DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

SEU AND STATE ENERGY EFFICIENCY PROGRAMS EM&V REPORT

Prepared for:

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

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1. EXECUTIVE SUMMARY

This report presents results from the evaluation of the state of Delaware Energy Efficiency programs. These programs were administered through the Delaware Sustainable Energy Utility (SEU) and funded with American Recovery and Reinvestment Act (ARRA) grant and Regional Greenhouse Gas Initiative (RGGI) proceeds. The Department of Natural Resources and Environmental Control (DNREC) took over the administration and closeout of these programs in October 2011. The primary objectives of the evaluation are to validate the gross energy impacts attributable to the programs, to assess program delivery procedures and to inform the design and implementation of future programs in Delaware. This work was secured by DNREC.

It should be noted that the program period covered under this evaluation represents the first phase of energy efficiency programs in Delaware. ARRA funding, whose primary focus was energy savings and job creation was also leveraged by the state to establish the groundwork for future state or utility run energy efficiency programs in Delaware. As such these programs bore a large brunt of the costs and efforts associated with program start up. In addition, the programs developed and implemented through the SEU and the ARRA stream of funding faced both launch and implementation time constraints not always seen in standard utility program or within regulatory cycles. With this in mind we provide both an assessment of the programs and their performance as implemented and guidance/feedback born from this work and these program efforts, that can help inform future programs in Delaware.

The portfolio of residential and commercial programs delivered in Delaware had varying start and end dates and operated with incentive budgets that ranged from $800 thousand to $6.9 million. Several entities were involved in the program administration, and several third party implementation contractors supported the delivery of the programs. Most programs became operational in 2009 with most ending in mid to late 2011. The evaluation team (Opinion Dynamics Corporation with subcontractors Nexant, TecMarket Works, Integral Analytics and Building Metrics) began the evaluation process in early 2012.

Validation Findings

In comparing the energy savings achieved by the Delaware programs to the reported savings we found that reported savings were generally lower than verified savings. Because the Delaware Programs were ARRA funded they had no specific energy savings goals. More information on realization rates and net to gross savings is discussed in each program section below.

All reported savings represent first year savings for measures installed or actions taken through the program. Because each program ran on varying program schedules the savings below represent first year savings achieved during the program life.

Table 1-1: Reported Savings, Verified Savings and Realization Rates

Program	Program Reported Savings			Verified Savings		
	kWh	KW	Therms	kWh	KW	Therms
ENERGY STAR Lighting	40,458,102	NA	NA	44,543,077	5,491.0	NA
Home Performance	5,043,586	4,427	372,592	See Section4[1]	1,583	See Section4
Green for Green	26,423	14.77	4,796	23,210	9.75	3,141
Residential Low Income Multifamily	123,799	82.66	NA	123,799	82.66	NA
Appliance Rebate Program	1,600,768	NA	33,759	2,259,265	276.31	24,477
Residential Total	*42,209,092*	*4,524.43*	*38,555*	*46,949,351*	*7,442.72*	*27,618*
C&I Portfolio	kWh	KW	Therms	MWh	KW	Therms
Efficiency Plus Business	13,202,870	2,025	75,200	13,280,201	2,132.0	52,090
Total	55,411,962	6,549.43	113,755	60,229,552	9,574.72	79,708

Findings and Recommendations

Below we highlight a few of the key recommendations and findings from the more detailed program sections provided in this report. These findings and recommendations are based on a review of program materials, tracking data, in-depth interviews with program staff and implementation contractors, and, for some programs, site M&V, and quantitative and qualitative surveys with program participants as well as Best Practices from other programs across the Nation. Findings often focus on areas of interest that were highlighted by DNREC in the planning phase of the EM&V project

ENERGY STAR Lighting

The ENERGY STAR Lighting program offered discounted energy efficient lighting at 67 participating retail locations from July 2010 through August 2011. The program exceeded the original goal of 500,000 bulbs, selling close to 900,000 energy efficient bulbs resulting in gross savings of 40 million kWh and close to 5,500 kW. Net savings were estimated at 22 million kWh and approximately 2,700 kW. The evaluation team calculated program free ridership by conducting an analysis of program topline sales. The results show that overall program free ridership was .51.

Nearly all Delaware residents (~90%) are aware of CFLs and have at least one installed in their homes. CFL socket saturation is lower with just under one-third of light sockets containing a CFL. Delaware has relatively high CFL penetration and socket saturation rates for a state that has only had a lighting program in effect for approximately one year.

[1] Evaluated savings converted into MMBtu to address multiple fuels covered in the programs including electricity, gas, oil and propane. The program tracked savings was73,923 MMBtu and evaluated savings was 61.101 MMBtu

We found that approximately 10 million standard and 4 million[2] specialty screw-based sockets contain a less efficient bulb than is currently available in the market. This means that there is still considerable opportunity for additional savings from lighting programs in Delaware.

The key to future program success will be deciding on the appropriate mix of products to incent and their associated incentive levels to achieve desired savings. Factors to consider include the socket potential based on products currently installed in homes, the impact of EISA on baseline savings, NTG ratios, and product pricing.

Home Performance with ENERGY STAR

An impressive 3,887 projects were completed through the Home Performance Program, resulting in tracked savings of 73,923 MBtu. While the majority of these projects (67%) included HVAC equipment installations only, projects completed through the Performance path (those saving at least 20% of baseline usage) resulted in the majority of tracked savings (66%).

Satisfaction among participating customers was high (80%) and nearly ¾ of participants and almost all interviewed contractors said that the rebates were important to customer decisions about whether to install measures. Some contractors noted that customers would have made changes with a lower rebate.

Information provided by interviewed contractors indicates that certain elements of the program might have favored the installation of HVAC equipment over shell measures, suggesting that having audits conducted by contractors specialized in certain types of equipment might pose a disincentive to striving for deeper savings. Findings suggest that for future programs to achieve maximum savings, it will be important to put in place requirements that encourage – or require – the inclusion of shell measures, and to ensure accurate and detailed tracking of recommended versus installed measures.

Green for Green

The Green for Green program provides homebuyer rebates for the purchase of a certified green home that meets either a Silver or Gold program level. We found that homes certified to the Gold level significantly exceeded code and baseline (i.e., typical) building practices, with gross savings estimated at 329 kWh and 59 therms per home. Net energy savings for Gold certified homes are estimated to be 287 kWh and 39 therms, which are 87% and 66% of gross energy savings, respectively. Conversely, homes built to the Silver certification level did not significantly differ from baseline home building practices in Delaware, indicating that there was no gross energy savings associated with the Silver level.

Evaluation findings suggest that the Gold Home certification level is providing energy savings and may prove to be an effective piece of an energy efficiency portfolio in Delaware. The Silver Home certification level however should be reassessed. Homes built to this level did not outperform homes built using common building practices throughout the state. It should be noted that this analysis did not take into consideration the non-energy components of the NGBS Silver Home certification. Achieving higher levels of overall program savings will require drawing more non participating builders into the program because for many of these builders, Gold certification would represent a significant reduction in home energy use.

[2] Opinion Dynamics (2012). DNREC Residential Baseline Study

Low Income Multifamily

The Low Income Multifamily program provided construction financing to one project, which realized 123,799 kWh and 82.66 kW savings. The program provided construction financing of $1,442,259 to one project located in Sussex County, Delaware. Total project development costs were $7,079,079, with a per unit cost of $176,976.

Partnership with Delaware State Housing Authority (DSHA), which enhanced program implementation through streamlining administration of the project application, underwriting and funding disbursement, allowing for a reduction in overhead costs and fees, proved successful and provided the program with access to the affordable low-income market, particularly to affordable housing developers applying for the Low Income Housing Tax Credit (LIHTC) program.

The program was used in tandem with several other programs offered to builders of Low Income multifamily buildings, making the influence of this specific piece of the project difficult to parse out. The program seems to have spurred increases in efficiency in three measures included in the project. However, one participant noted that they would have installed the energy efficiency measures as a result of their participation in DSHA's Low Income Tax Credits program and that the SEU financing did not play a role in their decision to install those measures.

Future program design and implementation should consider Best Practices and lessons learned from other programs across the country. We provide a review of successful programs across the nation and best practices in Section **Error! Reference source not found.** for future program design and implementation.

Appliance Rebate Program

The ENERGY STAR® Appliance rebate program successfully incentivized the purchase of approximately 16,000 appliances in Delaware between September 2009 and December 2010. The program's evaluated gross electric savings were 41% higher than what was reported and gross natural gas savings were 73% of what was reported. This was primarily, but not exclusively, due to the baseline study providing more accurate fuel shares (electric vs. natural gas) for water heating and clothes drying. This fuel share information is a major input to the savings realized for clothes washers, which accounted for approximately 50% of all rebates. The baseline study found a much higher penetration of electric water heating and electric clothes dryers than initially assumed, resulting in the savings from the installation of new clothes washers shifting from assumed natural gas savings to electricity.

Over the course of the program multiple funding sources, including the Regional Greenhouse Gas Initiative (REGGI) and the Department of Energy State Energy Appliance Rebate Program (SEEARP), funded the appliance efforts in Delaware. However, while overall dollars were tracked by funding source, the program did not track funding sources at the rebate level, something that should be considered in future programming. Additional enhancements to the database would be to clearly label the measure types to be more descriptive of the type of appliance rebated.

The evaluation did not include an analysis of free ridership or spillover. However, given that the market share for the ENERGY STAR qualified refrigerators, clothes washers, and room air

conditioners ranges from 30 to about 50%[3], rebate levels for future programs would need to be set very carefully to avoid high levels of freeridership.

Efficiency Plus Business

The Efficiency Plus Business program was a comprehensive incentive program offered to non-residential customers in the state of Delaware. The overall realization rates for KW and kWh savings were close to one, although there was significant variation in the project level ex-post evaluated savings compared to ex-ante savings. Some projects greatly underestimated savings while some overestimated savings. The ex-post natural gas savings were significantly lower than the ex-ante savings (a 0.69 realization rate) due to calculation errors found in the project sample.

Overall, customers reported high satisfaction with the program indicating they were most satisfied with the incentives and measures offered through the program.

Based on our surveys it appears that many customers learned of the incentives while the projects were in their early stages, with a high percentage indicating that the incentive did not influence the timing of the project or the efficiency level of the equipment chosen. Given that the program did reach customers, for the most part, early in the decision-making process, there is opportunity to mitigate free ridership going forward using tactics like reaching customers before they begin upgrading equipment and increasing the energy efficiency requirements for equipment incentivized through the program.

[3] Data from US DOE on ENERGY STAR market share shows refrigerators at 30%, clothes washers at 30-40%, room air conditioners at 50%. Other appliances had much lower market share including freezers at 3% and water heaters at 0-4% depending on the type.

2. EVALUATION METHODS

Based on discussions with DNREC, the evaluation team has provided an EM&V Report for each of the programs operated in Delaware. The EM&V effort varied based on the program type, needs of DNREC and the probability that the program will be included in a Delaware program portfolio in the future. Generally, one or more of the following four areas of analysis were completed for each program:

- Verification that measures were installed as reported.
- Verification of the Gross program savings – Reviewing program deemed savings or algorithms and assessing the reasonableness of engineering estimates for commercial and industrial custom projects. Together with installation rates, this information is used to establish a program level realization rate (also commonly referred to as "Verified Gross Savings").
- Net Impact analysis – Determining the portion of Verified Gross Savings that were induced by the program (i.e., would not have happened in the program's absence).
- Process analysis – Exploring how the program process works for program managers, implementers, participants, etc.

In most, but not all, instances our team also looked at the tracking systems (i.e., program databases) and the agreed-upon energy savings values. In most cases, this included verifying that the program's tracking databases were accurately applying the energy savings developed during program planning and comparing these estimates to the updated savings recommended in the Delaware TRM. As such, this document reports on the program's tracked energy savings versus its verified energy savings and reports on the realization rate (percent of tracked savings that is verified). Definitions of these two terms are:

- **Tracked savings** reflect the savings reported by the program implementers—both numbers of measures and units installed and the energy and demand savings that were applied per unit in the tracking databases.
- **Verified savings** reflect a review of the tracking savings to ensure that the numbers installed are correct and that the implementer applied the agreed-upon ex ante planning assumptions for energy and demand. The source of the agreed-upon ex ante savings is documented in this report. Where no documentation is available, we note that we were not able to verify the savings assumptions. In some cases verified savings include net-to-gross ratios.

Two programs also received a net-to-gross analysis as part of the evaluation activities. In this case Net savings are defined as:

- **Net savings** reflect the energy savings that are attributable to the program's intervention in the market, exclusive of other reasons for changes in energy use.

Process evaluation efforts were somewhat different for each program; to a certain extent these efforts all followed a similar overall approach, including the following efforts:

- Reviewing program materials
- Conducting interviews with program managers and implementers

- Conducting interviews with trade allies and partners as appropriate
- Conducting surveys with participants and/or non-participants as appropriate

Error! Reference source not found. below shows the methods that were applied, by program, in this impact evaluation report Details on each of these methods are provided below.

Table 2-1EM&V Methodologies

Program	Verification of Gross Savings	Net Impact Analysis	Realization Rate Analysis	Participant Interviews	Staff/Program Manager Interviews	Contractor/Market Provider Interviews	Baseline Analysis[4]
Residential Portfolio							
ENERGY STAR Lighting	X	X	X		X	X	X
Home Performance	X	X	X	X	X	X	X
Green for Green	X	X			X	X	X
Residential Low Income Multifamily	X			X	X		
Appliance Rebate Program	X				X		X
C&I Portfolio							
Efficiency Plus Business	X		X	X	X		X

Process Verification

There are many approaches to completing a process evaluation. The exact approach is identified by program and reflects the level of rigor needed to align with the overall EM&V goal for each program. The approaches utilized are briefly described below.

Review program materials and methods of operation. The evaluation team reviewed of all available information to familiarize ourselves with the detailed operations of the programs. This included reviewing all program-specific documents and incorporating this information with the verbal information obtained during the kick-off meeting and other discussions with the program implementers.

Interviews with program managers and implementers. The team conducted interviews with program managers and implementers to obtain a detailed understanding of the programs, the implementation process, intended program designs, operational procedures, marketing and

[4] Baseline efforts for Efficiency Plus Business, Lighting and Appliances were completed in coordination with the Baseline Study developed for DNREC "DNREC Residential Baseline Study", July 13, 2012

outreach efforts, tracking and data handling systems, interactions with contractors, allies, and participants' application procedures.

Interviews with participating and non-participating contractors, trade allies and partners. For some programs the team conducted interviews with a sample of trade allies and partners. These interviews focused on the program's design, operations, the interaction between the ally, program and participant, the service stream and the activities in that stream, and the influence of the program and the ally on the participants' decision to take action.

Surveys with participants, and where applicable, non-participants. In some cases the EM&V approach included completing surveys with a sample of participants or non-participants. Surveys with participants focuses on a wide range of issues including: their experiences with the program, their reasons for participation, their satisfaction with the program and the service components provided.

Impact and Ex-Post Verification

There are many approaches to completing Ex-post verification and impact analysis. The exact approach is identified by program and reflects the level of rigor needed to align with the overall EM&V goal for each program. The approaches utilized are briefly described below.

Net Impact Methodology

We derive net program impacts by applying a net-to-gross ratio (NTGR) to ex-post gross program savings. This NTGR typically comprises two concepts, freeridership (FR) and spillover (SO). This evaluation quantified freeridership but assessed participant spillover qualitatively. We used self-reported information from the telephone survey with program participants to assess both free-ridership and participant spillover. The overall NTGR is calculated as (1 - FR). The final ratio represents the percentage of gross program savings that we can reliably attribute to the program.

The following is a high-level description of the freeridership and spillover concepts, the questions we used to assess both free-ridership and spillover, and the algorithms used to calculate each.

Freeridership. Freeriders are program participants who would have implemented the incented energy efficient measure(s) even without the program. We base free-ridership estimates on a series of questions that explore the influence of the program in making the energy efficient installations as well as likely actions had the incentive not been available. For each respondent included in a survey, we developed a freeridership factor that consists of two scores:

Influence of Program Components. This score is based on a series of questions, which asked respondents to rate the influence of program components in their decision to make the improvements. The program components score is based on the highest rating given to any one of these components. Greater influence of the program components means a lower level of freeridership.

Likely Action without Program. This score is developed based on four questions: 1) the likelihood that the respondent would have installed new equipment without the program; 2) the likelihood that the installations would have been of the same efficiency without the program; 3) if the installation would have been done at the same time without the program; and 4) if the installation would have been done later, how much later. This score takes the response to the first likelihood question and adjusts this value by the responses to the efficiency and timing questions. Greater likelihood of installing equipment without the program means a

higher level of freeridership. Lower efficiency levels or later implementation without the program means a lower level of free-ridership.

The overall freeridership score is the average of the program components score and the likely action without program score. The free-ridership score for each respondent ranges from 0 (0% freeridership, 100% program attribution) to 1 (100% freeridership, 0% program attribution).

Participant Spillover. Participant spillover refers to energy efficiency installations that were influenced by the program but did not receive an incentive. The qualitative assessment of spillover is based on a series of four questions: 1) did the participant make any additional improvements after their participation and without getting a rebate; 2) if so, what improvements did they make; 3) were the improvements recommended through the program; and 4) how influential was the experience in the Program in their decision to make these additional improvements. We consider there to be evidence of spillover if the respondent reported that the program influenced their decision to make the improvement and strong evidence if the program influenced their decision and the additional improvements were recommended in the audit report.

Ex-Post (Gross) Savings Verification. Program tracking system review that examines data that are collected by the programs to both inform evaluation activities and help improve program delivery processes for future implementation. Review of the consistency of tracked data and the algorithms/protocols used to estimate savings; adequacy of data being tracked for use in the evaluations; and, to the extent possible, the accuracy of tracked data.

Engineering Desk Review and Deemed Savings/TRM verification. This activity entails a two-stage review of assumptions, calculations, and values used for the program or measure deemed savings. The first stage is a general engineering review of measures. The second is a project-specific review of assumptions of projects within the programs.

M&V. Engineering calculations, observation site visits used to varying degrees depending on the measure, the program and the site.

Realization Rate Calculation. Realization rate is the ratio of Evaluated Gross Savings to Claimed Gross Savings (versus comparing Net and Gross Savings estimates which is best defined with a Net-to-Gross Ratio). Once ex post (or verified) gross savings for a program were determined, the evaluation team developed a realization rate. The gross savings realization rate was calculated as the ratio of ex post (or verified gross) savings to ex ante (tracked or gross) savings.

Demand Savings. Peak demand savings analysis was conducted using the ex post gross energy savings estimates and applying coincidence factors from end-use load shapes for the various types of measures where available.

Baseline Study

Concurrent with the EM&V effort, the evaluation team completed Baseline studies that covered the commercial and residential sectors in Delaware, in some cases data collected through the baseline activity is also used to support the EM&V efforts for individual programs.

3. EFFICIENT LIGHTING

3.1 KEY FINDINGS

The efficient lighting program experienced stronger than anticipated sales. The program had to be closely managed to keep sales within the program budget. The vast majority of bulbs sold were CFLs along with a small number of LEDs. Overall, close to 900,000 energy efficient bulbs were sold through the program resulting in gross savings of 44 million kWh and close to 5,500 kW. Net savings were estimated at 22 million kWh and approximately 2,700 kW. The markdown side of the program accounted for nearly all of the sales. The coupon side had lower than expected sales. The program was generally well-run and managed. Program tracking data used to monitor the progress of the program closely matched the final verified sales data.

The program tracked most data needed for this evaluation. The evaluation team was able to obtain the missing data through additional research or data manipulation

Given the amount of time that has passed since the end of the program, retailers had difficulty remembering details of their program participation. Those who could remember felt that the program materials were useful and effective.

The residential baseline study found that nearly all Delaware residents (~90%) are aware of CFLs and have at least one installed in their homes. CFL socket saturation is lower with just under one-third of light sockets containing a CFL. Delaware has relatively high CFL penetration and socket saturation rates for a state that has only had a lighting program in effect for approximately one year. This is true of both standard and specialty CFLs.

There is still considerable opportunity for additional savings from lighting programs in Delaware. Both standard and specialty bulbs should be considered for future program incentives. Approximately 10 million standard and 4 million specialty screw-based sockets contain a less efficient bulb than is currently available.

3.2 PROGRAM DESCRIPTION AND OBJECTIVES

The efficient lighting program was a statewide effort, and built off the ENERGY STAR Appliance program that was part of the SEU program efforts and administered by *AEG* and then by *DNREC.* Applied Proactive Technologies (APT) implemented the program and Energy Federation Inc. (EFI) processed the program payments. The program focused on ENERGY STAR qualified compact fluorescent lamps (CFLs) discounting both standard CFLs as well as specialty CFLs. Light emitting diode (LED) products were also incentivized but LED lighting was statistically insignificant to the program energy savings. Discounts ranged from $.60 to $4.00 per bulb.

The program discounted energy efficient lighting at 67 participating retail locations from July 2010 through August 2011. The program discounted bulbs at a wide variety of retailer types and sizes. Participating retailers included large warehouse, do-it-yourself, and big box chains. To ensure that customers living in all parts of the state and who shopped at a variety of stores were included, the program also discounted bulbs at smaller hardware, discount, lighting, and grocery stores.

The program utilized a “markdown” and in some limited cases a coupon-based approach. For the markdown portion, products were discounted to customers at the point of purchase. This option was

available to retailers with centralized systems capable of tracking sales data; these were typically "big box" retailers like Home Depot. The coupon-based option allowed smaller retailers that did not have sophisticated tracking systems to participate in the program. Retailers provided sales data for the incentivized products, which were used to track the program's progress and reimburse the retailers for the incentives given to customers.

