utilization and overall quality of affordable housing;
- Decreased energy use and costs for affordable housing building occupants;
- Improved affordable home building practices;
- Increased awareness and appreciation of the benefits of energy efficiency among affordable housing occupants and developers;
- Increased knowledge of how to build energy efficient homes at reasonable costs; and
- Increased energy standards for affordable housing projects.

To achieve these desired outcomes, the program is designed so that grantees must accept a full set of efficiency measures[17]. It is believed that the energy standards required for this program are much higher than standard affordable building practices, and the grant is designed to *"help offset the incremental cost of getting to these higher standards."* When the program started in the 1980s, the grant amounts were set at below full incremental cost so that the developers would have to invest in the energy measures as well. Grantees currently receive a range of incentives for various types of rehab and new construction projects that includes $4,500 per unit in the rehab of a multi family building and $4,000 per unit for new single family homes. New multi-family buildings receive between $4.00 and $4.25 per square foot of living space. The program manager believes that the grant amounts should be increased because they do not think the grants cover as much of the incremental cost to install energy efficient measures as they used to, especially given the downturn in the economy. However, the program implementers do not currently know how much of the incremental costs the grants currently cover. If this continues to be an issue for the program, it is recommended that the program begin to track the incremental cost to install energy efficient measures in relation to the amount each grantee receives from the program to better justify the need for increased funding.

[17] According to the program implementation plan, these measures include Energy Star refrigerators, interior and exterior fluorescent fixtures, Energy Star bathroom exhaust fans, Energy Star dishwashers, SEER 14 CAC's with programmable thermostats, 90% AFUE furnaces with efficient air handlers, and improved building envelope practices resulting in reduced AC tonnage. The June 2009 application package notes specific R-value requirements for sidewalls, attics, and foundations; double glazed windows with low-E coating; specific air sealing requirements; specific efficiency levels for furnaces, boilers, water heaters, and air conditioners; duct sealing; specific requirements for bathroom and kitchen exhaust fans; Energy Star refrigerators, dishwashers, and clothes washers if provided; and a minimum of six interior fluorescent lighting fixtures.

"Usually every year I lose a couple of projects because the grant amount is not covering the amount of the upgrades I'm asking for… We desperately need more affordable, healthy, safe, energy efficient housing for the low income people of the state."

The program is also designed to account for mixed-use buildings, buildings that contain both affordable housing units and market rate units. In these cases, the program gives a grant for the number of units that will be affordable, but all the units must get the energy package. Therefore, the program is encouraging the installation of energy efficiency measures in market rate housing as well, although this is not a goal of the program nor is it funded by the program.