Only residential customers could purchase bulbs through the coupon program. The markdown program cannot limit sales to residential customers due to the nature of program delivery though the program focus was residential customers.

The program implementer provided support to the retailers including point-of-purchase marketing materials, in-store demonstrations, media purchases, and website content. Initially, two field staff served the participating retailers; this service level was cut down to one in the first quarter of 2011 when the high demand for the program allowed Delaware to reach full expenditure more quickly than expected.

3.3 METHODS AND APPROACH

Error! Reference source not found. summarizes the evaluation tasks used for this evaluation.

Table 3-1. Summary of the Efficient Lighting Program Evaluation Activities

Action	Details
Program Implementer Interviews (n=2)	• Gathered detailed information on the step-by-step operational conditions and implementation efforts to gain an expert understanding of the program design and delivery
Retailer Interviews (n=9)	• Conducted structured interviews with participating retailers to help gather insight into retailer satisfaction and program marketing and training, as well as to get an understanding of program impacts on store sales.
Review of Program Materials and Data	• Determined the number of CFLs sold by store and CFL type. • Compared tracked participation numbers to verified numbers. • Reviewed program marketing and outreach materials, as well as program implementation plans.
Energy Savings Calculations	• Applied the savings algorithm developed for the Delaware TRM and calculated kWh and kW savings.
Topline Sales Analysis	• Conducted analysis of program goals tracking database to determine program free ridership.
General Population Survey (n=500)	• As part of the residential baseline study, conducted 500 interviews with Delaware adult residents. The results from questions related to lighting are used to inform the lighting program evaluation.
In-Home Lighting Study	• As part of the residential baseline study, conducted 70 in-home visits that collected data on lighting technologies in use in Delaware households. Selected results are used to inform the lighting program evaluation.

Program Implementer Interviews

The evaluation team interviewed the program managers from APT and EFI about the program processes and day-to-day management of the program. Questions addressed roles and responsibilities, program startup, procedures, and performance.

Retailer Interviews

The evaluation team contacted top-selling lighting retailers from the markdown and coupon programs. We completed six interviews with markdown retailers and three interviews with coupon retailers. Though the coupon program accounted for a very small portion of total sales, it was important to interview some coupon retailers to better understand the low sales numbers. The evaluation team spoke with the staff member most knowledgeable about the program. In some cases, these individuals were store managers or assistant managers, while in other cases, they were lighting or appliance department heads.

Given that some months have passed since the program ended, it was difficult to find markdown retailers who recalled the program. In some cases, the involved staff member no longer worked at the store. In other cases, it seemed that the program was just not that memorable to the store staff. The corporate office made the decision to participate, APT came in and put some signs up, and that was all they recalled. As a result, we were not able to ask detailed questions of all retailers interviewed.

During the interviews, we explored the effectiveness of the program processes; retailer satisfaction with marketing, outreach, and other program activities at the store level; and suggestions for program improvements in future program years. We also asked retailers to assess, to the degree possible, the impact of the program on sales of the rebated energy efficient products.

Review of Program Materials and Data

The evaluation team conducted an extensive review of program materials and data, including program marketing materials, program coupons, field reports, and program tracking databases. The review of the tracking databases included calculating program participation numbers and comparing these verified numbers to the program-tracked participation numbers.

Energy Savings Calculations

We calculated gross program kWh and kW savings using the savings algorithm for residential lighting developed for the Delaware TRM.

Topline Sales Analysis

The evaluation team conducted an analysis of program sales, sales goals, and product pricing to estimate program free ridership. The analysis is based on a model of retailer behavior that we have verified through corporate-level retailer interviews. We have learned that despite the reimbursements that retailers receive for selling CFLs at a reduced price as part of utility lighting programs, many are still concerned that their gross sales revenue might drop as a result of program pricing. Retailers care about gross sales revenue because it influences investors, and corporate bonuses are often tied to it.

Through our discussions with retailers we have come to the understanding that retailers will avoid participating in programs with incentive levels and sales goals that do not stimulate enough additional sales, from their non program baseline, for them to make up lost gross sales revenue due to the reduction in price created by the program incentives (which are not counted towards gross sales revenues). For example, if a retailer wants to ensure that its gross revenue does not drop as a result of participating in a utility program that discounts the price of a product by 50%, the retailer must double its sales to maintain total gross revenue. Our understanding is that most retailers have enough information about product pricing and sales to evaluate program Memorandums of Understanding (MOUs) and will only agree to those that will allow them to remain at least gross sales revenue neutral, absent consideration of the rebate.

With this model as background, we estimated the sales lift that retailers expected from reduced program pricing. The tracking data maintained by the program implementer contains information for each retailer and product sold through the program including regular sales price, discounted sales price, and the number of units the retailer is allowed to sell at the discounted price. If the sales goal is the number of units the retailer must sell to remain gross sales revenue neutral, we can use the pricing information to estimate the percentage of total sales that would have taken place without the discount in place and the percentage that was due to the discount. We estimate program free ridership by taking the ratio of sales that would have taken place without the program to total program sales.

General Population Survey

The residential baseline study included a survey with 500 adult Delaware residents. We report the results of the lighting questions to understand the state of the CFL market in Delaware and future program potential. Questions covered CFL and LED awareness, barriers and motivators to adoption of efficient lighting technologies, and awareness of Energy Independence and Security Act (EISA) regulations.

In-Home Lighting Study

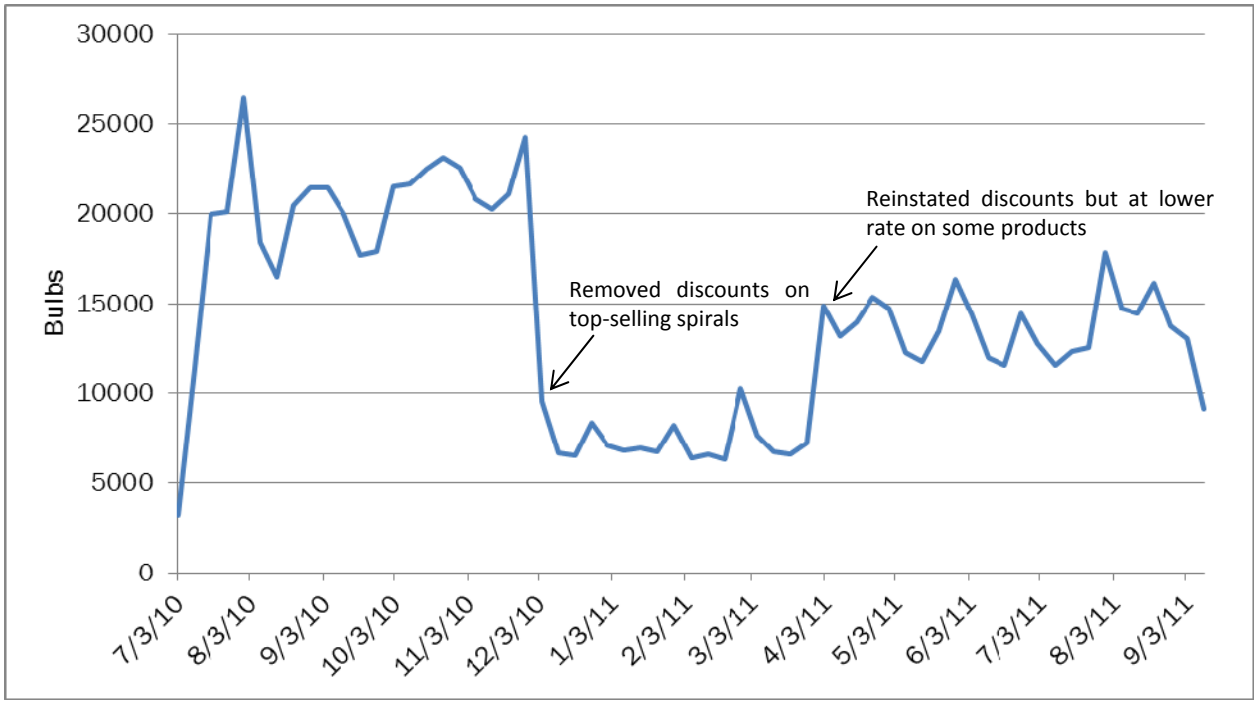
The residential baseline study included in-home audits of lighting in 70 Delaware single-family homes. As part of this evaluation, we use some of the study results to reflect on the CFL market and future program potential.

3.4 RESULTS

Participation

Program sales were strong and greater than expected when the program began. **Error! Reference source not found.** shows sales of CFLs throughout the program. Due to the high sales volume, the program either had to scale back the incentives, reduce the number of products it was selling at a discount, or cut the number of participating retailers to keep the program within budget. The implementer reduced the number of products that were discounted in late 2010. Sales dropped as expected. The program received enough additional funds to discount all of the original products but also run through the end of 2011. To keep sales in check, the implementer reduced the incentive on a few top-selling spiral CFLs so that sales remained below their initial level. The program eventually shut down in September 2011.

Figure 3-1. Number of Bulbs Sold by Week



Overall, 884,996 energy efficient light bulbs were sold through the Efficient Lighting program, which is far greater than the original plan of 500,00 bulbs. The large majority of bulbs sold were standard CFLs.

Table 3-2. Bulb Types Sold

Bulb Type	# of Bulbs	% of Total
CFL Standard	706,148	80%
CFL Specialty	178,389	20%
LED	426	< 1%
Other*	33	< 1%
Total	884,996	

**These bulbs were sold through the coupon program and the customer did not record bulb type on the coupon.*

Note: Percentages do not sum to 100% due to rounding.

A majority of standard CFLs sold through the program were low wattage CFLs designed to replace incandescent bulbs of 60 watts or less. One in five were 100 watt incandescent equivalents, the wattage first affected by EISA.

Table 3-3. Wattages of Standard CFLs Sold

CFL Wattage	Incandescent Equivalent	# of Bulbs	% of Total
9-11	40	44,240	6%
13-16	60	455,961	65%
17-20	75	62,504	9%
22-27	100	142,372	20%
28+	150	1,038	<1%
Total		706,115	

Note: Percentages do not sum to 100% due to rounding.

Just over half (54%) of the specialty CFLs sold through the program were reflectors or flood lights. Globe and a-lamps were the next most common type at 13% each.

Table 3-4. Types of Specialty CFLs Sold

Type	# of Bulbs	% of Total
Reflector/Flood	97,086	54%
Globe	23,316	13%
A-lamp	22,829	13%
3-way	15,632	9%
Candelabra	13,077	7%
Ceiling Fan	4,653	3%
Dimmable	1,421	1%
Post	408	< 1%
Total	**178,422**	

Note: Percentages do not sum to 100% due to rounding.

Nearly all bulbs were sold at retailers participating in the markdown program. Only 459 bulbs were sold through the coupon program, which is less than anticipated.

Sales volume varied tremendously across the 67 retailers participating in the program. Four retailers sold fewer than 50 bulbs apiece while top retailers sold close to or over 100,000 bulbs. The biggest sellers were large retailers such as warehouse, do-it-yourself, and large big box stores.

Impact

Tracking System Review

The evaluation team reviewed the program data maintained by EFI and calculated program totals. We compared these numbers to those maintained by AEG. Our verified total is very similar to the program tracking totals. Our verification found 3,064 fewer bulbs sold, which is only 0.3% of program sales.

Table 3-5. Verified Program Sales

Measure	Tracked	Verified	% Verified
CFLs and LEDs	888,060	884,996	99.7%

Gross Program Impacts

The evaluation team applied the savings algorithm put forth in the Delaware TRM to calculate gross energy and demand program savings. For each bulb sold, energy savings was calculated as followed:

kWh = ((ΔWatts) /1000) * ISR * HOURS * (1+WHFe)

Where:

*ΔWatts = Compact Fluorescent Watts * 2.95* [5]

In Service Rate (ISR) = 0.88 [6]

Average hours of use per year (HOURS) = 1088 (2.98 hrs per day) [7]

Waste Heat Factor for Energy (WHFe) =.14

Demand savings was calculated as follows for each bulb sold through the program:

kW = ((ΔWatts) /1000) * ISR * (1+WHFd) * CF

Where:

Waste Heat Factor for Energy (WHFe) =.39

Summer Peak Coincidence Factor (CF) = 0.11 [8]

We compared this verified estimate with the energy savings tracked by AEG.[9] We found slightly higher energy savings than AEG claimed (40 million kWh) for a realization rate of 1.1. The difference may be due to different savings algorithms applied. AEG applied an average savings per CFL

[5] Average wattage of compact fluorescent from RLW study was 15.5W, and the replacement incandescent bulb was 61.2W. This is a ratio of 3.95 to 1, and the delta watts is equal to the compact fluorescent bulb multiplied by 2.95. RLW Analytics, New England Residential Lighting Markdown Impact Evaluation, January 20, 2009.

[6] Starting with a first year ISR of 0.81 (based on EmPOWER Maryland DRAFT 2010 Interim Evaluation Report; Chapter 5: Lighting and Appliances) and a lifetime ISR of 0.97 (from Nexus Market Research, RLW Analytics and GDS Associates study; "New England Residential Lighting Markdown Impact Evaluation, January 20, 2009"), and assuming 43% of the remaining 16% not installed in the first year replace incandescents (24 out of 56 respondents not purchased as spares; Nexus Market Research, RLW Analytics, October 2004; "Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs", table 6-7). ISR is therefore calculated as 0.81 + (0.43*0.16) = 0.88. See Mid Atlantic CFL Adjustments.xls for calculation.

[7] Based on EmPOWER Maryland DRAFT 2010 Interim Evaluation Report; Chapter 5: Lighting and Appliances

[8] Residential Lighting Markdown Impact Evaluation, Final, January 20, 2009, Submitted to: Markdown and Buydown Program Sponsors in Connecticut, Massachusetts, Rhode Island, and Vermont. Submitted by: Nexus Market Research, Inc., RLW Analytics, Inc.

[9] AEG calculated program energy savings but there was no record of demand savings.

regardless of wattage. The Delaware TRM specifies different savings values per bulb, an installation rate adjustment factor, and a waste heat factor.[10]

Table 3-6. Verified Gross Program Impacts

Savings	Tracked	Verified	Realization Rate
kWh	40,458,102	44,543,077	1.1
kW	NA	5,491	NA

Net Program Impacts

We estimated net impacts by calculating a net-to-gross (NTG) ratio and applying it to program savings. Typically, NTG is based on two concepts – free ridership and spillover. The overall NTG ratio is calculated as (1 – free ridership + spillover).

The evaluation team calculated program free ridership by conducting an analysis of program topline sales. According to our model of retailer program participation, the number of CFLs a retailer must sell at program pricing to remain gross sales revenue neutral is equal to the sales goal for each product. This sales goal is made up CFLs the retailer would have sold without the discount (i.e., free riders) and CFLs the retailer sells because of the discount (i.e., not free riders). We estimate sales without the program by dividing the sales goal by the ratio of the regular retail price to the program price. We estimate program free ridership by dividing the number of CFLs that would have been sold without the discount by the total number of CFLs sold at program price. The results of this analysis show that overall program free ridership was .51, meaning that customers who purchased 51% of discounted program bulbs would have purchased them without the discount.

Program spillover would occur if customers purchased non-discounted CFLs based on what they learned from program marketing or their experience using discounted CFLs. Spillover is challenging to estimate for upstream programs such as lighting because it is difficult to capture these purchases and attribute them to the program. It is made more difficult for this program because the evaluation took place after the program has ended. Therefore, we were unable to estimate program spillover. The overall NTG should be considered a minimum level as NTG would be higher if the program generated spillover.[11]

The overall program NTG ratio is .49. We find little difference in NTG for standard and specialty CFLs.

Table 3-7. Net-to-Gross Ratios for Efficient Lighting Program

Measure	Free Ridership	Spillover	Net-to-Gross 1-FR+SO
Overall	.51	--	.49
Spiral CFLs	.51	--	.49

[10] Opinion Dynamics Corporation, Delaware Technical Reference Manual: An Addendum to the Mid Atlantic TRM. Prepared for Delaware Department of Natural Resources and Environmental Control, April 2012.

[11] It is unlikely that the program created much spillover given the short duration of the program and the somewhat limited marketing efforts that took place outside of retailers. It is unlikely the program changed the products available to consumers. Participating retailers interviewed did not report changing the mix of products stocked because of the program. It is unlikely the existence of the program pressured non-participating retailers to stock more CFLs to be competitive with the program.

Specialty CFLs	.53	--	.47

Net program energy savings are close to 22 million kWh while net program demand savings are 2,691 kW.

Table 3-8. Net Program Savings

Savings	Tracked
kWh	21,826,208
kW	2,691

Process Results

Program Design and Implementation

Based on interviews with program implementation staff, the program had a successful launch and ran smoothly without any problems or issues. The program exceeded expectations in terms of sales.

The evaluation team interviewed nine managers at participating stores about their experiences with the program for an additional perspective. It was difficult to locate markdown retailers who recalled the program, which is one indication that the program did not cause retailers problems. The markdown retailers who did recall the program reported that program requirements were clearly explained and it was easy to participate.

The experience of the coupon program retailers was mixed. One retailer stated that the program requirements were not clearly explained resulting in a large number of rejected coupons. Other retailers did not have this problem and felt that the requirements were made clear at the beginning. The retailer with the rejected coupons dropped out of the program because the requirements were barriers to purchase and too much of a hassle. Another coupon retailer felt the program was well run but would not participate again in the future because they did not sell enough to justify dealing with the coupon processing. This retailer sells lighting to a lot of contractors who were not eligible to participate because they were purchasing for commercial purposes and this was a residential program. Future programs may want to reconsider the eligibility requirements as this retailer reported that contractors are usually interested in the cheapest bulb possible and not energy efficient lighting.

Program Data

AEG tracked program progress on a monthly basis. These numbers matched the final verified data quite well, providing administrators with an accurate portrait of sales during the program.

The program tracked most data needed for this evaluation although a few critical variables were not tracked. For example, the program tracked the model number of bulbs sold but not key bulb characteristics such as wattage. This made it necessary to extract the wattage from the bulb model number. Wattage is necessary to track savings using the Delaware TRM algorithm. In the future programs should be sure to track wattage in addition to the model number.

Program data also did not track the type of specialty CFL purchased. The evaluation team conducted internet searches to obtain specialty CFL bulb type. This information is useful to track because

specialty CFLs are important to increasing socket saturation. It is important to understand what types of specialty bulbs are selling and what are not to manage program designs to maximize sales.

The coupon data did not track whether the bulb sold was a standard or specialty CFL. The evaluation team looked up the bulb type using the model numbers. Bulb types and type of specialty CFL are important to track as future program opportunity may be in the specialty bulb arena.

Program Marketing, Outreach, and Training

Based on interviews with program staff, the program was promoted both inside and outside participating retail locations. Outside marketing was done with email blasts, radio advertisements, and a booth at state and community events and home shows. Program records show that the program was marketed at 28 events including 10 days at the 2010 and 2011 Delaware State Fairs. Despite these efforts, one retailer interviewed for the evaluation felt that most customers were unaware of the discounts and recommended more mass marketing be used for future programs.

The program also had materials explaining the benefits of energy efficient lighting at participating retailers. Seven of nine retailers interviewed for this evaluation recalled the marketing materials. One retailer knew that the program provided materials but did not recall anything about the materials and could not assess their impact or usefulness. Those who could recall the materials felt they were useful and helped educate customers about the benefits of energy efficient lighting.

Program records show that the implementation firm held 25 events at the top-selling retail locations. Program field representatives explained the benefit of CFLs to customers during these events. Perhaps due to the time that has passed since the program ended, only one retailer interviewed for this evaluation recalled the events though APT records indicate that events were held at some of the other retailers interviewed for this evaluation. It is likely that with the passage of time and the variety of programs that these stores run, it was difficult to remember the events.

The program's field representative also typically trains store staff members on CFLs and how to best promote them. Like the store events, only a few retailers interviewed recalled these trainings. Three of nine retailers interviewed recalled the field representative talking with store associates about the program. One retailer recommended more formal sit-down trainings so that more staff could be involved and not simply those that were available when the field representative visited the store.

Energy Efficient Lighting Awareness and Usage

According to results of the residential baseline telephone survey, awareness of CFLs is high among Delaware residents. Nine in ten (90%) have heard of CFLs when asked about them without a description. When those who were not aware were read a description of the bulbs, only 4% of the population still said they were not at all familiar with the bulbs. A large majority (88%) are either very or somewhat familiar with CFLs.

Table 3-9. CFL Awareness and Familiarity

	% of Respondents
Unaided Awareness	
Aware	91%
Aided Awareness	
Very Familiar	50%
Somewhat Familiar	38%

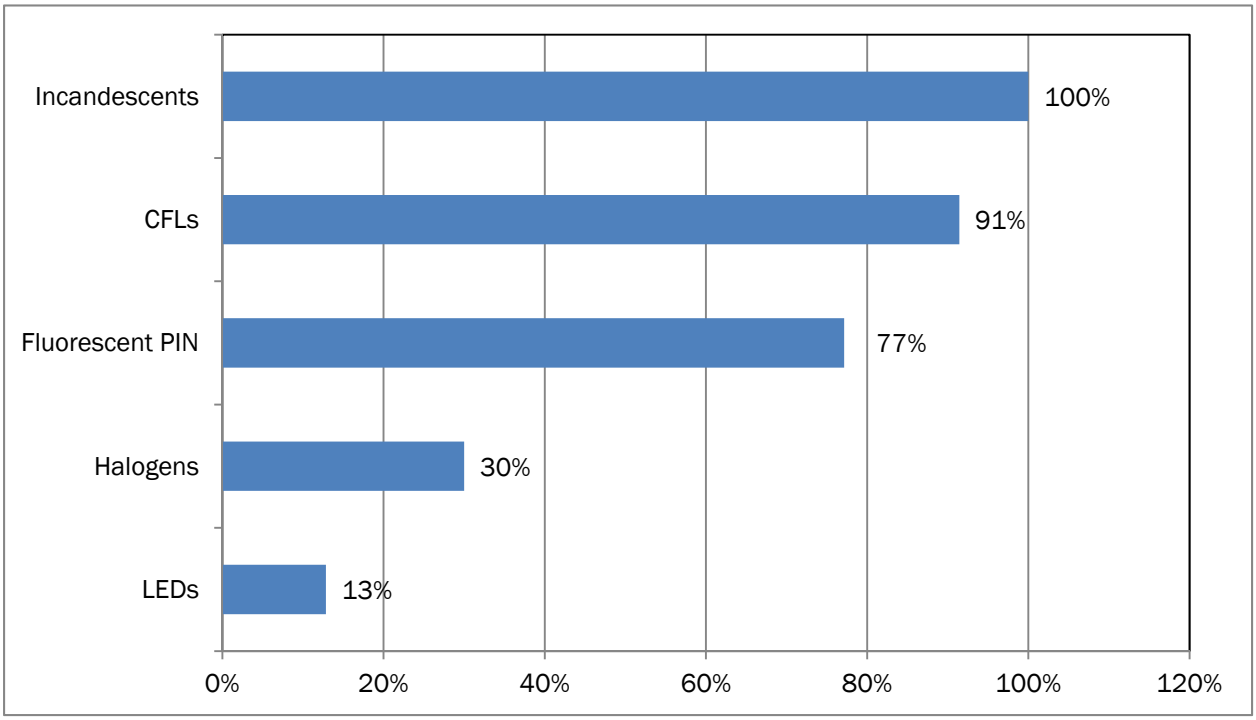
Not Very Familiar	8%
Not at all Familiar	4%

According to the residential baseline survey, a relatively large number of Delaware residents are aware of the next generation of energy efficient lighting, LEDs. Three-quarters (75%) of residents have heard of LEDs that can be used to replace standard light bulbs.

The penetration rates from the in-home baseline study show that consumers are more than just aware of CFLs; they are actually using them (see **Error! Reference source not found.**). The in-home lighting audit that was part of the baseline study found that 91% of homes had at least one CFL installed.

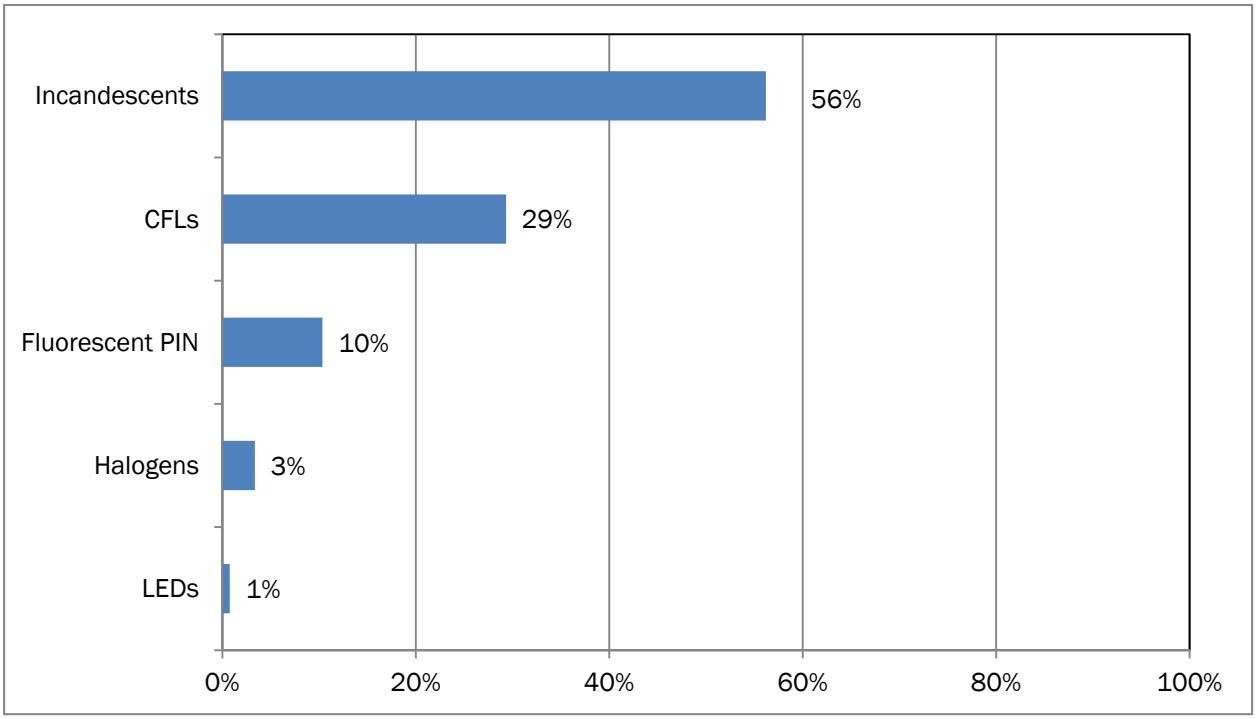
Though consumers are aware of LEDs, most are not using them yet. Only 13% of homes had an LED installed; most of these homes had a specialty or pin-based LED installed. Only one home had a new medium screw-based LED installed.

Figure 3-2. Lighting Penetration Rates



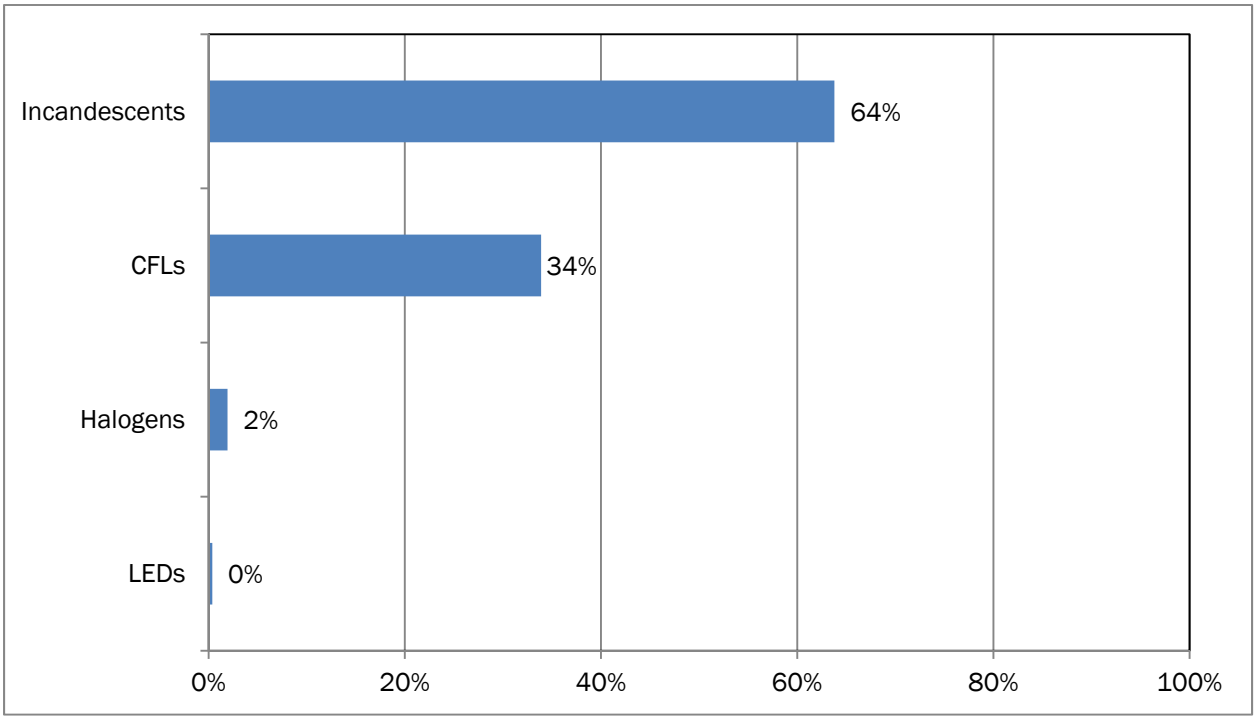
Though nearly all homes have at least one CFL installed, the majority of sockets do not contain a CFL or LED. CFLs comprise 29% of bulbs installed in the average Delaware home and LEDs are only 1% (see **Error! Reference source not found.**). Just over half are incandescents (56%) and one in ten are fluorescent pin (10%). The remainder are halogens (3%).

Figure 3-3. Overall Socket Saturation Rates



If we examine socket saturation of screw-based bulbs only, incandescents are installed in approximately two-thirds of sockets and CFLs are in one-third (see **Error! Reference source not found.**). Halogens are installed in only 2% of screw-based sockets and LEDs are in less than 1%.

Figure 3-4. Socket Saturation Rates for Screw-Based Sockets

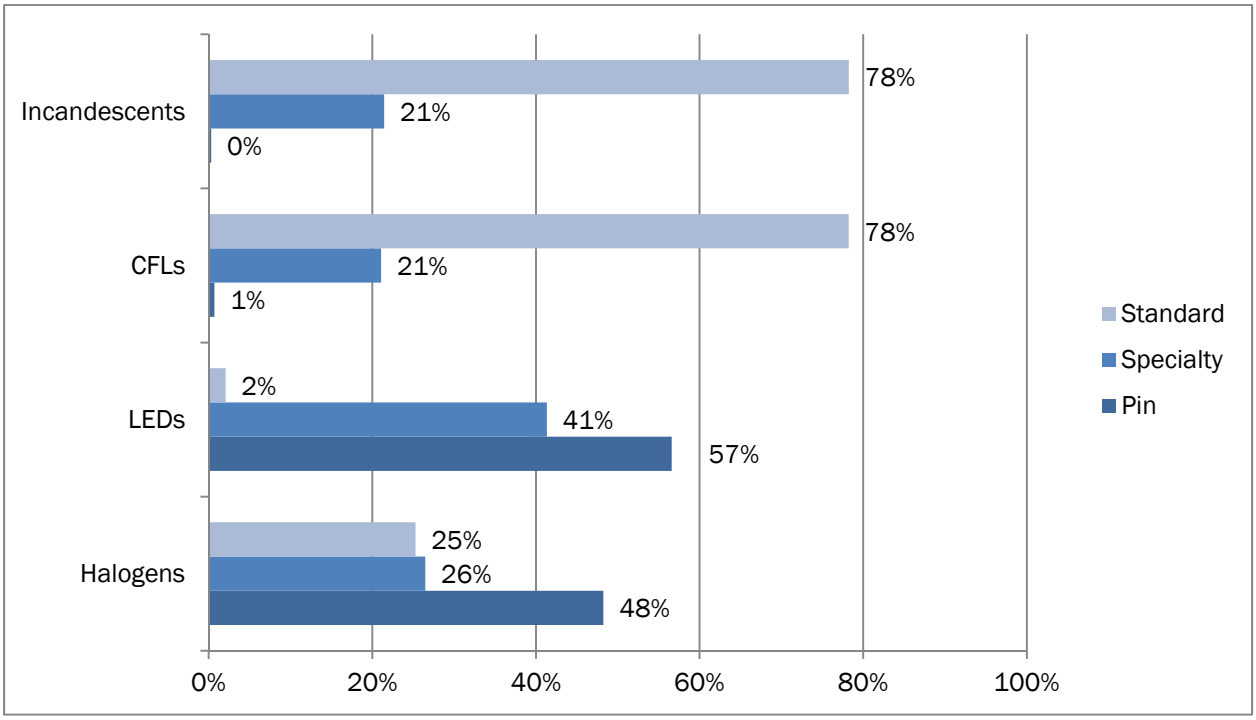


To understand how consumers are using the different lighting technologies available, we calculated socket saturation by bulb type for each technology (see **Error! Reference source not found.**). Of all incandescents installed, 78% are in standard screw-based sockets, 21% in specialty screw-based, and less than 1% are in pin-based sockets. Residents are installing CFLs in the same types of sockets as incandescents.

Expense is typically a greater barrier to purchase for specialty CFLs as they are more expensive than standard CFLs even with a program discount. These results suggest that specialty CFLs are selling quite well in Delaware despite the greater expense. This is reinforced by examining socket saturation of standard screw-based sockets alone compared to specialty screw-based sockets. As the results in **Error! Reference source not found.** would suggest, the CFL socket saturation in standard sockets is nearly the same as in specialty sockets (36% compared to 35%).

Until very recently, LEDs and halogens have not been available for standard screw-based sockets. As a result, most of these bulb types are installed in sockets that require a screw-based specialty bulb or a pin bulb (see **Error! Reference source not found.**). Since halogens and LEDs are now available for standard and specialty screw-based sockets, these results provide a good baseline for these technologies as they are entering the market.

Figure 3-5. Socket Saturation for Different Technologies by Bulb Type



The Potential for Future Lighting Programs in Delaware

Delaware has relatively high CFL penetration and socket saturation rates for a state that has only had a lighting program in effect for approximately one year. This is true of both standard and specialty CFLs.[12] Given the changes that have been taking place in the national lighting market, these results are not surprising. Nationwide chains, where most light bulbs are purchased, now stock the same products across the country regardless of the existence of a discount lighting program. CFLs have been gaining shelf space and incandescents have been losing space at major retailers in Delaware just as they have across the nation.

To gauge the potential for future lighting programs, the evaluation team estimated the number of standard and specialty screw-based sockets that currently have a less efficient bulb installed and thus could still be retrofitted with a more efficient option. With 405,885 households in Delaware, we

[12] The program incented standard and specialty screw-based bulbs. Our current estimate of CFL socket saturation is 36% for standard screw-based sockets and 35% for specialty screw-based sockets. Based on current estimates and program sales, we estimate that CFL socket saturation prior to the program was 31% for standard screw-based sockets and 32% for specialty screw-based sockets. Our earlier reported NTG ratio of .49 suggests that half of the increase in socket saturation from bulbs sold through the efficient lighting program would have happened without the program.

estimate that close to 10 million standard sockets and 4 million specialty sockets do not have the most efficient lighting technology installed.[13]

Error! Reference source not found. provides the inputs to the socket potential estimates. It shows that both standard and specialty bulbs should be considered for future program incentives. While standard and specialty CFLs have essentially the same socket saturation, there are more standard sockets than specialty sockets in Delaware homes.

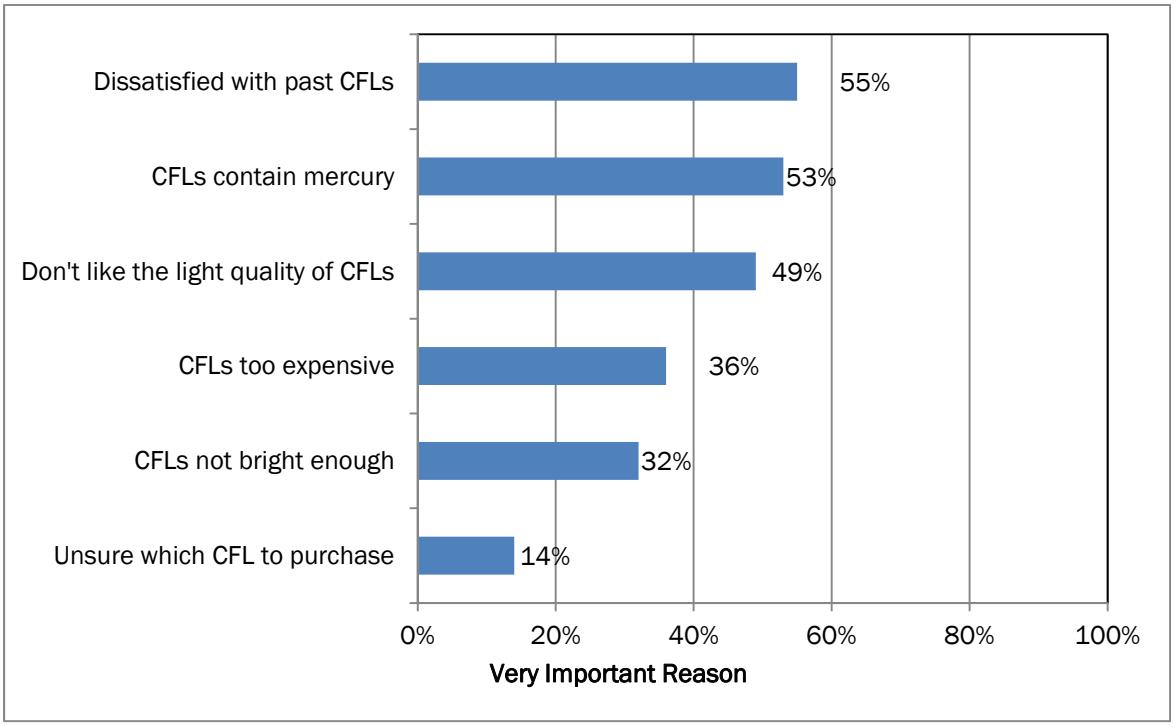
Table 3-10. Remaining Socket Potential for Energy Efficient Lighting

Socket Type	% of Households with Socket	Average Number of Sockets per Household	Total Sockets in Delaware	CFL Saturation	Socket Potential
Standard	100%	38	15,423,630	36%	9,871,123
Specialty	74%	20	6,007,098	35%	3,904,614

These results indicate that there is still considerable opportunity for additional savings from lighting programs in Delaware. Despite the high levels of awareness and use of CFLs, barriers to greater CFL usage remain. To understand what might be preventing some Delaware residents from purchasing CFLs, we asked those who are not likely to purchase CFLs about six potential barriers to purchase. **Error! Reference source not found.** shows the relative importance of each barrier. Bad past experience with CFLs (55%), mercury concerns (53%), and light quality (49%) are very important reasons for approximately half of respondents of who are not likely to purchase them. The expense of CFLs is an important reason for just over one-third (36%).

[13] It is unrealistic to expect that 100% of sockets will eventually contain the most efficient product available, which is what these numbers represent. These estimates present a best case target but one that is not likely fully achievable.

Figure 3-6. Barriers to CFL Purchase



The Impact of EISA on Lighting Programs

As EISA phases out traditional incandescent bulbs, consumers will have three main bulb options for standard screw-based sockets: CFLs, LEDs, and halogens. CFLs and LEDs are the most efficient and programs can still play a role in encouraging their customers to choose these technologies over the new EISA-compliant but less efficient halogen bulbs.

The impact of EISA on program savings from standard bulbs should be considered when determining the focus of future lighting programs. The new baseline for calculating savings for standard bulbs will be the EISA compliant halogens. Because EISA only impacts standard bulbs, sales of standard bulbs will result in 37% less savings per bulb. EISA is phased affecting 100 watt incandescent bulbs in 2012, 75 watts in 2013, 60 watts in 2014, and 40 watts in 2015. When EISA is fully implemented in 2015, programs will need to sell one-third more standard bulbs than specialty bulbs to get credit for the same savings. EISA will not impact the most popular bulb wattage until 2014. As shown in **Error! Reference source not found.** above, the most popular wattage of CFLs sold is 60-watt equivalents with 65% of efficient lighting program sales. Even with reduced savings for 60 watts beginning in 2014, current estimates indicate that incentives on EISA regulated bulbs will still be a cost-effective program offering given the increased cost of the EISA compliant halogens relative to standard incandescents.[14]

[14] Tami Buhr, "The Future of CFL Programs After EISA." Paper presented at ACEEE National Conference on Energy Efficiency as a Resource, Denver, Colorado. September 2011.

EISA does not affect specialty or pin-based bulbs so programs can also play a role in the continued spread of more efficient alternatives for these bulbs. However, program NTG ratios should also be considered when selecting the mix of products to incent and the level of support to provide in the post-EISA era. This evaluation found a NTG ratio of .49 meaning that half of program-incented sales would have taken place without the program. The NTG for standard and specialty CFLs were essentially the same at .49 and .47, respectively. Often, specialty CFLs have higher NTG ratios because the incentives are not large enough to bring down the price of these more expensive bulbs and attract people who are price sensitive and will not buy them at the higher price.

3.5 RECOMMENDATIONS

In addressing the key findings from the evaluation, the evaluation team recommends the following to improve the performance and achievements of the Lighting program:

- The markdown side of the program accounted for nearly all of the sales. The coupon side had lower than expected sales. Retailer interviews suggest that program procedures may have created some barriers to participation and also that the program may need to recruit a different mix of small retailers for this side of the program in the future. Given the small number of sales, future programs may determine that a coupon program is not cost-effective.

- To make it easier to track program progress during the program year, future lighting programs should track additional information about bulb characteristics including bulb wattage, bulb type of specialty CFL.

- Greater marketing of the program outside of stores is recommended for future programs. Also, future programs should provide additional and more formal training of sales staff on the variety of technologies available to consumers and their appropriate use.

- Lighting programs should still be a part of program portfolios in Delaware. The residential baseline study found that nearly all Delaware residents (~90%) are aware of CFLs and have at least one installed in their homes. That noted CFL socket saturation is lower with just under one-third of light sockets containing a CFL. Given this there remain ample opportunities for lighting programs to influence customers to fill the remaining 70% of sockets with CFLs. Despite relatively high CFL penetration and socket saturation rates, there is still considerable opportunity for additional savings from lighting programs in Delaware. As programs are developed in the future, consideration should be given to how program designs can influence installations in the remaining sockets. This might be addressed through more promotion of specialty bulbs and program messaging.