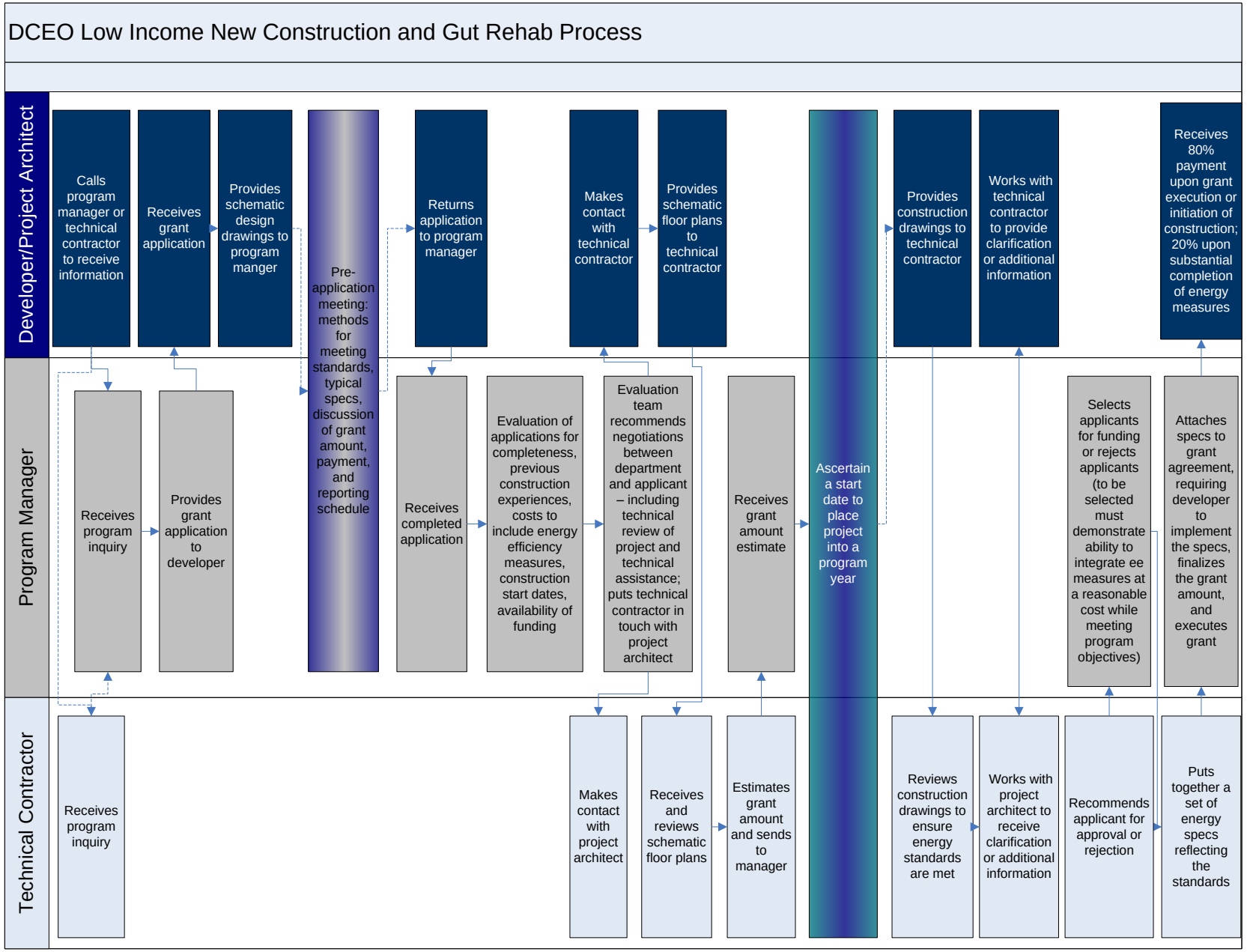
Program Implementation

This program is managed by three key people, the program manager, the DCEO division manager and an external contractor. The program is managed by DCEO, and DCEO works closely with the contractor, Domus PLUS, that provides technical assistance. All of the key management and technical personnel involved in implementing the program were managing the pre-existing program. The technical contractor has been working with the program manager for 21 years. Attorneys are also involved to review grants.

According to our depth interview, the greatest strength of the program is that it's not complicated. It's a one page application, and people only have to deal with two people who are "*pretty easily accessible."*

"And I think that close knit working relationship that we have has worked well. I think people, even though they are working with a state program, feel that it may not be a state bureaucracy."

Our evaluation explored the process by which applications are received, reviewed, processed and paid. The figure below provides a graphical presentation of how the program is implemented and the key steps involved by each stakeholder (i.e. technical contractor, program manager and developer/architect).