- The current lighting environment is in flux with new products introduced almost daily and unsettled product pricing. For future lighting programs to be cost-effective in this environment, they will need to be flexible and have the ability to change product mixes and incentive levels throughout the year if necessary.

- Future lighting programs should invest in consumer education. Different lighting technologies do not perform equally well in all situations. Consumers are likely to be confused about the best bulb for a given lighting situation. Programs will need to work with retailers and manufacturers to educate consumers to prevent dissatisfaction with their purchase, which could create long-term resistance towards a technology as happened with some of the early CFLs.

4. HOME PERFORMANCE

4.1 KEY FINDINGS

The Home Performance with ENERGY STAR Program offered incentives for an energy audit and qualifying installations of HVAC equipment, insulation and sealing, building shell improvements, and other energy savings measures for homeowners in Delaware. Based on our evaluation of the Home Performance Program, we provide the following key findings and recommendations for consideration in the development of any future programs:

- **Participation in the program exceeded expectations.** An impressive 3,887 projects were completed through the Home Performance Program, resulting in tracked savings of 73,923 million Btu (MMBtu) per year. While the majority of these projects (67%) included HVAC equipment installations only, projects completed through the Performance path (those saving at least 20% of baseline usage) resulted in the majority of tracked savings (66%).

- **Evaluated gross savings are 99.9% of tracked savings for HVAC Rebate projects and 76% of tracked savings for Performance and Standard projects.** Our gross impact analysis verified tracked savings for virtually all HVAC rebate projects. For Performance and Standard path projects, we found that Beacon estimates often exceed reasonable estimates based on commonly used data sources (e.g., the Mid-Atlantic TRM).

- **Levels of freeridership are higher among HVAC Rebate projects than Performance and Standard projects.** Based on our analysis of self-reported freeridership, we estimate that 33% of HVAC Rebate savings and 15% of Performance and Standard path savings would have occurred even in the absence of the program. The overall net-to-gross ratio for the program is 0.78; estimated evaluated net savings for the program are 48,269 MMBtu.

- **Customers were very satisfied with the program, but contractors expressed some dissatisfaction.** Satisfaction among participating customers was high (80%). Most contractors were dissatisfied with the limited duration of the program, which was a result of the timeframe available for using ARRA funding. Other reasons for dissatisfaction were changing program requirements, difficulty with day-to-day communication with the implementation staff, a slow disbursement of incentive and loan funds, and challenges with the Beacon software.

- **Incentives were high and a motivator for home energy improvements.** About three quarters of participants (74%) and almost all interviewed contractors said that the rebates were important to customer decisions about whether to install measures. Some contractors felt that the rebate amount was too high and that customers would have made changes with a lower rebate. Only 10% of participants reported that the available rebate amount limited the improvements they made. Overall, rebate payments averaged $97.53 per million BTU of tracked savings, or $0.33/kWh when savings of all fuels are converted to kWh. For Performance path projects, rebates or tracked savings averaged $0.40/kWh[15].

- **Slow payment of rebate funds created a challenge for homeowners and contractors.** While customers were generally satisfied with the program, one reason for dissatisfaction was a long

[15] These are costs for the first year program savings, for cost effectiveness calculations this cost would be spread out over the full lifecycle of the savings from each measure addressed.

wait to receive the rebate. Nearly all interviewed contractors also reported a slow rebate disbursement process, which created challenges for their businesses and their relationships with customers.

- **The majority of homeowners were not aware of the loan option.** Over three quarters (78%) of those who participated after a financing option was available were not aware of it. Almost all interviewed BPI certified contractors were aware of the loan option, and about half promoted it to their customers. Knowing about the loan would have made a difference to some customers who were not aware (11%), with most saying they would have installed different equipment or made additional improvements.

- **Some contractors reported challenges with the Beacon software.** More than half of the interviewed contractors felt that the Beacon software did not always provide accurate savings estimates, with some reporting that the software allowed the user to manipulate or bias the results. Others noted that Beacon did not include all necessary measures or related components. On the other hand, some interviewed contractors would have liked to continue using it after the program ended. Many contractors noted that the training on how to use the software was insufficient.

- **Certain elements of the program structure favored HVAC equipment installations**. Information provided by interviewed contractors indicates that certain elements of the program might have favored the installation of HVAC equipment. Some contractors noted that they did not recommend shell measures because it was not core to their business, suggesting that having audits conducted by contractors specialized in certain types of equipment might have posed a disincentive to striving for deeper savings. While the $250 audit incentive was designed to encourage deeper savings by being restricted to projects achieving 20% savings, tracking data suggests that it was paid to all participants who received an audit. In addition, savings assumptions in Beacon appear to favor HVAC equipment, by assuming early replacement instead of end-of-life installations.

- **The program encouraged investments in the infrastructure for Home Performance services, but market effects were likely temporary because of the nature of the ARRA funding.** While many contractors pursued BPI certification in order to be eligible to participate in the Home Performance Program, demand for audits sharply decreased after the program ended. In addition, many interviewed contractors reported that they now sell lower efficiency units compared to when the program was in place, with some noting that most of their current sales are minimum efficiency units. If the program had a more stable funding source, an environment would be created that allows market effects to develop over time.

4.2 Program Description and Objectives

The Energize Delaware Home Performance program targeted existing owner-occupied homes, regardless of heating fuel type. The program consisted of a two-step process, a comprehensive Home Assessment (energy audit) that generated specific recommendations for energy efficiency improvements and the implementation of some or all of the recommended improvements. Customers were eligible for incentives and/or financing to make the improvements more affordable. The program was implemented by ICF International.

The program launched in three phases:

1. Phase 1 – the HVAC Equipment Rebate path – launched on July 7, 2010 and included prescriptive rebates for heating and air conditioning equipment. There was no Energy Audit requirement to participate in the program.
2. Phase 2 – the Standard path – launched on August 18, 2010 and included an audit combined with prescriptive incentives for specific energy efficiency measures using a deemed savings approach for eligible measures. All projects implemented after January 1, 2011 required an audit as well as the use of ICF International's Beacon home energy modeling software.
3. Phase 3 – the Performance path – also launched on August 18, 2010. Performance path projects also required an audit and use of the Beacon software, and added performance-based measures.

Customers who participated in the Energize Delaware Home Performance program had to schedule an appointment with a participating contractor to provide a Building Performance Institute (BPI) Certified Home Energy Audit. Once an appointment was made, the BPI Contractor:

- Performed an assessment of the home per the program standards
- Performed Energy Modeling using the program's software
- Made recommendations for energy improvements
- Provided a cost estimate to implement those improvements
- Made the improvements[16]
- Conducted a test out of the installed measures
- Submitted for rebates and program incentives on the property owner's behalf

Program measures included:

- HVAC equipment (furnaces, boilers, heat pumps, central air conditioning)
- Insulation
- Air and duct sealing
- CFLs
- Other efficiency upgrades

Rebates under the Performance Path were based on whole house energy reductions, as defined below:

- Home Performance 20% Reduction - $3,000
- Home Performance 25% Reduction - $4,000
- Home Performance 30% Reduction - $5,000
- Home Performance 35% Reduction - $6,000
- Home Performance 40% Reduction - $7,000
- Home Performance 45% Reduction - $8,000

Rebates were capped at 50% of the total installed cost or to the incentive level indicated above, whichever is lower. In addition, $250 was paid toward the cost of the audit.

[16] In some instances, a separate contractor installed some or all of the measures recommended in the audit report.

In addition to the rebates, Delaware participants were able to apply for financing to cover the full cost of efficiency projects (up to $20,000). Interest rates on the financing ranged from 3.9% for the biggest efficiency projects that deliver the most energy savings to 6.9% for smaller projects. The payback period for the loans could be up to 10 years. The financing option came into effect later in the program's life cycle, in April of 2011.

Because of the high demand for program incentives, the program stopped accepting applications in September 2011. The program still allowed projects for which an audit had been completed by August 31, 2011, as long as a rebate request was submitted by September 10 and the work was completed by December 31, 2011. However, no new projects were accepted after September 1, 2011.

4.3 METHODS AND APPROACH

In support of the process and impact analyses, Opinion Dynamics implemented a variety of data collection and research efforts. We describe each of the activities and the intended outcome in Table 4-1 below.

Table 4-1. Evaluation Activity and Outcomes

Activity	Outcome
Program Material review	• Gain understanding of program processes and procedures • Gain knowledge of program marketing strategy and tactics
Database Review	• Review tracked data and equipment eligibility for HVAC Equipment Path projects
Impact Analysis	• Analyze savings calculations for HVAC Equipment Path projects • Review sample of Standard and Performance Path projects (43)
Database Review	• Capture tracked savings numbers and compare with reported results
Program and Implementation Staff Interviews	• Gain knowledge of program design and implementation • Develop understanding of processes and procedures
Participating Customer Interviews (143)	• Explore a variety of process-related aspects including the audit and installation processes, program marketing, and customer satisfaction • Verify installation of reported measures • Determine freeridership and participant spillover

Activity	Outcome
Interviews with Participating BPI Contractors (15)	• Explore a variety of process-related aspects including marketing and outreach, training and technical support, the audit process, uptake of recommended measures, satisfaction, and opportunities for program improvement

Primary Data Collection

We conducted two primary data collection activities, a quantitative survey with 143 program participants and 15 in-depth interviews with participating BPI contractors.

Participant survey: We completed the participant survey in May 2012 and focused on participants who received the program incentive in March of 2011 or later.[17] We interviewed 72 participants in the Standard or Performance path and 71 participants in the HVAC Rebate Equipment path. The response rate for this survey was 8%; the cooperation rate was 40% (see also Appendices A, B and C). For the process analysis, we did not apply survey weights as the completed interviews well represented the population. Our process results achieved a precision of 10% with 90% confidence. For the freeridership analysis, we applied savings-based weights. The overall precision level of the freeridership analysis was 4% with 90% confidence.

BPI contractor interviews: We conducted in-depth interviews with BPI contractors in May and June of 2012. The program tracking database contained 56 unique BPI contractors who implemented a Standard or Performance path project through the Home Performance Program. We attempted to contact all 56 BPI contractors, completing interviews with 15 of them. These 15 contractors implemented over 500 of the 1,270 Standard and Performance projects.

Gross Impact Methodology

Separate impact analyses were conducted for the HVAC Equipment Path projects and the Standard and Performance Path projects of the Home Performance Program.

HVAC Equipment Path Methodology

HVAC Equipment Path project savings are based on equipment that is assumed to be replaced at the end of its useful life. Savings are therefore calculated based on comparing the energy and demand of new equipment to equipment that just meets federal efficiency standards (see Table A-1 in Appendix A for a comparison of federal minimum standards and program minimum standards for the equipment installed under the HVAC Equipment Path).

Review of the HVAC Performance Path projects involved three steps:

[17] We omitted earlier participants to minimize respondent recall issues and to focus on participants who received an energy audit as part of their participation.

- A check of database entries for equipment capacities to make sure the sizes were reasonable.
- A check of the equipment efficiencies to determine that they met the program's minimum standards. Savings were set to zero for any equipment not meeting the program standards.
- A check and, if necessary, recalculation of energy and demand savings calculations for each type of equipment and comparing evaluated savings compared with tracked savings. Calculations for evaluated savings were based on equations in the Mid-Atlantic TRM.

Standard and Performance Path Methodology

We evaluated the Standard and Performance Path projects together, because the methods used by the implementer to estimate energy savings were the same for both paths. Both Standard and Performance Path projects required energy audits, and efficiency measures were recommended based on the audit information collected. Savings for the recommended measures are based on calculations made in the "Beacon" energy modeling tool. Beacon is proprietary software developed and maintained by ICF International, the implementer of the Home Performance Program. Beacon reports are given to each homeowner; they contain information about the home, its current energy use, recommended efficiency measures, and the total expected savings for the suite of recommended measures. Based on information from implementation staff, a second report is generated by Beacon which calculates savings of the individual measures for each project. Measure-level savings values in the tracking database are based on this second report. The evaluation team was not given access to any of these second reports of measure level savings.

Savings of HVAC equipment in Beacon are based on early replacement of equipment, and calculations are based on a comparison of new, energy efficient equipment with existing equipment that often is much less efficient than the current federal standards. This means that savings for HVAC equipment are larger than savings of other measures available under the HVAC Performance Path.

The impact evaluation included an in depth review of a random sample of 43 Standard and Performance Path projects. We requested and received all available program files for this sample, including the final Beacon output files listing characteristics of the home, the existing equipment, and the recommended measures; invoices and/or AHRI certificates; and post-installation test and inspection reports.

Our impact evaluation included four steps:

- A check to see if the recommended measures in our 43 project sample were actually installed. Based on this review, we developed end use specific installation rates.[18]
- A check on fuel types, to make sure that energy savings are being assigned to the correct fuels, especially when new equipment switches to a different fuel.
- Calculation of the energy savings of all measures in our 43 project sample. The Mid-Atlantic TRM was used as the primary resource and point of comparison to estimate energy and demand savings. Additional resources include the New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, and the US EPA Energy Star program. The savings calculations were primarily used to determine sample-wide realization

[18] Note that these installation rates were not applied when estimating evaluated gross savings. However, low installation rates indicate potential concerns about data tracking and documentation procedures.

rates for demand and energy savings, on a fuel-specific basis. The realization rates for kW, kWh, therms, gallons of oil, and gallons of propane are applied back to savings for the entire program, to determine evaluated energy savings.

- Examination of measure-level realization rates. Our measure-level realization rates are not statistically significant, due to the low incidences of some measures in our 43 project sample. However, our evaluated savings estimates were made in accordance with well-documented references that represent a consensus about the average energy savings expected for a particular measure. Large variations from the evaluated savings are cause for concern about the tracked savings estimates.

Net Impact Methodology

We derive net program impacts by applying a net-to-gross ratio (NTGR) to ex-post gross program savings. This NTGR typically comprises two concepts, freeridership (FR) and spillover (SO). This evaluation quantified freeridership but assessed participant spillover qualitatively. We used self-reported information from the telephone survey with program participants to assess both free-ridership and participant spillover. The overall NTGR is calculated as (1 - FR). The final ratio represents the percentage of gross program savings that we can reliably attribute to the program.

The overall freeridership score is the average of the program components score and the likely action without program score. The freeridership score for each respondent ranges from 0 (0% freeridership, 100% program attribution) to 1 (100% freeridership, 0% program attribution).

We developed separate freeridership scores for HVAC Rebate path projects and Standard/Performance path projects. Within each of these two groups, the freeridership scores of individual respondents were weighted by their projects' savings. To estimate the program's overall level of freeridership, we took a savings-weighted average of the HVAC Rebate path freeridership and the Standard/Performance path freeridership.

This evaluation only included a qualitative assessment of participant spillover. Quantification of participant spillover requires detailed information on additional actions taken by participants. Given other research objectives, this level of detail could not be included in the participant survey.

4.4 RESULTS

Participation

Overall, Delaware residents completed close to 4,000 projects through the Home Performance Program, an impressive level of participation. Of these, 67% were HVAC Equipment Rebate projects, 27% were Performance path projects, and 6% were Standard path projects. Performance path projects were significantly larger than other projects, averaging approximately 46 million Btu per project, compared to 9 million Btu for Standard and HVAC Rebate path projects. Similarly, the average rebate amount for Performance path projects was much larger, at $5,418 per project, more than ten times that of Standard and HVAC Rebate projects.

Table 4-2 summarizes participation in the three HPwES participation paths.[19]

Table 4-2. Summary of Participation in HPwES Program

Program Path	Projects	% of Projects	Tracked Gross Savings (MMBtu)	% of Savings	Savings/ Project (MMBtu)	Total Rebates	% of Total Rebate	Rebate/ Project
HVAC	2,624	67%	22,875	31%	8.72	$1,353,500	19%	$516
Performance	1,055	27%	48,899	66%	46.35	$5,715,707	80%	$5,418
Standard	240	6%	2,149	3%	8.95	$106,887	1%	$445
TOTAL	**3,919**	**100%**	**73,923**	**100%**	**18.86**	**$7,176,093**	**100%**	**$1,831**

Source: Program tracking database; gross impact analysis.

Table 4-3 summarizes the number of tracked projects by key program measures as well as the total number of measures installed. The table shows that the Home Performance Program relied heavily on the installation of HVAC equipment, with 60% of projects including a furnace, 28% including a heat pump, and 21% including a central AC system. Many of these projects were completed under the HVAC Rebate path, before an energy audit was required.

Lighting measures were included in 22% of projects, mostly through the Performance path. Air sealing and insulation were included in 20% of projects, and thermostats and ECM fans were included on 17% of projects.

[19] The numbers in this section are based on evaluated gross savings. Excluded from these results were 32 projects listed in the program tracking database that had no installed measures, zero savings, or that only included measures that did not meet program eligibility requirements. These projects are not included in the numbers presented in this section.

Table 4-3. Summary of HPwES Projects with Installed Measures

Measure	# of Projects with Measure				# of Measures			
	TOTAL	Perform.	Standard	HVAC Rebate	TOTAL	Perform.	Standard	HVAC Rebate
HVAC Equipment								
Furnace	2,320	487	13	1,820	2,369	501	13	1,855
Heat Pump	1,100	440	11	649	1,154	471	12	671
Central AC[1]	821	207	11	603	844	212	14	618
Boiler	103	43	1	59	105	44	1	60
Window AC	34	34	--	--	37	37	--	--
HVAC Updates								
Thermostat[2]	689	654	18	--	830	786	23	
ECM Fans[3]	654	637	17	--	884	863	21	
Ducts	303	245	58	--	478	397	81	
HVAC Tune-Ups	46	42	4	--	55	51	4	
Water Heating								
Water Heater	161	140	21	--	163	142	21	
DHW Measures	230	212	18	--	368	337	31	
Low Flow Devices	148	143	5	--	274	266	8	
WH Temp Turndown	229	226	3	--	235	232	3	
Envelope								
Air Sealing	788	665	123	--	789	665	124	
Insulation	806	669	137	--	2,409	2,133	276	
Doors & Windows	200	173	27	--	349	316	33	
Appliances & Lighting								
Appliances	167	158	9	--	241	223	18	
Lighting[4]	863	828	35	--	863	828	35	
TOTAL Projects	**3,887**	**1,048**	**222**	**2,617**				
TOTAL Measures[4]					**12,447**	**8,504**	**718**	**3,131**
Measures/Project[4]					**3.20**	**8.11**	**3.23**	**1.20**

[1] The program tracking database counts the cooling energy savings of all heat pumps as central AC systems. We adjusted the Central AC count, assuming that any home with both a heat pump and central AC system has installed just a heat pump.

[2] The program tracking database counts the heating and cooling energy savings of any programmable thermostats as separate measures. These counts recombine these measures, assuming that any home with both a heating and cooling thermostat has installed just one thermostat.

[3] The program tracking database counts the heating and cooling energy savings of any ECM fans as separate measures. These counts recombine these measures, assuming that any home with both a heating and cooling ECM fan has installed just one fan motor.

[4] In order to not skew the total number of measures and the number of measures/project, we only include one CFL per project. The total number of CFLs rebated through the program was 21,549, with 20,735 installed through the Performance path.

Source: Program tracking database.

Gross Impact Results

Table 4-4 presents a summary of tracked gross program savings, by program path and fuel type. The Performance path accounted for 66% of tracked program savings, the HVAC Rebate path for 31%, and the Standard path for 3%.

Table 4-4. Home Performance Gross Tracked Savings

Program Path	Projects	kW	kWh	Therms	Oil gals	Propane gals	MMBtu[1]	% MMBtu
HVAC Rebate	2,624	403	835,920	199,019	868	-	22,875	31%
Performance	1,055	1,917	3,908,708	168,976	112,699	32,917	48,899	66%
Standard	240	2,107	298,958	4,597	3,321	2,277	2,149	3%
Total	3,919	4,427	5,043,586	372,592	116,888	35,194	73,923	100%

[1] Includes all fuels. We use the following conversions between fuels: 1 kWh = 3,413 Btu; 1 therm = 100,000 Btu; 1 gallon of oil = 139,000 Btu; 1 gallon of propane = 91,000 Btu.

Source: Program tracking database.

The HVAC Equipment Path of the program was evaluated separately from the Standard and Performance paths, and two separate realization rates (RR) were developed.[20] Table 4-5 summarizes the energy and demand realization rates and evaluated savings.

Table 4-5. Home Performance Realization Rates and Gross Evaluated Savings

Program Path	Tracked Gross Impact	RR	Evaluated Gross Impact	Tracked Gross Impact	RR	Evaluated Gross Impact
	MMBTU			kW		
HVAC Rebate	22,875	0.999	22,843	403	0.992	400
Performance	48,899	0.757	37,032	1,917	0.295	565
Standard	2,149		1,627	2,107		621
Total	73,923	0.832	61,512	4,427	0.358	1,586
	kWh			Therms		
HVAC Rebate	835,920	0.992	829,541	199,019	0.999	198,909
Performance	3,908,708	0.344	1,343,188	168,976	0.471	79,605
Standard	298,958		102,734	4,597		2,166
Total	5,043,586	0.451	2,275,463	372,592	0.753	280,679
	Oil Gallons			Propane Gallons		
HVAC Rebate	868	1.000	868	0	--	0
Performance	112,699	1.012	114,101	32,917	0.975	32,090
Standard	3,321		3,363	2,277		2,220
Total	116,888	1.012	118,331	35,194	0.975	34,310

[20] The realization rate is the ratio of evaluated savings to tracked savings.

The HVAC Equipment Path of the program achieved near-perfect realization rates, with a fuel-neutral energy realization rate of 0.999 (MMBtu RR) and a demand savings realization rates of 0.992. The small amount of lost savings in the HVAC Equipment Path was due to a handful of measures that did not meet program efficiency requirements. More details about the HVAC Equipment Path evaluation are provided in Appendix A.

The realization rates for the Performance and Standard paths of the program are much lower. The fuel-neutral energy realization rate (MMBtu RR) is 0.757; the demand realization rate (kW RR) is just 0.295. By fuel type, the energy realization rate is close to 1.0 for oil and propane but lower for electricity and gas (0.344 and 0.471, respectively).

The low realization rates of the Performance and Standard Path projects had two major causes.

- The effects of fuel switching were not accounted for correctly, in particular for air sealing, insulation, thermostat, duct work, tune-ups, and water conservation measures. Savings for these measures tended to be tracked under the old HVAC or water heating fuel types, not the new fuel types. In addition, negative kWh impacts of switching from oil or gas heat to a heat pump were accounted for in the tracked savings, but were generally understated.
- For many measures, tracked savings based on the Beacon software were unreasonably high when compared to estimates based on the Mid-Atlantic TRM and other commonly used sources. While the measure-level realization rates may not be statistically significant, due to the low number of measures we reviewed, they do indicate some large differences between tracked savings and evaluated savings. Some measures had very high realization rates; however, these were not enough to offset the low realization rates.

Table 4-6 shows realization rates (by fuel type) and demand realization rates, by end use.

Table 4-6. Performance and Standard Paths Realization Rates by End Use

End-Use	MMbtu RR	kW RR	kWh RR	Therm RR	Oil RR	Propane RR
Cooling	0.69	0.55	0.69	n/a	n/a	n/a
Heating	0.90	n/a	5.61*	0.26	1.22	1.30
Ducts	0.24	0.64	0.42	0.27	0.00	0.02
Air Sealing	0.74	4.17	1.15	0.65	0.77	0.69
Insulation	0.84	0.02	0.52	1.12	0.45	1.35
Envelope	1.09	0.60	0.63	0.95	4.36	2.08
Hot Water	0.32	0.29	0.43	0.37	0.00	n/a
Appliances	0.24	0.37	0.24	n/a	n/a	n/a
Lighting	0.61	0.50	0.61	n/a	n/a	n/a
Total	0.76	0.29	0.34	0.47	1.01	0.97

*This rate is applied to a negative tracked value, i.e., the estimated *increase* in electricity use is larger in evaluated results than in tracked results.

In addition to the realization rates presented above, we also verified the installation of measures for which savings are claimed in the program tracking database. It is general evaluation practice to only validate and count towards evaluated savings measures for which documentation of installation is available. Our analysis considered measures to be verified as installed if there was 1) an invoice or 2) a mention of the measure in the post-inspection report.

Overall, we found a relatively high incidence of measures for which we could not verify installation. Verified installation rates varied by end use, as shown in

Table 4-7 below. While we did not apply these rates in our gross impact analysis (which would have reduced evaluated savings), it should be noted that lack of documentation is of concern. If installations cannot be independently verified, the program risks losing some of its claimed savings during the evaluation process.

Table 4-7. Performance and Standard Paths Installation Rates by End Use

End-Use	Installation Rate
Cooling	1.00
Heating	1.00
Ducts	0.92
Air Sealing	1.10
Insulation	0.92
Envelope	0.82
Hot Water	0.49
Appliances	1.00
Lighting	0.83
Total	0.88

Appendix B presents more details about the Performance and Standard path evaluation; Appendix C presents measure level analyses and results.

Net Impact Results

Net program impacts are calculated by applying the net-to-gross ratio (NTGR) to ex-post gross program savings. The NTGR, which represents the percentage of gross program savings that we can reliably attribute to the program, is calculated as:[21]

1 – Free-Ridership

Based on the levels of freeridership, calculated below, the NTGR for the Home Performance Program is estimated to be 0.78. Applying the NTGR to evaluated gross program savings yields annual program-level net impacts of approximately 48,269 million BTU.

Table 4-8 summarizes the net impact results for HVAC Rebate projects, Performance/Standard projects, and the Home Performance Program overall.

[21] In this evaluation, we only quantified freeridership; we assessed participant spillover qualitatively. Any spillover would increase the NTGR and therefore net program savings.

Table 4-8. Net Impacts for Home Performance Program

	Ex Ante Gross Savings (MMBtu)	RR	Ex Post Gross Savings (MMBtu)	NTGR	Ex Post Net Savings (MMBtu)
HVAC Rebate	22,875	0.999	22,853	0.67	15,269
Performance/ Standard	51,048	0.757	38,660	0.85	33,000
Total	73,923	0.832	61,512	0.78	48,269

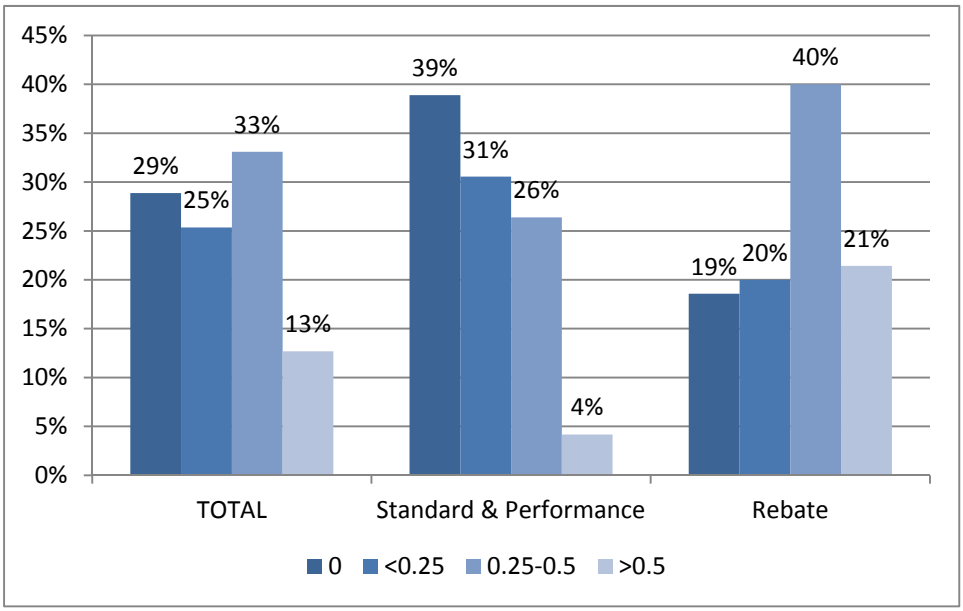
Source: Program tracking database, net and gross impact analyses.

Freeridership

Through our participant survey, we collected data to estimate separate freeridership values for HVAC Rebate projects and Performance/Standard path projects. The program-level estimate of freeridership is 0.22 (meaning 22% of savings would have occurred in the absence of the program). Notably, HVAC Rebate projects, which account for 31% of program savings, have a higher level of free-ridership (0.33) than Performance/Standard projects (0.15).

Of the 143 respondents to the participant survey, 29% had a freeridership score of 0, 25% had a score of less than 0.25, 33% between 0.25 and 0.5, and 13% above 0.5. Figure 3-7 shows the distribution of levels of freeridership for the program overall and by project type.

Figure 3-7. Levels of Freeridership, by Project Type



Source: Participant telephone survey, net impact analysis.

Participant Spillover

Thirty-six percent of participants report having implemented additional energy saving improvements to their home since receiving the rebate through the Home Performance Program.[22] Of these, about half (17% of all survey respondents) report that the program had a strong influence (a score of 8, 9, or 10, on a scale of 1 to 10) on their decision to implement the additional improvements.

Overall, 13% of participants made additional improvements that were recommended by the audit – the most common reason for not making the improvements through the program was cost/financial reasons.

A total of 7% of participants report additional improvements that were strongly influenced by the Home Performance Program AND were recommended by the audit. About half of these participants installed insulation. Other improvements included doors, storm doors, or door sealing; HVAC equipment (furnace, central air conditioning, water heater), air sealing, and an Energy Star refrigerator.

These findings suggest the presence of participant spillover[23].

Process Results

Rebates

The program offered two different incentive structures: the Performance path incentive ranged from $3,000 to $8,000, depending on the percentage of energy reduction achieved (but capped at 50% of installed cost); participants in the Standard and HVAC Rebate paths received a fixed incentive, based on the type of measure installed (between $400 and $550 per piece of HVAC equipment, and up to $400 each for a variety of insulation, air sealing, and other building shell measures). The average rebate across all three program paths was $1,840. Notably, the average rebate for Performance path projects was over $5,000, more than ten times the average rebate amounts for HVAC rebate and Standard path projects. For Performance path projects, the rebate per unit of energy saved was twice that of Standard path and HVAC Rebate path projects, or $0.40/kWh.[24]

[22] It should be noted that it is unknown if this equipment would have qualified for incentives through the Home Performance Program.

[23] Additional detail on spillover is provided above under Methodologies.

[24] Including all fuels, but converting savings of all fuels types to kWh.

Table 4-9. Program Rebates Compared to Annual Tracked Savings

Program Path	Total Rebate	% of Total	Average Rebate	Total Savings (MMBTU)	% of Total	Average Savings (MMBTU)	$/ MMBTU	$/ kWh
Performance	$5,743,818	80%	$5,444	48,895	66%	46	$117	$0.40
Standard	$111,924	2%	$466	2,149	3%	9	$52	$0.18
Rebate	$1,353,500	19%	$516	22,873	31%	9	$59	$0.20
TOTAL	$7,209,242	100%	$1,840	73,916	100%	19	$98	$0.33

Source: Program tracking database.

For 74% of participants, the rebate was influential in their decision to make the improvements to their home.[25] Similarly, almost all interviewed contractors thought that the rebates were important to their customers' decision about which measures to install, particularly for those that did not have the initial capital to make large investments. Nearly all interviewed contractors reported slow payment of rebate funds to customers, which in turn created administrative challenges for their own companies.

Several of the contractors thought that the rebates provided to customers for the program were too large and that the funding could have been allocated in a way that would have allowed the program to run for a longer period of time. However, due to the temporary nature of ARRA funding, the program also needed to be aware of federal deadlines and ensure that funds were spent by the end of the grant period. Only 10% of participants reported that the available rebate amount limited the improvements they made.

Loan Option

A financing option through AFC First was introduced in April 2011. Eligible Home Performance Program participants could get a loan to cover the full cost of their project (up to $20,000), with interest rates ranging from 3.9% for projects with the largest savings to 6.9% for smaller projects. Overall, 56 participants took advantage of the loan offer, all but one participants in the Performance path.[26]

A large majority of participants were not aware of the availability of the loan (78%).[27] Of those that were aware of the loan, about half found out about it through a contractor or an auditor. Knowing about the loan would have made a difference to some of those unaware (11%). Most of these respondents would have made additional improvements or installed different equipment. A few noted that waiting for a loan would actually have delayed their project.

[25] A rating of 7 to 10 on a scale of 1 to 10, where 1 means "not at all influential" and 10 means "extremely influential.

[26] Based on the program's savings reports; data through March 2012.

[27] Based on participants who received the rebate in June 2011 or later, i.e., they participated after the loan option became available.

Almost all interviewed contractors were aware of the financing option, and over half said they offered it to their customers. Several contractors reported very long delays in the disbursement of loan funds.[28] Others felt that the loan's eligibility criteria were too restrictive, disqualifying many of their customers. A few contractors noted that the complicated loan application process deterred them from offering it more frequently to customers.

Marketing and Outreach

Marketing and outreach activities were largely conducted at the portfolio level, i.e., for Energize Delaware as a whole rather than for individual programs. Key marketing activities included e-blasts, website marketing, radio advertisements, billboards, and print ads. In addition, the portfolio benefitted from earned media and developed a social media presence. These often highlighted the HPwES Program, due to its broad applicability.

The primary conduit of the marketing and outreach efforts for Energize Delaware was through the contractor base. Marketing materials were developed for the contractors, including cooperative marketing pieces. A home makeover give-away was offered as part of the HPwES Program, and contractors were encouraged to offer free services as part of the give-away.

The majority of participants (61%) heard about the program from a contractor, HVAC company, or retailer. Other sources of program awareness included newspapers, journals, or other print media (13%); friends, family, or word of mouth (11%); and the program website (8%).

The interviewed BPI contractors provided a mixed assessment of the outreach efforts for Energize Delaware and the HPwES Program. While some contractors thought that the program was promoted adequately, many suggested areas where the effectiveness of marketing efforts could have been improved:

- Over half of the interviewed contractors said they did not receive any marketing materials from Energize Delaware, or that they did not know of any materials that were available. Some contractors that were aware of the marketing materials chose not to use them because they felt that they were inadequate. Some contractors thought that more marketing materials for contractors would have been helpful.
- Several contractors thought that the clarity of messaging about what the Energize Delaware effort entailed could have been improved.
- Some contractors reported a lack of awareness of the program among other contractors and participants, despite the Energize Delaware outreach efforts.
- One contractor noted that the energy saving message rarely inspires customers to take action and that messaging should also include discussions of the other reasons customers may want to participate in Home Performance (e.g., comfort, safety).

It should be noted that due to the temporary nature and financial constraints of ARRA funds, it was difficult for programs to significantly revamp or revise marketing and outreach materials once more information on the effectiveness of materials was available. DOE wanted to maximize dollars going directly to customers, which sometimes left little for marketing and outreach.

[28] According to AFC First, loan funds were typically disbursed within a business day of receiving verbal confirmation from the customer that the work was completed. However, AFC First noted that due to the change/transition in program administration, for a short period of time loan funding was delayed for close to 30 days. This resulted in high levels of dissatisfaction among contractors affected by this delay.

Home Energy Audits

All Home Performance projects that were implemented after January 1, 2011 required an energy audit regardless of whether they were incented through the HVAC Rebate, Standard, or Performance paths. The audit requirement was intended to encourage participants to make additional home energy improvements, particularly shell measures such as insulation and sealing, and to lead to deeper savings.

The most common reason participants had the audit performed was to learn about the home's energy use and identify needed improvements and opportunities to save on their energy bill (44%). Notably, replacing broken or old equipment was the reason most often mentioned by participants in the HVAC Rebate path (44%). For participants in the Standard and Performance paths, qualifying for the rebate was another key motivator for having the audit done (42%).

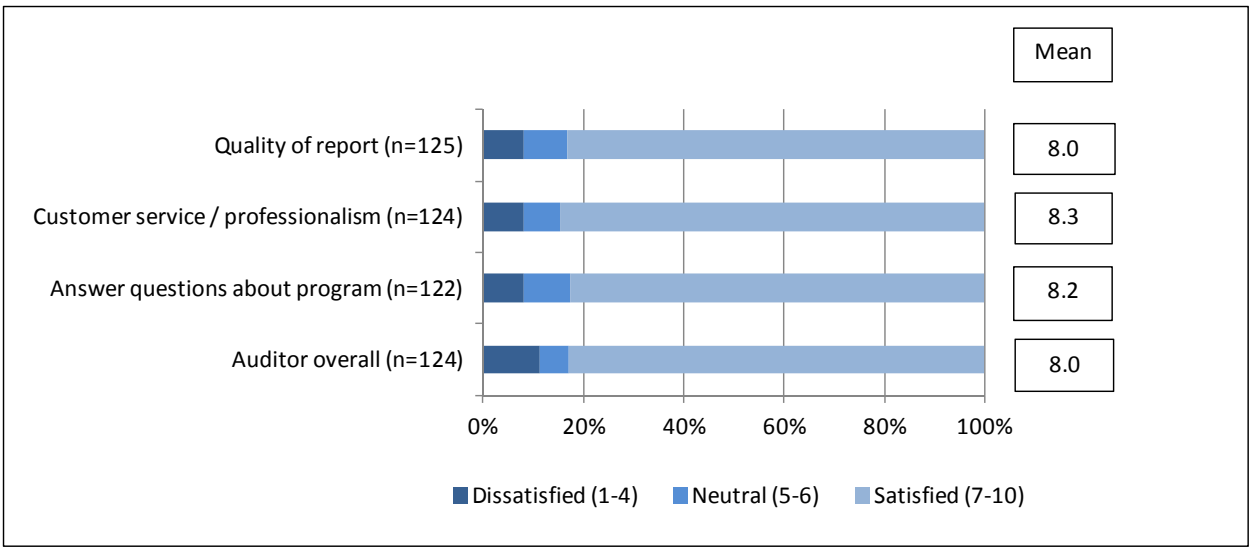
The audit was an effective vehicle in raising the homeowners' awareness of energy efficiency: the majority (83%) report that as a result of the audit, their awareness increased substantially (40%) or somewhat (43%). In addition, 58% would likely not have had the audit done without the program. Similarly, most contractors thought that that the home audits were an effective way to increase the number of measures installed, as the audit report allowed them to better explain the type of measures and their related savings to participants. However, a few contractors found that participants were not very interested in the audit because the homeowner already knew what equipment they wanted or because they were more interested in the rebate amount than the details of the audit report.

Participant satisfaction with the audit, the auditor, and the audit report was generally high:

- Between 83% and 85% of participants were satisfied with four elements of the audit experience about which they were asked: the quality of the report, the auditor's customer service and professionalism, the auditor's ability to answer questions about the program, and the auditor overall.[29]
- Reasons for dissatisfaction included: the auditor's responsiveness, the auditor's lack of knowledge about the program, the auditor's explanation of energy and cost savings, and the quality of the job.
- The majority of participants found the estimates of energy and cost savings of recommended measures in the audit report to be very clear (55%) or somewhat clear (39%).

[29] Satisfied is a rating of 7 or higher on a scale of 1 to 10, where 1 means "not at all satisfied" and 10 means "extremely satisfied."

Figure 3-8. Satisfaction with Various Audit Components*



**Results include valid responses only, i.e., they exclude "don't know" and "refused" responses.*

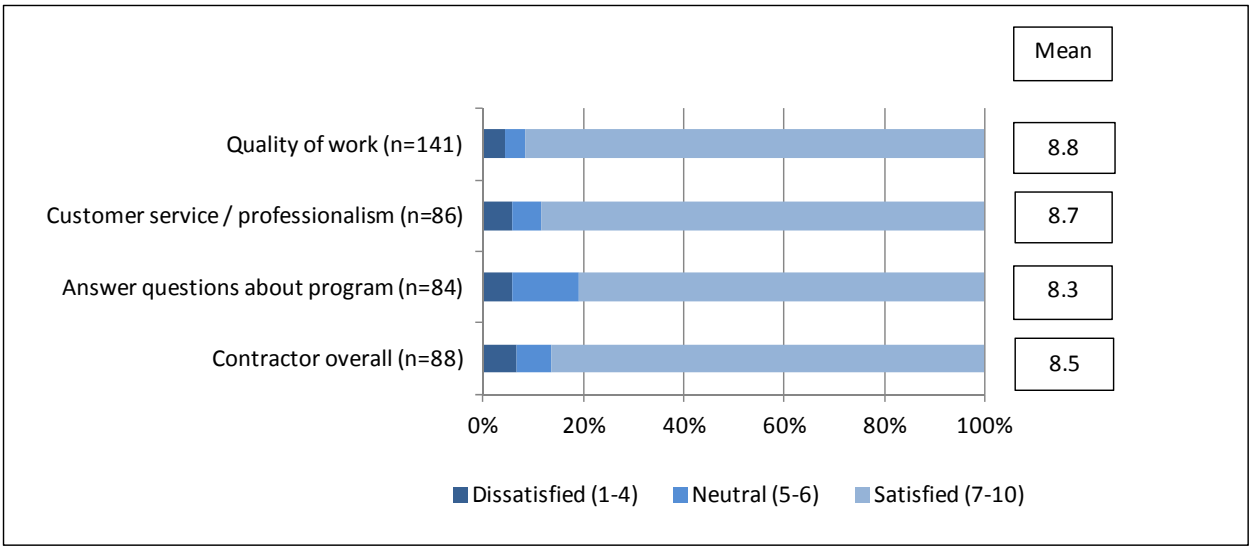
Source: Participant telephone survey.

Installation Contractors

Over two-thirds of participants (69%) used the company who conducted the audit to make some or all of the energy improvements to their home. Participants who used a different contractor to perform the installations were most commonly referred through family, friends, or word of mouth (27%), or they called a contractor they knew (18%).

Most participants were satisfied with the contractor's quality of work (91%), their level of customer service and professionalism (88%), and the contractor overall (86%). Slightly fewer participants were satisfied with the contractor's ability to answer questions about the program (81%).

Figure 3-9. Satisfaction with Installation Contractor*



**Results include valid responses only, i.e., they exclude "don't know" and "refused" responses.*

Source: Participant telephone survey.

A few of the interviewed contractors strongly recommended that the auditing contractor should have been a separate company from the installation contractor because there was the potential to bias both the types of recommended measures as well as the test out results. However, these contractors noted that it is very important to create a network of contractors that the auditor trusts to adequately install the recommended measures.

Beacon Software

Contractors implementing projects through the Performance or Standard paths were required to use ICF International's proprietary Beacon software to model energy savings and generate audit reports.