DCEO Low Income New Construction and Gut Rehab Process
Developer/Project Architect
Program Manager
Technical Contractor
Calls program manager or technical contractor to receive information
Receives grant application
Provides schematic design drawings to program manger
Pre-application meeting: methods for meeting standards, typical specs, discussion of grant amount, payment, and reporting schedule
Returns application to program manager
Makes contact with technical contractor
Provides schematic floor plans to technical contractor
Provides construction drawings to technical contractor
Works with technical contractor to provide clarification or additional information
Receives 80% payment upon grant execution or initiation of construction; 20% upon substantial completion of energy measures
Receives program inquiry
Provides grant application to developer
Receives completed application
Evaluation of applications for completeness, previous construction experiences, costs to include energy efficiency measures, construction start dates, availability of funding
Evaluation team recommends negotiations between department and applicant – including technical review of project and technical assistance; puts technical contractor in touch with project architect
Receives grant amount estimate
Ascertain a start date to place project into a program year
Selects applicants for funding or rejects applicants (to be selected must demonstrate ability to integrate ee measures at a reasonable cost while meeting program objectives)
Attaches specs to grant agreement, requiring developer to implement the specs, finalizes the grant amount, and executes grant
Receives program inquiry
Makes contact with project architect
Receives and reviews schematic floor plans
Estimates grant amount and sends to manager
Reviews construction drawings to ensure energy standards are met
Works with project architect to receive clarification or additional information
Recommends applicant for approval or rejection
Puts together a set of energy specs reflecting the standards

Grants are often paid with 80% up front because the grants are not made *"until they are ready to dig."* The remainder is paid upon *"substantial completion."* However, because of the split between electric and gas, it might be 65% out of one funding source and 35% out of another. Generally EE Trust fund payments (i.e., funds from the natural gas side) are split 90/10 and EE Portfolio dollars are split 50/50, resulting in the overall 80/20 split. The plan also often pays the first portion of the payment in one program year and the remainder in another program year. For PY2 and beyond, the program is considering changing the payments to 50/25/25.

The project completion deadline to receive a grant is May 31st, which we found to be a challenge for the program managers.

"I have to tell my grantees, I need you to have all the electric measures installed, not just obligated money, but I have to have them plugged in saving a kilowatt by May 31st. That is the worst date you could pick for construction to say you have to be complete"

We found in the interviews that a new construction project generally takes 12 to 18 months, and the May 31st deadline creates only an 11 month window for completion. This is the reason that they are now writing two-year agreements. However, problems often come up when developers say they can do it in the year and then issues come up on-site.

"Some of them lost their funding; took them a year to get their funding and that whole thing expired before they even began."

3.2.2 Process Findings

Impact of New Funding on an Existing Program

The Energy Efficient Affordable Housing Construction (EEAHC) program has been in existence since 1988. EEAHCP started as a gut rehab program for multifamily and single family homes, but later merged with new construction. 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 Trust Fund (now covering only gas measures) and the Energy Efficiency Portfolio Fund (covering only electric measures).

The additional funding source and subsequent need to split and track two funding sources has presented a challenge for the program. Program management is currently working on a method to best assess and allocate funds. Currently, the program and division manager work together to examine each grant application and appropriately split the grants since some measures, such as insulation, can claim both kilowatt hour (kWh) and therm credits. Two funding sources require twice the paperwork to get each project into the DCEO's accounting system. The accounting system cannot currently put two funding sources into a single grant. A solution to this inefficiency is considered outside the purview of the program as it is a larger issue with the DCEO's accounting system.

The program historically provided grants to non-profit affordable housing developers for energy efficiency opportunities. However, beginning in PY1, the grants were made available to for-profit developers as well. This has presented another challenge for the program as they now need to establish protocols for ensuring that for-profit builders intend to build housing for low-income populations, a protocol that was not deemed necessary for non-profit builders given their inherent missions and established relationships with the program. The program manager has a long history working with non-profits and feels assured that the building will always stay as affordable housing. However, with new for-

profit participants, the question was raised, *"How do I make them prove it is low-income and it stays [that way]?"* The program managers are working on documents to make the grant recipient sign that would provide some sort of assurance or proof.