More than half of the interviewed contractors thought that the savings and payback calculations developed in Beacon were not always accurate. They reported that the way the software was developed allowed for it to be manipulated or biased by the user. For example, one contractor said:

> *"You could show a higher savings by replacing an HVAC in the house before sealing up windows. I did a model where basically the house had open windows. The leakage was off the chart. But if I air sealed them my savings was significantly lower than if I just put a brand new HVAC system in. Leave the holes alone and put a new HVAC system in and they would qualify for the Performance pack [...] I didn't have to do any of the air sealing and they were ok with it..."*

A number of other contractors said that the software was not comprehensive enough or left out certain fields of importance related to some measures. Others said that while they thought the savings and payback calculations were accurate, the report itself was too technical for homeowners to understand without the contractor providing additional verbal context. A few contractors also reported having technical difficulty with the software, e.g., it timing out or being very slow. One contractor noted that Beacon required a lot more effort than most other software programs.

While the program provided Beacon training, many interviewed contractors found that the training was too limited and did not adequately prepare them to use it. For example, one contractor that attended an initial training session about the Beacon software noted:

> *"The three hour session didn't even - we ran out of time before we actually covered the entire...data collection form. So certainly it was sort of left up to us to work our way through it."*

A few contractors reported using online training to learn about the Beacon software.

Other common challenges that contractors reported with the Beacon software included:

- Software design was confusing and time intensive
- The forms were cumbersome to submit
- Took too much time to use
- Savings estimates were not accurate (as noted above)
- Software did not include all necessary measures or fields related to certain measures (as noted above)

A few interviewed contractors were displeased that the Beacon software was no longer available to them after June 2012 – they would like to continue using it for their own projects because they have taken the time to learn how to use it. Several others said that they would not recommend continuing to use the Beacon software.

Shell Measures

Over two-thirds of all Home Performance projects (67%) went through the HVAC rebate path; these projects only included HVAC equipment (boilers, furnaces, central air conditioning, and/or heat pumps). Over 75% of all Home Performance projects did not include any insulation or air or duct sealing.

Starting in January 2011, contractors participating in the Home Performance Program had to be BPI certified. One goal of this requirement was to ensure that the contractor was knowledgeable about a range of home performance measures, not just about the types of measures they specialize in. With this requirement, the program hoped to encourage installations beyond HVAC equipment and to achieve deeper savings in each completed project.

Shell measures were embraced by contractors in a variety of ways. Over half of the interviewed contractors said that they always or most of the time recommended shell measure installations to homeowners. Some contractors noted that they do not install insulation, duct sealing, or other shell measures, so they did not offer them to their customers, whereas other contractors who do not install shell measures themselves worked with subcontractors to make those installations, when necessary. One interviewed contractor only installed shell measures when it was needed to qualify customers for the Performance rebate.

Several contractors thought that some of their colleagues encouraged their customers to install certain measures more than others, particularly HVAC equipment. They suggested that the program was not set up in a way that could compensate for this bias, and felt that other measures, such as shell measures, were not pushed enough by those contractors. For example, one contractor said:

> *"The heating/HVAC contractors used this as a way to sell their product…so what got sold was mostly HVAC products versus insulation and low hanging fruit. It was because they already needed a heater. They used this program as a way to lower the cost of the heater, when that wasn't the way this was intended to do. It was intended to get the low hanging fruit…"*

Contractors who felt that the program structure favored HVAC installations gave the following recommendations for encouraging more installations of shell measures:

- Put in place a program requirement to ensure that shell measures are included, where appropriate.
- Ensure that the modeling software more adequately represents shell measures and their savings.
- Offer a graduated rebate that would reward customers that install more measures, such as a combination of HVAC and shell measures.

Market Effects

According to program staff, market transformation was one of the goals of the Home Performance Program. While this evaluation did not fully explore this topic, our interviews with BPI contractors – as well as the HVAC contractor interviews in support of the Residential Baseline Study – provided some insights on potential market effects of the program. Based on these interviews:

The program succeeded in stimulating the infrastructure for home performance services. BPI certification was required to participate in the Home Performance Program after January 1, 2011. While some interviewed contractors were already BPI-certified before the program launched, many others pursued the certification in order to be eligible to participate. Any future Home Performance Program should be able to leverage this increased pool of qualified contractors.[30]

Demand for home performance services sharply decreased after the end of the program. One measure of market transformation is the continuation of increased home performance activity once a program has ended. The majority of contractors said that the ending of the program dramatically affected their business, reporting that they are performing far fewer audits, if any, than they were when the program was running. For example, one contractor reported the cancellation of over 20 audits scheduled for September of 2011, when he informed the customers that the program had ended. These customers did not want to pay for the audit, or were not interested in having it conducted if no rebate for the installation of measures was available. Unfortunately, due to the temporary nature of ARRA funds, a continuation of funding was not possible.

The Program's effect on HVAC efficiency levels was likely temporary. Contractors participating in the HVAC Rebate path of the program reported a mixed and largely temporary impact of the program on the efficiency levels of the equipment they install. About half of interviewed contractors found that the program, while it was active, had an overall positive impact on both their volume of sales and on the efficiency levels of the units.[31] However, most of these contractors reported that they now sell lower efficiency units compared to when the program was in place, with some noting that most of their current sales are minimum efficiency units. Some interviewed HVAC contractors continue to promote higher efficiency installations as part of their business model, while others were not impacted by the program because they chose not to pursue BPI certification or found that their customers did not want an audit.

Participant and Contractor Satisfaction

Most participants were satisfied with the program overall (80%).[32] For those not fully satisfied, reasons for dissatisfaction included a long wait to receive the rebate as well as difficulties communicating with the program or being provided inconsistent information. Many of these reasons are a related to the constraints and funding limitations of ARRA funds.

A large majority of participants reported that their energy bills have decreased since making the improvements through the program (80%) and that the level of comfort in their home has increased (73%). Nearly all participants (91%) said they would recommend the program to their friends and family members.

Overall, the majority of interviewed contractors were not fully satisfied with the program. Almost all were dissatisfied with the limited duration of the program, which, when over, left them with a lack of customers after having invested in the infrastructure (e.g., hiring new staff, purchasing new

[30] However, given the reduced demand for audits following the program's ending (see next bullet), some of this new capacity will likely be lost if it is not utilized for extended periods of time.

[31] Eleven HVAC contractors were interviewed in support of the Residential Baseline Study.

[32] Satisfied is a rating of 7 or higher on a scale of 1 to 10, where 1 means "not at all satisfied" and 10 means "extremely satisfied."

equipment, investing in BPI certification) to support the high volume of audits and installations generated by the program.

Several contractors also noted that changes to program requirements at various points during the course of the program made it challenging for them to ensure that their audits or installations were adhering to all of the program requirements. According to one contractor:

> *"The early rebates that we submitted were passed through and taken care of and then all of a sudden we found out that the requirements to sign off on the work had increased significantly and they kept moving their goalpost until the end of the day and if we had been aware from day one that they wanted the requirements that they wanted in the end [...] it would have been easy to comply with. But to continuously move the goalpost was very, very difficult for us."*

These contractors recommended that any future program should keep contractors better informed about changes to the program, including if it is coming to an end or running low on funding. Most interviewed contractors said this was important to help them better plan their business strategies.

In addition, some contractors had difficulty with day-to-day communications with the program. Over half of interviewed contractors noted that ICF representatives were hard to reach. However, a few of these contractors found that once they were able to get in touch with ICF, the information provided was effective. Other contractors reported that it was easy to communicate with ICF representatives and that they provided valuable information.

As discussed in previous sections, other areas of dissatisfaction among participating contractors included:

- Inadequate program promotion and marketing
- Challenges with the BEACON software
- Slow dispersal of funds for the rebate and financing components

4.5 RECOMMENDATIONS

The Home Performance Program in Delaware had a quick launch in response to the American Recovery and Reinvestment Act funding made available to the state. This provided the opportunity to lay the ground work for future programs in Delaware, giving the state a "pilot" like opportunity to learn while running the program. As a result of this evaluation we have identified a number of recommendations that should be considered when developing future Home Performance programs in Delaware.

- **Consider offering HVAC incentives for equipment only customers as a standalone offer.** The program included HVAC incentives without the requirement of an audit that paid the same incentive levels as those customers who received an audit. Consider offering a standalone HVAC track that has lower incentives than those available to customers who undertake the audit and who complete additional measures. This can be done by tiering prescriptive incentives, ratcheting up the amount paid based on number of actions taken. This approach may encourage customers who were only planning to address HVAC measures to do more and will keep the program from paying audit incentives to those customers whose only intention is to replace HVAC equipment.

- **Provide more motivation to customers to complete shell measures.** There is indication that the program model favored HVAC installations. This can be addressed by:
    - Putting in place program requirements that encourage – or require – the inclusion of shell measures, where appropriate, to achieve the maximum incentive levels available.
    - Ensuring that the modeling software more adequately represents shell measures and their savings.
    - Offering tiered rebates that reward customers that install more measures, such as a combination of HVAC and shell measures.
- **Provide the audit rebate only to those customers who complete multiple measures.** While the program plan indicated that the $250 audit rebate was only supposed to be paid if the project achieved 20% savings, it appears that customers who only replaced HVAC equipment were also paid the audit incentive. If the program goal is to get customers to take deeper action (i.e., replace multiple measures and address shell issues), then the audit rebate should be tied to those types of actions. While a rebate on the audit can help spur initial participation in the program, it can become a costly addition to what becomes essentially a prescriptive HVAC rebate program. Instead, consider offering "bonus" incentives that cover the cost of the audit only after customers have taken a certain set of actions.
- **Reassess incentive levels.** Feedback from participants was that incentives were motivating them to make the home energy improvements. However, contractors indicated that they could have garnered customer participation in the program with lower incentives.
- **The cost per unit of energy saved was quite high for this Home Performance program.** In future programs, where cost-effectiveness requirements might come into play, it is unlikely the program could cost effectively support the costs associated with this initial program model.
- **Add an independent QA/QC component to address any concerns with the way the modeling software is used by contractors.** Several contractors indicated that they could manipulate the Beacon software to achieve higher savings and higher incentives. Consider adding a QA/QC component that checks inputs and assumptions in Beacon throughout different phases of program participation.
- **Support an option for third party auditors in addition to contractor auditors.** There is the potential that having contractors (who sell certain measures) conduct the audit will result in recommendations that align to the types of measures those contractors sell/install, creating bias to both the types of recommended measures as well as the test out results. Encouraging a network of third party auditors to complete the initial audit and the test out of the project removes the bias risk. If this approach is considered, it would be very important to create a network of contractors that the auditor trusts to adequately install the recommended measures.
- **Simplify financing offers and provide contractors more training and marketing materials on the offer.** Contractors indicated that the financing was complicated. This proved to be a barrier to both customer participation in the financing option and contractor willingness to offer/promote the financing. Consider options for simplifying participation in the financing

and invest in tools and training that will allow contractors to easily include the financing offer in their package of customer options.

- **Encourage future programs to address all fuels.** This program was able to include all fuels providing customers greater motivation to address a myriad of measures in the home. As utility programs roll out in Delaware, utilities should be encouraged to partner or offer Home Performance programs jointly so that customers can address their whole house and savings from all fuels can be counted. In states where only electricity is addressed,[33] Home Performance programs often struggle to be cost-effective, and important savings potential are left on the homeowner table.

- **Require systematic documentation of installed measures.** Our impact analysis found that project documentation (e.g., invoices, the Quality Assurance Inspection Form) often does not sufficiently document the measures for which the program claims savings. While invoices for all installed measures were required for incentive disbursement, complete invoices are not always present. Future programs should put into place procedures that ensure that measure installation can be verified. This could include increased QA/QC on the supporting documentation that contractors provide or ensuring that the post-inspection report captures important details of the installation.[34] If installations cannot be independently verified, the program risks losing some of its claimed savings during the evaluation process.

- **Ensure that modeling software generates reasonable savings.** For many measures, tracked savings based on the Beacon software were unreasonably high when compared to estimates based on the Mid-Atlantic TRM and other commonly used sources. This resulted in a relatively low realization rate for the Performance and Standard paths of the program. When selecting modeling software for future Home Performance programs, ensure that model outputs are within reasonable ranges of other commonly used sources, such as the newly developed Delaware TRM.

[33] This is the challenge faced in neighboring Maryland where Home Performance programs are addressing electric measures only.

[34] In the case of insulation, the Quality Assurance Inspection Form does not closely match the measure categories tracked by the program, having no option to document installation of cantilever or rim joist insulation.

5. GREEN FOR GREEN

5.1 KEY FINDINGS

The Green for Green program is a new residential "green" construction program first offered in the summer of 2010 that provided homebuyer rebates after the purchase of a certified green home. It is important to note that the program was a green building program, not just an energy-efficiency program and it had goals that included economic development, job creation and green building upgrades beyond those that influence energy efficiency. That noted the assessment of non-energy savings benefits was outside the scope of our evaluation contract. As of September 2011, the program suspended submittal of new applications with 201 homes receiving rebates or pending certification. Approximately 59% of these homes were designated at the National Green Building Standard (NGBS) Silver certification level ($3,000 incentive) and the remaining 41% at the NGBS Gold certification level ($5,000 incentive). The primary purpose of this evaluation was to assess the program's gross and net energy savings. Gross energy savings represent the savings achieved by the program when compared to baseline or "typical" building practices. Net energy savings represent the savings that would not have been realized in the absence of the program (i.e., the program-induced savings).

To estimate gross savings, it was first necessary to determine what baseline building practices were for the "typical" or "average" builder in Delaware. The evaluation team found that builders across the state were building above code and that their homes typically exceed code compliance by approximately 6.6%. Therefore, the baseline against which gross savings was determined reflects this above code baseline.

With respect to gross program savings, we found that homes certified to the NGBS Silver certification level do not significantly differ from baseline home building practices. Therefore, we determined that homes built to the Silver certification level do not produce gross energy savings. Gold homes, however, significantly exceeded code and baseline (i.e., typical) building practices, with gross savings estimated at 511 kWh and 61 therms per home.

In addition to the estimation of gross energy savings, the evaluation team measured net energy savings. This is the energy savings that the program achieved over and above what would have been expected in the absence of the program. Net savings were estimated by assessing Green for Green participating builders' building practices within and outside the program. We found that participating builders are a select group of "green" builders in that – in absence of the program – they not only build above minimum code requirements but also above baseline building practices. Because participating builders already build beyond baseline practices, it was necessary to determine that portion of gross energy savings that is attributable to the program (i.e., net savings). This portion of gross energy savings only applies to Gold certified homes as it was already determined that Silver certified homes do not produce gross energy savings. Net energy savings per Gold certified home are estimated to be 287 kWh and 39 therms, which are 56% and 64% of gross energy savings, respectively. These findings are summarized in the table below.

Table 5-1. Measured Gross and Net Energy Savings

Fuel Type	Measured Gross Savings		Measured Net Savings	
	Silver	Gold	Silver	Gold
Electricity Savings (kWh)	0	511	0	287
Gas Savings (therms)	0	61	0	39

These findings suggest that the Silver Home certification level should be reassessed. Silver Homes did not outperform homes built using common building practices throughout the state. Therefore from an energy savings perspective, the current certification and rebate does not add value to the program. Actions to remedy this scenario are to eliminate the Silver home rebate, or increase the overall stringency of energy efficiency requirements. However, any adjustment to the program should also take into consideration the non-energy components of the NGBS Silver Home certification. Moreover, key to achieving higher levels of overall program savings, it will be necessary to draw more builders into the program. In particular, it important to bring nonparticipating builders into the program as, for many of these builders, Gold certification would represent a significant reduction in home energy use.

5.2 Program Description and Objectives

The Green for Green program leveraged existing national green certification programs to promote the construction of new green homes through customer rebates. The program offered incentives ranging from $3,000 to $6,000 to customers that purchase newly constructed homes certified Silver or better in the Leadership in Energy and Environmental Design (LEED) or NGBS certification programs. The program was implemented by the Home Builders Association of Delaware (HBADE) with stimulus funds administered by the Delaware SEU. In addition to word-of-mouth, HBADE publicized and promoted the program through the following website: www.degreen4green.com. The incentive amounts varied by certification level and certification program according to Table 5- below:

Table 5-2. Green for Green Rebate Levels

Program	Certification Level	Rebate Amount
NGBS	Silver	$3,000
NGBS	Gold	$5,000
NGBS	Emerald	$6,000
LEED	Silver or more	$5,000

Builders that agreed to follow the program terms and conditions and registered with the program were listed on the program website. Customers were required to use a participating builder. Builders applied for incentives on behalf of their customers and the incentive was paid as a check to the homeowner at or shortly after the time of closing. The program implementer reported that all customers and builders applied under the NGBS certification standard as opposed to the LEED standard.

The application process was tracked through an online database. The program implementer did not

perform the verification for certification; rather they relied upon third-party contractors for the certification process.

Due to high demand, the original program budget of $300,000 was expanded to $800,000. In total, 201 homes received rebates or are pending certification. Approximately 59% of these homes were designated at the NGBS Silver certification level ($3,000 incentive) and the remaining 41% at the NGBS Gold certification level ($5,000 incentive)[35].

5.3 METHODS AND APPROACH

The goal of the Green for Green evaluation was to determine both gross and net energy savings. Gross savings represent the savings achieved by the program when compared to baseline practices, which are the "typical" or "average" building practices used across Delaware. The evaluation team's experience in other states suggested that baseline practices are often higher than code. Therefore, research was necessary to determine if this was, indeed, the case across the state of Delaware. In addition to gross energy savings, the evaluation team measured net energy savings. Net energy savings is the portion of gross energy savings that is attributable to the program. In other words, it is the savings the program achieved, through homes built by participating builders, which would not have been expected in absence of the program. The remainder of this section highlights the methods used to determine gross and net energy savings and the related results. First, we discuss gross energy saving methods and results (immediately below) and then net savings methods and results.

The evaluation team assumed a Coefficient of Variance of .5 to determine the precision and confidence intervals for the evaluation tasks. For the participant builders the population size limited the precision and because the population size for the non-participating builders is unknown the evaluation team used an estimated population of 425 to determine the precision and confidence intervals.

Table 5-3. Precision and confidence

Evaluation Task	Population	Sample	Confidence	Precision	Cv***
Green for Green Homes Analysis	201	27	90	15	0.5
Non-Participant Builder Plan Reviews	3027	70	90	10	0.5
Non-Participant Builders	~425*	29	90	15	0.5
Participant Builders	16	8	NA**	NA**	0.5
* Because the number of builders that operate in Delaware is unknown we estimate it to be about 425.					
** Limited population of participating builders does not allow accurate Confidence/Precision					
***Cv assumed to be .5					

Gross Savings: Methodology

The evaluation of estimated gross savings for the Green for Green program required two pertinent sets of data: an assessment of baseline building practices used in new residential construction outside of the Green for Green program and an assessment of building practices used in Green for

[35] One home in the program was pending certification at the NGBS Emerald level.

Green Program Homes. The difference found in energy consumption between Program Homes and the baseline determined the gross savings for the program.

Determining Baseline Building Practices

The first step in the gross savings evaluation process was to understand existing building practices across the state of Delaware. This step in was necessary to determine whether or not current Delaware residential building practices exceed code, and if so, to what extent. The current practices observed by the evaluation team serve as the baseline to compare against Green for Green Program Homes, as they are indicative of the "typical" Delaware newly constructed home built outside the program.

The evaluation team took a multifaceted approach to determining baseline building practices. As previously mentioned, these are the practices of the "typical" or "average" builder in the state. To determine these practices and assess the extent to which these practices met or exceeded code, the evaluation team completed the following research tasks:

- ✓ *Code Review.* For context, we reviewed Title 16, Chapter 76 of the Delaware Energy Code that stipulated statewide adoption and implementation of the IECC 2009 energy code beginning July 1, 2010. The enactment of the IECC 2009 energy code set a minimum baseline for new residential construction.
- ✓ *Nonparticipating Builder Telephone Survey.* These interviews were drawn from a statistically valid sample of non-participating builders across the state (i.e., builders that did not participate in the Green for Green program) and were intended to allow the evaluation team to assess the extent to which common building practices in Delaware met or exceeded minimum code requirements. The sample for this effort was developed from a Hoovers database of Delaware businesses classified as residential homebuilders. The reliability of the Hoovers database proved to be low as several contacts had incorrect or disconnected phone numbers listed or the contacts were not residential homebuilders. This effort yielded 13 completed phone surveys. Due to limited success with cold call recruitment, we abandoned these phone surveys and substituted building plan reviews of homes built by non-participating builders from across the state (see below).
- ✓ *Nonparticipating Builder Plan Reviews.* We selected a statistically valid sample of residential building permits from across the state based on the number of permits issued in the 2011 calendar year. DNREC provided the total number of 2011 permits issued by county; a total of 3,027 permits for multifamily and single-family homes. From this, the evaluation team made requests to Delaware jurisdictions for energy measure documentation including building permits, REScheck files/certificates, HVAC worksheets (e.g., Manual J), as well as floor plans, elevations, and building sections. We completed a thorough review of all available documentation for each project to determine crucial building parameters including conditioned square footage, foundation type, insulation details, and glazing area. We used this documentation to triangulate the baseline building conditions and to develop parameter inputs for baseline REM/Rate models. We asked jurisdictions to provide one building plan issued for each month from March 2011 through March 2012. We made this request to increase the variation in building types by preventing the receipt of similar or identical plans filed by a single builder. We provided plans and associated documentation to the evaluation team electronically, in hard copy form by mail, or by collecting on site at the jurisdiction office. This time frame balanced the need to conduct follow up site visits with homes that were in mid-construction or recently constructed while maintaining a level of randomness.

DNREC provided a contact list of jurisdictions. A total of 14 of 30 reporting[36] jurisdictions provided the requested documentation.[37] In total, we completed plan reviews on a total of 70 homes built by non-participating builders. Results were weighted by permits issued at the county level.

- ✓ *Nonparticipating Builder Site Visits.* To verify and augment the data collected from building plans, we solicited those builders whose plans were collected for a site visit to the corresponding home or to a similar home in the surrounding vicinity. We cross-referenced data collected on site with building plans to validate data extracted from the plans. If we noted a discrepancy, we used values recorded from the site visit in the analysis. We recruited these builders via cold calls after gathering contact information from building plan documentation. We provided these builders with a $125 gift card as an incentive for their participation in an on-site visit. The purpose of the on-sites was to validate the information observed on building plans as well as to provide further data for developing the baseline building conditions. In total, we completed 16 site visits, five of which were recruited during the phone survey process.

The result of this multifaceted effort was a list of energy measure values (insulation R-values, window U-factors, HVAC efficiencies, etc.) that represented the typical building practices employed in Delaware. We determined measure values by taking a weighted average of each measure based on the number of permits issued by county in 2011. For example, we determined the baseline R-value for above-grade walls by taking an average of all observed R-values weighted by the number of building permits issued by county.

<u>Assessment of Green for Green Program Homes</u>

The second step in the gross savings evaluation process was an assessment of building practices used in Green for Green Program Homes and how they compare to baseline (i.e., typical) practices discussed in the previous section. To complete this second step in the gross savings determination process, the evaluation team completed the following research tasks:

- ✓ *Program Design Review.* We reviewed the program design for Green for Green as well as the NGBS certification standards, which served as the sole certification method for the Green for Green program. We focused attention on how homebuilders achieved the necessary points for each NGBS rating – Silver and Gold. This review provided a basic understanding of the conditions that Program Homes were required to meet to be certified (and receive a rebate).
- ✓ *Program Home Reviews.* We requested Program Home certification documentation from the HBADE, third-party verification firms, and homebuilders for a statistically valid sample of Program Homes. Specifically, the HBADE provided a database of the complete population of Green for Green homes (201 homes), from which a sample of 27 homes was drawn. Due to the variation in homes within the program, we stratified the sample by certification level. As there was only one Emerald Home listed that had not yet received a rebate, we stratified the sample between Silver and Gold homes using the Dalenius-Hodges sampling methodology. The final sample consisted of a total of 16 Silver homes and 11 Gold homes. DNREC, third-party verifiers, and homebuilders provided NGBS score sheets, certificates, and REM/Rate

[36] There are 57 jurisdictions in Delaware; however, 27 jurisdictions outsource building permitting to the county jurisdiction.

[37] Not all jurisdictions were able to provide one plan for each month requested; requests were fulfilled based on permit availability.

models and/or outputs for the requested sample. We used these data to estimate energy impacts of the Green for Green program relative to the baseline conditions determined in step 1.

Table 5- below summarizes the information collected and analyzed to inform gross energy savings.

Table 5-4. Summary of Gross Savings Evaluation Tasks

Information Source	Population	Sample Size	Site Visits	Phone Surveys	Document Reviews
Nonparticipating Builders	Unknown	29	16	13	0
Homes Built by Nonparticipating Builders	3,027	70	0	0	70
Program Homes	201	27	0	0	27

Net Savings: Methodology

The net savings analysis determined the portion of the gross savings achieved by Gold homes that can be attributable to the Green for Green program. Similar to the gross savings analysis, two pertinent sets of data were required: an assessment of the building practices used by participating (Green for Green) builders on homes built outside the Green for Green program and an assessment of building practices used in Green for Green Program Homes. The difference found in energy consumption between these builders program and non-program homes determined the net savings for the program.

<u>Assessment of Home Built by Participating Builders Outside the Program</u>

A key first step in the net savings evaluation process was to understand the practices of participating builders when constructing homes outside the program. This step in the evaluation process was necessary to determine if the baseline (i.e., typical) building practices are representative of the building practices that participating builders use outside the program. This additional step was taken due to the evaluation team's experience in other states, where we found that early builder entrants into new "green" construction programs often build more efficient homes than the "typical" non-participating builder (i.e., the building practices that were the basis for the baseline condition used in the gross savings analysis). If participating builders did build above and beyond the baseline building practices, then the gross energy saving realized by the program need to be further adjusted downward.

In order to address this question, the evaluation team completed the following research tasks:

- ✓ *Participating Builder Phone Interviews.* Interviews were conducted from a representative and statistically valid sample of participating builders (i.e., builders that participated and constructed homes under the Green for Green program). The interviews assessed building practices outside of the program. Additionally, participant builders were asked about the level of influence the Green for Green program had on their building practices. The sample for participant builders was developed from the Green for Green builder database provided

by the HBADE. The database listed 40 builders enrolled in the program; however, only 16 unique builders actually built homes that were certified and awarded a Green for Green rebate. Due to the small population size, the Evaluation Team contacted all of the builders that participated in the program. Eight builders agreed to an interview and of those, seven agreed to a follow up site visit.

- ✓ *Participating Builder On-Site Visits.* Participant builders were recruited during the interview process for follow up site visits at recently constructed or mid-construction homes built outside of the Green for Green program. Builders were provided a $100 gift card incentive for their participation. The site visits at these homes validated information collected through interviews (i.e., assessed the extent to which their self-reported building practices accurately represent the homes they built outside the program) and provided insight into building approaches. In cases where discrepancies were observed between interview responses and site visit observations, the site visit data served as the default input. A weighted average of participant builders' responses regarding measure values was taken based on the proportion of homes the builder built outside of the Green for Green program in the 2011 calendar year[38].

Assessment of Green for Green Program Homes

This was the same analysis described in the previous section outlining gross energy savings. It was an assessment of the energy usage and related characteristics of Gold certified homes (note: Silver homes were not included in the analysis as it was determined that they achieved no gross energy savings).

Table 5- below summarizes the information collected and analyzed to inform net program savings.

Table 5-5. Summary of Net Savings Evaluation Tasks

Data Set	Population	Sample Size	Site Visits	Phone Surveys	Document Reviews
Participant Builders	16	8	7	8	0
Program Homes	201	27	0	0	27

5.4 RESULTS

Gross Savings: Analysis & Results

As previously mentioned, the evaluation of estimated gross savings for the Green for Green program required two pertinent sets of data: an assessment of building practices used in new residential construction outside of the Green for Green program and an assessment of building practices used in Green for Green Program Homes. The difference in energy consumption between Program Homes and baseline homes determined the estimated gross savings for the program.

[38] Phone surveys and on-site surveys asked builders to estimate how many homes their company had constructed in the 2011 calendar year.

Gross Savings Calculations and Findings:

The evaluation team used the International Performance Measurement and Verification Protocol (IPMVP) Option D to estimate gross energy savings. Option D employs a model simulation approach to determine energy savings. The Program Homes data, which was presented as REM/Rate models, provided the estimated annual energy consumption of the Program Homes as built to Green for Green certification standards (see appendix D to this report for additional details of the REM/Rate modeling process). Each REM/Rate model was recalibrated based on the baseline measure values. The recalibration included adjustments to insulation R-values, window U-factors, HVAC and water heater efficiencies, and appliances. The general characteristics of a Program Home (square footage, volume, foundation type, HVAC, and water heater systems) were not altered. This allowed for a direct comparison between Program Homes and the baseline as the model recalibration only modified the energy measures but did not affect the home size or type.

Recalibrating each REM/Rate model provided amended annual energy consumption values representing the energy a baseline home would consume. The difference between this amended consumption and the initial Program Home REM/Rate model consumption provided the gross energy savings estimate. See equation below.

Green for Green Gross Savings Equation

$$Baseline_{per\ home\ consumption} - Program\ Home_{per\ home\ consumption} = Gross\ Savings_{per\ home}$$

Because the Green for Green sample was stratified between Silver and Gold homes, separate analyses were conducted to calculate the expected average annual savings per home of a Silver home and a Gold home over the baseline. To arrive at the estimated gross energy savings per Silver and Gold home, a weighted[39] average of the differences in energy consumption for each strata was calculated.

A REScheck analysis of Silver and Gold homes and the baseline showed that each home type exceeded compliance with the IECC 2009 energy code.[40] However, as illustrated in Table 5-4, the analysis indicated that Silver Homes only outperformed the baseline code compliance by 0.1% (Silver homes surpassed code by 6.7% as compared to the baseline which surpassed code by 6.6%). Please see appendix D to this report for a complete comparison of measure values between Silver and Gold homes and the baseline.

The slight difference in code compliance between Silver homes and the baseline presented in Table 5-6 was reflected in the REM/Rate energy consumption analysis. The REM/Rate analysis also concluded a very small difference in energy consumption values between Silver and baseline homes; however, counter to the REScheck analysis, the REM/Rate models indicated that Silver homes, on average, consumed more energy than their baseline counterparts. Despite the conflicting conclusions between the REScheck and REM/Rate analyses, the difference in energy consumption between Silver and baseline homes estimated in both analyses appeared negligible. To confirm this assumption, a weighted two-tailed paired t-Test at an alpha level of 0.05 was performed to determine if the mean difference in energy consumption between Silver homes and the baseline was statistically different from zero. The result of the t-Test showed that there was no statistically

[39] Weights were calculated based on the proportion of homes constructed by a builder as reported in the Green for Green home population.

[40] Percentage values of above code compliance were derived from REScheck certificate outputs and/or modeling from Software Versions 4.3.1 - 4.4.3.

significant difference between the energy consumption of the Silver homes and the baseline (Full t-Test results appear in appendix D to this report). Therefore, the gross energy savings for Silver homes was estimated to be zero.

Table 5-6. Percentage Compliance above IECC 2009 Energy Code

Level of Compliance Above Code	Statewide Baseline	Green for Green	
		Silver Homes	Gold Homes
%	6.6%	6.7%	21.1%

Gold homes, however, showed significant gross energy savings. On average, and as illustrated in Table 5-, Gold homes are estimated to be 21.1% higher than code and significantly exceed baseline building practices, resulting in gross energy savings per Gold home of 511 kWh and 61 therms. To estimate gross energy savings for the Green for Green program overall, we multiplied estimated gross savings per Silver home (i.e., zero savings for kWh and therms) and per Gold home (i.e., 511 kWh and 61 therms) by the number of rebated homes in each category. Table 5- shows the results of this process, with total gross electricity and natural gas savings of 41,403 kWh and 4,956 therms, respectively. All the gross program savings are due to homes built to the Gold certification level.

Table 5-7. Estimated Gross Energy and Summer Peak Demand Savings by Fuel Type

Fuel Type	Green for Green Savings per Home		Green for Green Total Homes		Total Green for Green Program Savings
	Silver	Gold	Silver	Gold	
Electricity Savings (kWh)	0	511	119	81	41,403
Gas Savings (therms)	0	61	119	81	4,956
Total Savings (MMbtu)	0.00	7.86	119	81	636.88
Demand Savings (kW)	0.00	0.25	119	81	20.45

Net Savings: Analysis & Results

Following the same analysis approach used to estimate gross savings, net savings were determined by comparing the energy consumption of Program Homes to homes built by participating builders outside the Green for Green program. The difference found in energy consumption between these builders' program and non-program homes determined the net savings for the program.

Net Savings Calculations and Findings:

The Evaluation Team utilized IPMVP Option D to estimate net energy savings. Savings were estimated by quantifying the difference between the energy consumption of Participant Builder homes built outside the program and Program Homes. The REM/Rate models were again used to determine these parameters. As described in equation below, the net savings achieved per home was determined by difference in energy consumption between the Program Homes and participating builder homes built outside the program.

Green for Green Net Savings Equation

$$Home\ built\ by\ Participating\ Builders\ Outside\ the\ Program_{per\ home\ consumption} - Program\ Home_{per\ home\ consumption} = Net\ Savings_{per\ home}$$

A weighted average of Gold home energy savings was determined based on the homebuilder company and the quantity of Gold homes it had constructed under the program. As illustrated in 7, net savings per Gold home were estimated to be 287 kWh and 39 therms, which are 56% and 64% of gross energy savings achieved by a Gold home, respectively. To estimate net energy savings for the Green for Green program overall, estimated net savings per Gold Home (i.e., 287 kWh and 39 therms) were multiplied by the number of homes receiving Gold certification. The results of this process are illustrated in Table 5-.

Table 5-8. Estimated Net Energy and Summer Peak Demand Savings by Fuel Type

Fuel Type	Green for Green Savings per Home		Green for Green Total Homes		Total Green for Green Savings
	Silver	Gold	Silver	Gold	
Electricity Savings (kWh)	0	287	119	81	23,210
Gas Savings (therms)	0	39	119	81	3,141
Total Savings (MMbtu)	0.00	4.85	119	81	393.25
Demand Savings (kW)	0.00	0.12	119	81	9.75

The results of the net savings analysis confirmed that participating builders are, indeed, a select group of “green” builders in that—in absence of the program—they not only build above minimum code but also above baseline building practices. The evaluation found gross energy savings per home of 511 kWh and net savings per home of 287 kWh. This indicates that participating builders’ practices outside the program, with respect to practices impacting kWh usage, are significantly more efficient than “typical” or baseline building practices. As a result, a significant portion of the kWh savings attributed to the program in the gross savings analysis would have been realized in absence of the program. With respect to therm savings, the evaluation found gross savings per home of 61 therms and net savings per home of 39 therms. This indicates that participating builders’ practices outside the program, with respect to practices impacting therm usage, are significantly more efficient than “typical” or baseline building practices. Consequently, a significant portion of the therm savings

attributed to the program in the gross savings analysis would have been realized in absence of the program.

Green for Green program influence on builders:

To further substantiate the results of the net savings analysis, each sampled participant builder was asked how the Green for Green program had influenced his or her company's building practices outside of the program. This additional step was taken because of a concern that the net impact analysis would be compromised if the Green for Green Program had caused participating builders to change practices across all homes they built (both Program Homes and homes built outside the program).

All of the interviewed participant builders reported that they built to Energy Star or LEED/NGBS standards before participating in the Green for Green program. Although half of the interviewed builders (4 of 8) reported that participation in the program had no influence on their building practices, the other half noted some differences. In most of these cases, the program influenced the builder to make small changes to their building practices to step up from a baseline of Energy Star or NGBS Bronze (or similar) level to NGBS Silver or Gold. Common changes to building practices that affect energy efficiency included installing tankless water heaters and high efficiency furnaces as standard practice instead of as an option.

Notably, Habitat for Humanity was already constructing homes to Energy Star standards before participating in the program and then changed their practices to achieve NGBS Silver or Gold certification through the Green for Green program. These changes included installing tankless water heaters, 95% AFUE furnaces, and using advanced framing techniques. The organization ultimately stopped participating in the program because the rebate assignment to the homeowner did not fit with the organization's model. However, Habitat continued to build to the new standards adopted as part of the program.

5.5 RECOMMENDATIONS

In addressing the key findings from the evaluation, the Evaluation Team recommends the following to improve the performance and achievements of the Green for Green program:

- **It is recommended that the Silver Home certification be reassessed.** Silver Homes did not outperform homes built using common building practices throughout the state. Therefore from an energy savings perspective, the current certification and rebate does not add value to the program. Actions to remedy this scenario are to eliminate the Silver Home rebate, or reevaluate the energy standards for Silver Homes and increase the overall stringency of energy efficiency requirements. However, any adjustment to the program should also take into consideration the non-energy components of the NGBS Silver Home certification.

- **The energy saving realized through construction of Gold homes is significant when compared to baseline building practices across the state.** Therefore, we recommend the continued support of this certification level through rebates and marketing efforts. However, it is important to note that this evaluation did not attempt to assess the cost-effectiveness of this program, nor whether or not the rebate amount is justified in light of the energy saving realized. This type of analysis would appear to be an important pre-requisite to continuing this program offering.

- **Participation in the Green for Green program was dominated by existing green builders.** It is recommended that efforts be made to attract builders that are not traditionally green

builders. Clearly, to achieve higher levels of energy savings it is important for the program to reach builders who are not pre-disposed to building green. As demonstrated in this report, if the program can reach and change the practices of the "typical" or baseline builder, the program could save 511 kWh and 61 therms per home. If the program continues to reach builders who are pre-disposed to building energy efficiently, kWh savings (287 kWh) and therm savings (39 therms) will be significantly lower.

6. LOW INCOME HOUSING CONSTRUCTION FINANCING PROGRAM

6.1 KEY FINDINGS

We outline key Low Income Housing Construction Financing (LIHCF) program findings below. It should be noted that there was only a single participant and findings should be viewed with that perspective in mind. The very low participation rate suggested a change in approach is needed. Knowing this DNREC advised the evaluation team to focus on Best Practices for future programs as a part of this effort. Findings include:

- There were barriers to participation in the program, including logistical difficulties associated with having multiple entities involved within the program, constraints associated with ARRA and with the financing associated with things like the Davis-Bacon Wage Act, and competition within the broader financing market.

- The program provided construction financing to one project, which realized 123,799 kWh and 82.66 kW savings. The program provided construction financing of $1,442,259 to one project located in Sussex County, Delaware. Total project development costs were $7,079,079, with a per unit cost of $176,976.

- Delaware State Housing Authority's (DSHA) Low Income Housing Tax Credits (LIHTC) recipients were eligible for the LIHCF program. The LIHTC provided a system of points to applicants who installed energy efficiency measures. The LIHCF program was designed to promote the installation of incrementally more energy efficient measures than the LIHTC system for an approved project. However, we found that only three measures had additional points awarded to the proposal for more efficient measures. Due to this, it is difficult to parse out attribution of savings for the program. This is particularly so because the project participant noted that they would have installed the energy efficiency measures as a result of their participation in Delaware State Housing Authority's (DSHA) Low Income Tax Credits program and that the SEU financing did not play a role in their decision to install those measures.

- Partnering with DSHA enhanced program implementation through streamlining administration of the project application, underwriting, and funding disbursement, allowing for a reduction in overhead costs and fees. The partnership also provided the program with access

- to the affordable low-income market, particularly to affordable housing developers applying for the LIHTC program. This removed costs associated with marketing and outreach for the program.

- Future program design and implementation should consider offering services to the low-income multifamily sector via rebates and access to financing. Delaware should also consider leveraging Weatherization Assistance Program (WAP) resources to target the low-income multifamily market. We provide a review of successful programs across the nation and best practices in Section **Error! Reference source not found.** for future program design and implementation.

- Partnership opportunities are available within the Delaware market. DSHA noted that they are interested in acting as a subrecipient for DNREC, for construction financing as well as other financing opportunities (i.e., Weatherization Assistance Program funds).

6.2 PROGRAM DESCRIPTION AND OBJECTIVES

The Low Income Housing Construction Financing Program is designed to support the development and renovation of affordable, energy efficient multifamily housing. Tied to the DSHA LIHTC program application and underwriting process, the program goals are 1) to increase the energy efficiency of multifamily housing units constructed or rehabilitated through moving towards ENERGY STAR performance levels, and 2) to increase the availability of affordable, energy-efficient, multifamily housing by providing low cost construction financing targeting components that have the largest influence on energy consumption.

To meet these goals, the DSHA developed minimum construction and rehabilitation standards for energy efficiency, including installation of energy efficient components, HVAC equipment, and appliances that are ENERGY STAR qualified. Further, the Delaware SEU offered construction financing for qualifying measures through the use of American Recovery and Reinvestment Act (ARRA) economic stimulus funds.

The program provided low-interest construction financing for the full costs of materials and labor for all qualifying measures categorized as 1) insulation and air sealing, 2) testing by a qualified auditor (Building Performance Institute certified), 3) HVAC equipment and duct work, 4) windows and entry doors, and 5) domestic hot water heating equipment. The portion of financing for measures is up to $1,000,000 but not more than 20% of the total development costs for an individual project. Total available financing from the SEU is $2 million up to $5 million. **Error! Reference source not found.** describes eligible measures.

Table 6-1. Eligible Prescriptive Measures

Component	SEU Standard
Insulation	• Insulation levels must exceed current minimum code requirements by at least 25% for 1 point and by at least 50% for 2 points • Complete and pass the ENERGY STAR Thermal Bypass Checklist with verification by a certified HERS rater.
Weather Sealing	Unit leakage does not exceed 5 air changes per hour when pressurized to minus 50 Pascals using a blower door test.
Duct Sealing and Insulation	Install R-6 minimum insulation on ducts in unconditioned spaces and verify that duct leakage does not exceed 4 CFM to outdoors per 100 sq. ft using a duct leakage test.
Windows and Entry Doors	• Below 0.33, Low-E, Argon Gas • U-Value of 0.14
Domestic Hot Water Heating Equipment	• R=20 • R greater than 20 • Electric Storage >= 0.93 • Gas Storage >= 0.67 • Gas On Demand >= 0.82 or Gas Condensing >= 0.8 • Electric Heat Pump >= 2.0
Gas Warm Air Furnaces	AFUE 93% or higher

Component	SEU Standard
Split System Air Conditioning	SEER = 14 – 18

6.3 METHODS AND APPROACH

Below we outline the methods used to evaluate the Low Income Housing Construction Financing program.