In addition, the DCEO generally defined low-income as 80% of the Average Median Income (AMI). When the additional Energy Efficient Portfolio funds began, the definition for low-income was set at less than 150% of the poverty level, which the program implementers noted set the bar too high for grants. However, a bill signed in 2009 changed that eligibility to 80% AMI. The original 150% poverty line designation also presented some challenges until the statute was changed to 80% AMI. According to the interviews, 150% poverty is *"very, very low. It was too difficult for [the] program to work with."* We found that 150% poverty is approximately equal to 30% AMI; the people that fall into that category generally rent rather than own. For this reason, almost all of the projects in 2008 were paid entirely out of the Efficiency Trust Fund because they could not meet the 150% poverty level requirement to receive Energy Efficiency Portfolio Funds. The program mangers noted that they could only claim kilowatt savings on one project last year. However, with the statute change to 80% AMI, all of the projects now qualify, so this issue is no longer a problem. Furthermore, because the program implementation plan assumes no completions and therefore no kWh savings the first year, the program actually exceeded its goals.

The program implementation plan shows the estimated participation increasing from 652 units in 2008 to 1,087 in 2009 and 1,957 in 2010. The corresponding budget rises from $1.5 million in 2008 to $2.5 million in 2009 to $4.5 million in 2010. These numbers, along with the challenges foreseen in the depth interviews, indicate that increased staffing may be warranted. The division manager noted that additional people being hired to help with stimulus programs may be moved into EEAHCP projects *"either in the third year of the program or the second three year plan."*

Marketing

Many groups including the Illinois Housing Development Authority, the Chicago Department of Housing, and the Community Investment Corporation, as well as project architects, suggest the program to affordable housing developers. The program implementation plan adds, "Combined with the expanded level of funding that will be available, close cooperation with these groups will be critical to expanding the implementation of energy efficiency to additional new construction and gut rehab projects." In addition, the EEAHCP partners "will be utilized to market the program changes, particularly the scope expansion to for-profit developers".

Our interviews confirmed that although program staff and contractors have made a lot of presentations at conferences and workshops, because this program has been around so long, marketing is primarily word of mouth with architects, lenders, developers - *"a relatively close knit network."* Many architects and general contractors who have previously worked with the program tell the developers to get in touch with the program manager. Our depth interviews showed that additional marketing is not necessary at this time because the program is receiving a sufficient amount of interest.

Communication and Tracking

The program and division manager work down the hall from each other so they communicate informally whenever there is a need. They noted that about once a month the technical consultant comes in and all three of them meet. Communication between the technical contractor and the program manager is informal – emails and phone calls. The informal communication *"works very well. It worked for 20 some years…But we talk every other day."*

The tracking database for the program is also informal. The technical contractor keeps track of start dates and contact people for projects and checks up with them. The technical contractor eventually gets completion dates and does site visits to keep track of progress. The technical contractor uses an Excel spreadsheet. The technical contractor sends the program manager the spreadsheet every three months as part of a quarterly status report. The quarterly status report contains the projects completed the previous quarter, the projects under construction, and the projects in negotiation. Program staff also have a running tally of projects completed since the start of the program.

This informal communication and tracking structure may need to be reconsidered if the program expands to include new staff and more projects. Program administration may occur more efficiently if all program staff utilize the same tracking spreadsheet, thus avoiding duplication or contradictory information.

The division manager also noted:

> *[The program manager and technical consultant] really have down the process of communicating with the developers, the architects, and so on, the whole process of actually they've reviewed the plans, [the technical consultant] makes sure they've built in all of the specs into the project. And so we're getting what we're paying for…*

Program Internal QA/QC Procedures

The program implementation plan notes that this program will continue EEAHCP practices of annual fuel bill analysis for the first three years following occupancy of units, field inspections prior to closing of sidewalls for insulation and air sealing inspection, and another inspection and blower door test upon substantial completion. The 2009 application package notes that grant recipients must agree to assist with energy consumption analysis for three years following building occupancy. It specifies that the analysis will be conducted using run time meters on the heating system or signing fuel bill release forms. Based on our depth interviews, these QA/QC procedures are the responsibility of the technical contractor.

Our depth interviews revealed that field inspections are performed for most every project, except on occasion if they are *"way down state,"* then the architect or builder may send photos. Site visits are made for the following reasons:

> *You know I don't need to see structural work going up for new construction for example. But I would like to see all of the installations going in and if you've got the right insulation. When the heating system is going in, I want to make sure you've got the right one. So I'll do that type of work. Then when the project is done, I'll try to get in to do a blower door test…And that's also interesting because I like to get one of the first couple of units that are done, get the architect out to the builder so they can see how well they are doing. If there is some leakage sights, that's stuff that they can correct on future units.*

A fuel bill analysis has not been performed for a couple of years: *"We don't do everything. We'll pick out projects that we're really curious about and get fuel bills and do the analysis for that."* Items that trigger an analysis include *"the size of the project, if they did a little bit differently in there, perhaps a different insulation type. Maybe a project that is a new builder or a new architect, you want to see how it did. That's primarily it."* This analysis had not been done for any projects funded in 2008 as of September 2009.

Participant Satisfaction

Our depth interviews with the program staff suggest that developers are very satisfied with the program: *"My feeling is that they actually love it because a lot of them keep coming back."* Anecdotally, developers tell the program managers that they can see huge differences in their fuel bills between buildings where they take an energy grant and those that do not. The only slight dissatisfaction might be the amount of time it takes to get a grant. However, interviews with developers are planned to occur in PY3 and we will check to see if they agree with the program manager's assessment of satisfaction.

3.3 Cost Effectiveness

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."*[18]

Table 10 summarizes the unique inputs used in a spreadsheet model to assess the TRC ratio for the EEAHC program in PY1. Most of the unique inputs come directly from the evaluation results presented previously in this report. DCEO administration, implementation and other costs come from the budgets filed as part of the 2008 DCEO Energy Efficiency Plan.[19] 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.

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

[19] Exhibits 1.2 through 1.10 in DCEO testimony filed in Docket Nos. 07-0539 and 07-0540.

Table 10. Inputs to TRC Assessment for EEAHC Program

Item	Value Used
Measure Life	20 years
Participants	614
Annual Gross Energy Savings in Year 3 and beyond	1,294 MWh
Gross Coincident Peak Savings in Year 3 and beyond	0.817 MW
Net-to-Gross Ratio	100%
DCEO Administration Costs	$35,833
DCEO Implementation Costs	$0
DCEO Other Costs	$0
DCEO Incentive Costs	$1,412,200
Participant Contribution to Incremental Measure Costs	$0

Based on these inputs, the TRC for this program is 1.84 and the program passes the TRC test.

At this time, additional benefits related to reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC. These additional benefits would increase the given TRC benefit/cost ratio.

4 CONCLUSIONS AND RECOMMENDATIONS

- It is recommended that the ex-ante electricity impact claim be revised to reflect the findings in this report. This would decrease electricity savings claims by 5 percent, and demand claims by 11 percent. Final ex-post impact values for the PY2 claim will integrate the algorithm reviews presented here with verification and baseline work to be completed as part of the PY2 Evaluation.
- It is recommended that a formal tracking system be instituted for this program.
  - The tracking system should hold detailed records of inspection activities. Records should include dates and location of blower door tests, and related results. Dates, activities and results of all inspections should be housed centrally in a tracking system database.
  - The tracking system should record model numbers of equipment installed, including refrigerators, dishwashers, air conditioners, furnaces, and bathroom fans. Key energy consumption statistics should also be recorded, such as Eae or EUR for the efficient air handler, CFM for bathroom fan, and the capacity and efficiency of air conditioning equipment.
  - The tracking system database should be constructed with standardized variables that can be manipulated with database tools, such as SAS or MS ACCESS. Such a system would better support impact evaluation and verification efforts.
- It is recommended that the wording of the specification sheets be modified as follows:
  - Wording should be modified such that it is clear whether refrigerators and dishwashers are being installed. Specification sheets say "Refrigerators, dishwashers and clothes washers ***(if supplied)*** shall be Energy Star rated." These measures are claimed in the unit impact, and therefore their installation should be confirmed.
  - Specification sheets should confirm that installed lighting fixtures are certified to be Energy Star compliant. The total number of outdoor and common area fixtures should also be noted.
- It is recommended that the electrical efficiency of the furnace or heating-system air handler be directly referenced in the specification documents, and that DCEO require an EUR[20] of 6 or less for this measure.

[20] 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.aceee.org/pubs/a033full.pdf)

- It is recommended that DCEO consider adopting IECC[21] codes as program standards or as a starting point from which more stringent standards can be invoked. These codes are developed to be both flexible and comprehensive, and leave fewer gaps than program standards can typically afford.
- It is recommended that the program begin to track the incremental cost to install energy efficient measures as a means of addressing program management's concern with the size of the grants relative to the incremental cost of the measures.
- 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 continue its efforts to move from a 12-month timeline toward a 24-month timeline for building construction.

[21] See Appendix, Section 5.2 for a full discussion and comparison of EEAHC Program Guidelines to IECC 2009 Code.

5 APPENDICES

Appendices to this Report include the in-depth interview guide used in program implementation and management staff interviews.

5.1 Data Collection Instruments

PY2008 Evaluation Depth Interview Guide

Program Overview

1. Could you briefly describe the program?
    a. Can you describe the history of the program? How did it begin and why?
    b. How is the program implemented? Who are the implementers?
    c. What is the DCEO's role in the program?
2. Could you describe the goals and objectives for the program? Did it meet its target for 2008?

Program Management

1. Could you briefly summarize your role in program?
2. What are your main responsibilities?
3. How long have you been involved in the program?
4. Who else is involved in the program implementation?
5. Can you describe each person's roles and responsibilities?
6. What other groups does this program work with, i.e. Illinois Housing Development Authority and architects?
7. How do they work together and how often?
8. How is this going?
9. Areas of improvement?
10. What kind of formal and informal communication is set up between program stakeholders? (regular meetings, calls, email, informal communication between set meetings, etc.)
11. Were there any marketing or promotional efforts done for PY2008?
    a. Who is responsible for it?
    b. Do you have any marketing materials that you can share?
    c. Is new construction and gut rehab marketed together?
12. Does this program collaborate with similar ComEd and/or Ameren residential new construction and rehab programs?

Program Databases & Documents

1. Is there a tracking database for the program?
    a. Is it electronic or hard copy?
    b. How can we obtain tracking data and project records such as applications?
2. Are there any monthly or quarterly reports that you can share with us?

QA/QC and Verification Procedures

1. Can you walk me through the ways in which you check-in on the program for quality assurance?
    a. Who implements this process?

b. How are the samples selected?
c. How often is it done?

2. The implementation plan states that the program includes an annual fuel bill analysis for the first three years following occupancy of units.
    a. Is that happening or still planned?
    b. Have you, or do you plan to, report on this analysis?
    c. Do you already have something that outlines the approach and results of any verification efforts underway? We will likely ask for detailed information regarding any verification efforts for the evaluation including the actual algorithms used.

Program Participants

1. Let's focus for a minute on the builders that participate in the program.
    a. What do you perceive as the level of satisfaction among the builders that participate in the program?
    b. What are the standard practices for building low income homes?
    c. How do builders find out about the program?
    d. What is the builders' motivation to participate in the program?
    e. Do you think builders would likely implement these energy efficient measures without the program?

Program Strengths & Weaknesses

1. What do you see as the greatest strengths of the program?
2. What are some challenges to program success so far? [Probe for internal barriers such as application processes, management, implementation program design and external barriers in the marketplace]
3. How are the challenges being addressed?
4. Are there any program issues that you would like to see explored through this evaluation?

5.2 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 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 commercial buildings.

The EEAHC grant recipients are single and multi-family residential structures and thus may not be directly covered by this regulation. The standard does not apply to most residential structures:

"The Law does not apply to officially designated historic buildings, buildings exempt from a local building code, buildings that do not use energy for comfort conditioning and buildings wired for less than 100 amps of power or buildings that do not have electric comfort heating. The Law also does not apply to residential structures: with three stories or less above ground, houses, townhouses, row houses,

apartments, convents, monasteries, rectories, fraternity and sorority houses, dormitories, and rooming houses, all of which are three stories or less[22]."

However, since it is the intent of the state to adopt energy efficiency codes for commercial structures, it would seem by extension the state would want to follow the residential section of the same code if possible. It is even possible that the residential section of the code may be adopted as a statewide efficiency code in the future.

To see if DCEO specifications meet the IECC 2009 code a comparison was done between the two. The IECC divides Illinois into two separate climate zones. Those are zone 5A in the north and zone 4A in the south.

Table 11 below shows principal cities in Illinois and corresponding climate zones.

Table 11: Major Cities and Corresponding Climate Zones

City	Zone
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 12 below.

[22] From the DCEO website: http://www.illinoisbiz.biz/dceo/Print/default.htm?uid={EDB09923-4FFF-4BBE-A043-DB0E76DA31FD}

Table 12: DCEO Program Specifications Versus IECC 2009 Code: Building Envelope Requirements

Structure Area	IECC Climate Zone 4 Requirements	IECC Climate Zone 5 Requirements	DCEO Specifications	Comment
Sidewall, wood frame	R-13	R-20 or R-13+R-5 sheathing	R-21	DCEO exceeds IECC, Note (1)
Sidewall, brick or concrete	R-5/R-10	R-13/R-17	R-21	Note (1)
Attic	R-38	R-38	R-49	DCEO exceeds IECC
Foundation/Slab on Grade	R-10	R-10	R-10	Note (2)
Basement wall	R-10/13	R-10/13	R-10	Note (3)
Crawl space wall	R-10/13	R-10/13	R-10	Note (3)
Crawl space ceiling	R-19	R-30	R-21	Note (4)
Windows	U-0.35	U-0.35	U-0.35	
Ceiling with no attic	R-38	R-38	R-49	DCEO exceeds IECC

1) 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) DCEO meets IECC requirements except it is unclear on the depth of insulation as is directed in IECC.
3) DCEO requires only R-10 for basement/crawl space 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, as the floor/crawl space ceiling framing will not allow R-30 to be installed.

Table 13 below summarizes the major appliance or mechanical requirements and differences between IECC requirements and the current DCEO EEAHC Specifications.

Table 13: DCEO Program Specifications Versus IECC 2009 Code: 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 (5)
Boiler	Prevailing minimum federal efficiency (80% AFUE at writing)	88% AFUE, sealed combustion, direct vent,	Note (5)
Water Heater	Prevailing minimum federal efficiency. None stated in Federal standards however.	62% EF and Energy Star rated	Note (6)
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 (7)
Air distribution ducts	R-6 except for attic, R-8 insulation in attic, sealing per IRC	No insulation standard, All ducting in building thermal envelope, seal with mastic	Note (8)
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 (9)
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 (9)
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

5) The DCEO exceeds the IECC in gas furnace efficiency requirements, as well as for hydronic heating boilers.
6) 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%.
7) 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.
8) 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 13Table 12.
9) 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.

There are many nuances in specifying code requirements for energy efficient residential construction. DCEO may want to consider that instead of attempting to list exact program requirements by construction type or appliance, that program guidelines state that the specifications are general guidelines but that the installer must follow the requirements of the IECC and International Residential Code (IRC). This would tighten up the code requirements and leave less room for misinterpretation or abuse. It would also align the EEAHC program specifications with the newly implemented state codes for commercial structures.

The DCEO can, of course, always have specifications stronger than the IECC and IRC. For appliance ratings there are usually single number ratings that can easily be specified with little room for misinterpretation. Examples of this would be air conditioning and heat pump systems, water heaters and furnaces.