Table 6-2: Methods Used for Low Income Housing Construction Financing Program

Method	Approach
Process Evaluation	The process review assessed the effectiveness of program design, implementation, and program participation. The team reviewed program materials to assess program documentations and provide recommendations going forward for tracking energy savings information, conducted in-depth interviews with program and implementer staff, and an in-depth interview with the program participant. Process findings were gleaned through in-depth interviews with the organizations involved in managing and administering the program (DNREC, AEG, and DSHA), as well as from interviews with the program participant. Note that the evaluation team did not conduct in-depth interviews with program non-participants.
Energy Savings Review	To identify program energy savings, the team modeled the buildings using DOE2-based eQuest modeling software version 3.64. To identify lighting savings, the evaluation team determined savings values based upon the Delaware TRM[41].
Literature Review to Understand Best Practices for Low Income Multifamily Programs	Our general approach was to conduct a literature review to understand approaches across the country that can inform Delaware's program. The key evaluation task was to conduct a literature review to understand best practices associated with programs that are targeted to low-income, multifamily audiences. We collected reference material from various professional and governmental organizations, such as the American Council for an Energy Efficient Economy (ACEEE), the United States Department of Energy (DOE), the United States Department of Housing and Urban Development (HUD), and the Delaware State Housing Authority (DSHA). We gathered further material through a search for key terms within Google Scholar, the Association of Energy Services Professionals (AESP), the International Energy Program Evaluation Conference (IEPEC), the Northwest Energy Efficiency Alliance (NEEA), the Northeast Energy Efficiency Partnerships (NEEP), the National Renewable Energy Laboratory (NREL), and the Home Performance Research Center (HPRC). We also used a snowball approach by identifying articles of interest within the bibliographies of other relevant articles. We reviewed a total of 26 articles in the process of compiling this report, which are listed in Appendix E.

[41] Delaware Technical Resource Manual: An Addendum to the Mid Atlantic TRM, Opinion Dynamics Corporation, April 30, 2012.

6.4 RESULTS

The program's goals were to increase energy efficiency in multifamily housing units towards ENERGY STAR performance levels, and to increase the availability of affordable, energy-efficient, multifamily housing through providing low-cost construction financing.

The program provided construction financing of $1,442,259 to one project located in Sussex County, Delaware. Total project development costs are $7,079,079, with a per unit cost of $176,976. Total available SEU program financing ranged from $2 million to $5 million, subject to approval.

The construction began in March 2011, with an expected completion date of March 2012. However, as per the participant, construction is still in progress, with 80% to 95% completed in May 2012. The project participant provides affordable housing to families who fall in the 50% to 80% of median household income. **Error! Reference source not found.** provides program results. Note that there were no savings goals for this program.

Table 6-3. PY1 Program Results

	Program Results
Gross MWh	123,799 kWh[a]
Gross MW	82.66 KW[b]
[a] Incorporates complex level modeling savings and lighting savings for summer and complex level modeling savings for winter.	

6.4.1 IMPACT FINDINGS

The evaluation team estimated gross energy savings impacts by modeling energy impacts from the retrofit – this is a departure from the evaluation plan, which described a desk review. We also qualitatively assessed net savings through the in-depth interview with the sole program participant. Notably, the project is 85% to 90% complete, as per the program participant. Below we provide estimated savings based upon project completion.

Building Construction

The building consists of five multifamily two-story buildings, with eight housing units in each building, for a total of 40 housing units. There are three one-bedroom buildings, and two two-bedroom buildings, for a total of 24 one-bedroom units of 795 square feet each, and 16 two-bedroom units of 950 square feet each. Each building has four units on two floors, and the units are joined vertically by a semi-conditioned center stairwell and laundry area. **Error! Reference source not found.** lists details about the number of buildings, units, and square footage.

Figure 6-1. Project Facilities[42]

[42] Image from www.apartmentsmart.com

Table 6-4. Unit Types and Quantities per Building

Type of Building	Number of Buildings	Units per Building	Total Units	Unit Square Footage	Square Footage per Building	Total Square Footage
One-Bedroom Buildings	3	8	24	795	6,360 ft^2	19,080
Two-Bedroom Buildings	2	8	16	950	7,600 ft^2	15,200
Overall Total			**40**			**34,280 ft^2**

Building Improvements

Measure Type	Baseline Characteristics		Retrofit Characteristics	
	RemRate File	Additional Program Documentation[43]	RemRate File	Additional Documentation
Attic Insulation	**R-19**	R-19	**R-38**	R-38
Above Grade Walls	**2x4 16" o.c. R-11**	R-11	**2x6 24" o.c. R-19**	R-19
Rim Joist Insulation R-11	**R-11**	Not given	**R-19**	Not given
Windows	U-0.35**[44] SHGC-0.55	U-0.35	**U-0.30 SHGC-0.55**	U-0.30
Door	**U-value 0.55**	U-value 0.35	U-value 0.55	**U-value 0.14**
Cooling/Heating	**ASHP with 13 SEER/8.5**	PTAC with 13 SEER	ASHP 14 SEER/8.5 HSPF	**ASHP 14.5 SEER/8.2 HSPF**

[43] These values demonstrate a reasonable 15% reduction in building infiltration Additional documentation came from a review of program materials, more specifically, the "Project Savings Calculation.docx" and "Energy Savings Calculations.xlsx" files developed by AEG.

[44] We assume the original windows were single pane, and U-0.35 is lower than expected.

	HSPF			
Water Heater	**Electric storage 40 gal, EF 0.90**	Electric storage 40 gal, EF 0.90	**Electric storage 40 gal, EF0.93**	Electric storage 40 gal, EF 0.95
Infiltration	**1174@cfm50**	1174@cfm50	**998@cfm50**	356@cfm50
Refrigerator	EF 0.46	**672 kWh/yr**	EF 0.46	**547 kWh/yr**
Dishwasher	537 kWh/yr	**355 kWh/yr**	537 kWh/yr	**303 kWh/yr**

The evaluation team received REMRate modeling files as well as additional documentation in the form of Excel spreadsheets, outlining the building improvement measures for the buildings. The energy modeling and savings estimates for this project were never completed. Information about the installed measures was not always consistent in the documentation, as shown in **Error! Reference source not found.**. We were unable to clarify these inconsistencies in our follow-up with the energy contractor, and therefore made assumptions about the implemented measures based on our best engineering judgment. The values in bold represent what we think are the most likely characteristics of each improvement.

Table 6-5. Baseline and Upgraded Measures per REMRate Files and Provided Documentation

Modeling

To estimate energy and demand savings, we modeled the buildings using DOE2-based eQuest modeling software version 3.64. Modeling is needed to estimate the savings of building envelope measures. Modeling can also address the interactivity between the improved building envelope, the new HVAC systems, and other changes to the building.

We constructed a single model to represent four one-bedroom units and four two-bedroom units. As shown in **Error! Reference source not found.**, this model is a two-story structure with a footprint of about 50 by 70 ft, and a height of 18 ft, for 3,490 ft^2 per floor, or 6,980 ft^2 total. This area represents four units of 795 ft^2 and four units of 950 ft^2. Our model has four perimeter zones of 15 ft width and one core zone of about 20 by 40 ft on each floor. **Error! Reference source not found.** lists eQuest model inputs for the baseline and retrofitted building. Unless noted, all schedules and internal loads and other settings used in the model were left as eQuest default values for a low-rise multifamily building.

Figure 6-2. eQuest Rendering of Modeled Building

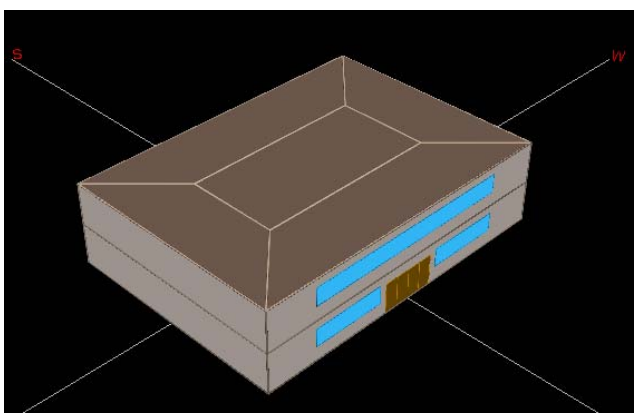


Table 6-6. Input to eQuest Modeling Software

Measure	Baseline Characteristics	Retrofit Characteristics
Attic Insulation	Built up roof, absorptivity of 0.9 5/8" plywood, R-19 insulation batt, 5/8" gypsum	Built up roof, absorptivity of 0.9, 5/8" plywood, R-38 insulation, 5/8" gypsum
Above Grade Walls	5/8" plywood, R-11 insulation, 5/8" gypsum	5/8" plywood, R-19 insulation, 5/8" gypsum
Windows	Single Pane, Clear (glass type 1000)	Double Pane, Low-E (glass type 2600)
Door	Uninsulated Metal, U-0.55	Insulated Metal, U-0.14
Cooling/Heating	ASHP 13 SEER / 8.5 HSPF modeled as a DX system with 0.3282 cooling EIR, 0.4014 heating EIR	ASHP 14 SEER / 8.2 HSPF modeled as a DX system with 0.2942 cooling EIR, 0.4161 heating EIR
Water Heater	Electric Storage 40 gal, EF 0.90	Electric Storage 40 gal, EF 0.93
Infiltration	0.0290 CFM/ft^2	0.0246 CFM/ft^2 (reduction of 15%)
Refrigerator & Dishwasher	0.300 W/ft^2 internal equipment loads	0.277 W/ft^2 internal equipment loads

Savings Results

Error! Reference source not found. and **Error! Reference source not found.** list the energy use, peak demand, and estimated savings from the eQuest models. Savings for our combined one- and two-bedroom building model were multiplied by a ratio of the total complex square footage divided by the model square footage, to estimate the overall energy savings of the apartment complex.

Cooling, heating, ventilation, hot water, and equipment energy use are reduced, for a total savings of 24% of the baseline energy use, or 3.16 kWh per square foot. Because this building uses a heat pump, the annual peak building electricity demand occurs in January during the heating season. Peak summertime demand occurs in July or August. **Error! Reference source not found.** lists the peak summer and winter demand for the baseline and retrofitted models, and the demand savings in both seasons. We found summer peak demand reductions of 12% and 0.25 kW per square foot.

Table 6-7. Energy Savings for the Project from eQuest Modeling

	Baseline Building kWh	Retrofitted Building kWh	Savings kWh
Space Cooling	10,276	8,198	
Space Heating	35,556	18,745	
Ventilation	6,135	5,507	
Hot Water	10,339	10,007	
Equipment	12,440	11,807	
Lighting	10,243	10,243	
Total Model	84,989 kWh	64,507 kWh	20,482 kWh (24%)
Model Square Footage	6,480 ft^2		
Savings per SF			3.1608 kWh/ft^2
Complex Square Footage	34,280 ft^2		
Complex Savings			**108,352 kWh**

Table 6-8. Demand Savings for the Project from eQuest Modeling

	Baseline Building kW	Retrofitted Building kW	Savings kW
Model Winter Peak	39.97	26.66	13.31 kW (33%)
Winter Savings per SF			2.054 W/ft2
Complex Winter Savings			**70.41 kW**
Model Summer Peak	18.30	16.05	2.25 kW (12%)
Summer Savings per SF			0.347 W/ft2
Complex Summer Savings			**11.90 kW**

We used the following algorithms to calculate annual energy savings and coincident summer peak kW savings from lighting installed.

Equation 1. Annual Energy Savings Algorithm

$$\Delta kWh = ((\Delta Watts) / 1000) * ISR * HOURS * (1+WHFe)$$ [45]

Equation 2. Summer Coincident Peak kW Savings Algorithm

$$\Delta kW = ((\Delta Watts) / 1000) * ISR * (1+WHFd) * CF$$ [46]

[45] Where:
ΔWatts = Compact Fluorescent Watts (if known)
ISR = In Service Rate or percentage of units rebated that get installed.
HOURS = Average hours of use per year
WHFe = Waste Heat Factor for Energy to account for cooling savings from efficient lighting

[46] *Where:*
WHFd = Waste Heat Factor for Demand to account for cooling savings from efficient lighting.
CF = Summer Peak Coincidence Factor for measure

We used a basic calculation based upon the Delaware TRM[47] installation of common area lighting and exterior lighting.

Table 6-9: Lighting Savings

Lighting Type	Δ Watts	In Service Rate	Hours of Use	Waste Heat Factor for Energy	Δ kWh	Units Installed	Total kWh
Interior Common	100	0.88[b]	4,300	-0.08[a]	348	24	8,355
Exterior	50	0.88[b]	8760	-0.08[a]	355	20	7,092
Total Annual kWh Savings							**15,447**
Lighting Type	**Δ Watts**	**In Service Rate**	**Coincidence Factor**	**Waste Heat Factor for Demand**	**Δ kW**	**Units Installed**	**Total kW**
Interior Common	100	0.88[b]	0.11[c]	0.05 [a]	0.010164	24	0.243936
Exterior	50	0.88[b]	0.11[c]	0.05 [a]	0.005082	20	0.10164
Total Summer Peak kW Savings							**0.345576**

[a] Calculated for Heat Pumps in Salisbury.

[b] Starting with a first year ISR of 0.81 (based on EmPOWER Maryland DRAFT 2010 Interim Evaluation Report; Chapter 5: Lighting and Appliances) and a lifetime ISR of 0.97 (from Nexus Market Research, RLW Analytics and GDS Associates study; "New England Residential Lighting Markdown Impact Evaluation, January 20, 2009"), and assuming 43% of the remaining 16% not installed in the first year replace incandescents (24 out of 56 respondents not purchased as spares; Nexus Market Research, RLW Analytics, October 2004; "Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs", table 6-7). ISR is therefore calculated as 0.81 + (0.43*0.16) = 0.88. See Mid Atlantic CFL Adjustments.xls for calculation.

[c] RESIDENTIAL LIGHTING MARKDOWN IMPACT EVALUATION, FINAL, January 20, 2009, Submitted to: Markdown and Buydown Program Sponsors in Connecticut, Massachusetts, Rhode Island, and Vermont. Submitted by: Nexus Market Research, Inc., RLW Analytics, Inc. RLW Analytics, New England Residential Lighting Markdown Impact Evaluation, January 20, 2009.

Based upon our interview with the sole participant, we found that the participant would have installed the energy efficiency measures as a result of their participation in DSHA's Low Income Tax Credits program and that the SEU financing did not play a role in their decision to install those measures. The participant is also installing a solar array through SREC after participating in the program. AEG noted that the SEU Energy Efficiency standards were designed to be incrementally more energy efficient than the Low Income Tax Credit program standards, and that the SEU construction financing was considered supplemental funding to take the energy efficiency of the installed measures to a deeper level. We note, however, that many of the standards were similar across the LITC and LIMFC programs, except for the HVAC standards, duct sealing and insulation for new construction, hot water heaters, and gas warm air furnace standards.[48]

[47] Delaware Technical Resource Manual: An Addendum to the Mid Atlantic TRM, Opinion Dynamics Corporation, April 30, 2012.

[48] HVAC standards ranged from SEER 14-16 for DSHA's program, rather than SEER 14-18 for SEU's program; Duct Sealing and Insulation for new construction received no points under DSHA's program, but did under the SEU financing; Hot water heaters were R=16 or greater, 0.82 and 0.91 EF for DSHA's program, while SEU's program required R=20 or greater; Gas warm air furnaces were required to AFUE 90% or higher for DSHA's program, while SEU's program required AFUE 93% or higher.

6.4.2 PROCESS FINDINGS

The Energize Delaware Multi-Family Financing program was designed to use ARRA funding and had to follow the constraints associated with that funding. Since Future program will not use ARRA funding source, the evaluation team conducted a limited process improvement evaluation of the program to inform future program design and implementation. In addition when referring to the program implementation efforts, we exclude discussing barriers related to the ARRA funding; particularly those related to the Davis-Bacon Wage Act since these will not apply to future program efforts. We provide process findings below.

Program Management and Administration

A range of organizations were involved in implementing the program. These included the SEU, Applied Energy Group, Inc. (AEG), and the DSHA. SEU worked with AEG to administer the program. AEG's role was to identify potential loan recipients, process financing checks to the participant, and verify energy savings. DSHA acted as a contract administrator and served as the main point of contact with potential program participants.

The partnership with the DSHA offered several benefits to the program, streamlining participation processes and providing access to the low-income multifamily market in Delaware.[49]

DSHA served as the point of contact for program participants. This partnership streamlined administration of project applications, underwriting, and funding disbursement, allowing for a reduction in overhead costs and fees. Further, the program used DSHA's LIHTC program eligibility criteria[50] for their application. The program participant noted that their organization would not have participated in the program if the financing had not been offered through DSHA because it made the construction and underwriting process seamless.

DSHA has a sizable network of contacts within the low-income multifamily market[51]. DSHA owns and operates 10 public housing sites in Delaware and, in addition to assisting homeowners, provides affordable rental housing assistance to low-income Delawareans The program's partnership with DSHA allowed the program to understand the financial and ownership structure of the local multifamily market and relationships among various market actors.[52]

The partnership with DSHA also provided the program with access to the affordable low-income market, particularly affordable housing developers applying for the LIHTC program. Because DSHA has their own client base, no marketing and outreach efforts were needed for the program.

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[49] AEG, in their role as contract administrator, also reached out to some municipal organizations, to identify potential partners for the program.

[50] Programs that leverage additional funding sources, but do not align eligibility criteria within their program application may encounter limited participation. We note that many low-income program eligibility criteria are similar (up to 80% of median family income). DSHA's Low Income Tax Credit Program requires up to 80% of median family income. Section 8 funding is for 80% of area median income.

[51] DSHA offers Section 8 Housing Choice Voucher program to private rental residencies, administering 902 vouchers. DSHA also provides listings of Section 8 housing as well as providing an Affordable and Accessible Online Apartment Locator Service with over 200 properties listed. http://www.destatehousing.com/Renters/rt_s8hcv.php

[52] Typically, multifamily building ownership models fall into the following general categories: 1) Principal owner with rented dwelling units (this can also include partnership arrangements involving multiple owners who do not reside in the building and often include a third-party management company), 2) Common area owner or management company with individually owned dwelling units (some condominiums) and, 3) multiple owners with a central governance body (for example, co-op's and some condominiums.) It is important to note that condominiums and co-ops represent approximately 7% of the total US housing stock or 9.5 million units and are among the most challenging ownership/governance structures to work with for energy retrofit projects. Home Performance Resource Center. Best Practices for Energy Retrofit Program Design: Marketing Recommendations. 2010. http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/BestPracticesForMultifamilyEnergyRetrofitProgramDesign.pdf, pg 4

Going forward, DSHA noted that they are interested in acting as a subrecipient for DNREC, for construction financing as well as other financing opportunities (i.e., Weatherization Assistance Program funds). DSHA is well positioned in the market as they have access to a large portfolio of affordable multifamily properties that could benefit from energy efficiency upgrades, have a background in underwriting, and have staff that conducts oversight of their projects. If DNREC would like to continue providing financing, program design should consider the competitive nature of the financing market (particularly from federal financing sources).

Participation Processes

In-depth interviews revealed logistical difficulties associated with multiple entities involved within the program period, constraints on financing (i.e., Davis-Bacon Wage Act), and competition within the financing market. These include:

- Logistical difficulties that led to delays in the process. Many organizations were involved at various stages over the program period.
- Constraints on financing; particularly the Davis-Bacon Wage Act, which required paying prevailing wages, that were not required by other sources of financing.
- Affordable housing developers in Delaware have many competitive financing options to consider when securing financing for projects. That pre-existing financing market that acted as a barrier to participation for some of the potential program applicantswho found it esier to secure financing elsewhere. For example, one potential participant secured funding through the United States Department of Agriculture (USDA) Rural Development program whose requirements were more advantageous for their project.

Construction Financing

The program offered construction financing to the retrofit and new construction market. Construction financing was described by AEG as a cost-effective method of reaching the low-income multifamily market. Because the loan is repaid to DNREC, the costs of operating the program only include the discount rate of the loans and administrative fees.

In-depth interviews revealed that the 3% interest rate was competitive in the past, but is now similar to what a developer could receive from other sources. Also, many developers are interested in syncing loans to reduce overhead costs. We found that it is common practice in construction financing to add 1% on the loan rate to cover administrative costs for each loan originator. By including SEU funds, these extra fees increased from 1% (DSHA's fee) to 2% (DSHA and SEU fee). This served as a barrier for one potential participant, as these fees can make projects no longer cost-effective.

Energy Efficiency Upgrades

The LITHC provided a system of points to applicants who installed energy efficiency measures. In our review we found that only three measures had additional points awarded to the proposal for more efficient measures. The few points awarded in this project made it difficult to parse out attribution of savings for the program. This is particularly so because the project participant noted that they would have installed the energy efficiency measures as a result of their participation in DSHA's LIHTC program and that the SEU financing did not play a role in their decision to install those measures. Notably, developers may consider energy efficiency standards a relatively less important factor when applying for construction financing loans. This is because, incorporating energy efficiency standards

gains developers only 5 points out of a possible 121 points to remain competitive for tax credits.[53] (See Appendix F for an overview of the energy efficiency measures that are available for the LIHTC and SEU programs).

Program Tracking

Program tracking is currently in the form of supporting documentation. However, because there was one participant, no formal tracking database was developed.

6.5 DELAWARE LOW INCOME FAMILY MARKET

Below we provide a summary of the Low Income Market in the state of Delaware. This information is gathered through a review of the Delaware State Housing Authority's Strategic Plan for 2013-2015 and Delaware's Five-Year Consolidated Plan for Housing and Community Development for 2010-2014.

Delaware has a sizable and growing need for low-income housing:

- Forty-two percent of renter households (36,150) in Delaware have income below 50% of median (very low income). Further, 75% of renter households are cost-burdened, meaning that they pay more than 30% of their income for housing.[54]

- At least, 13,200 households are on public housing and Housing Choice Voucher waiting lists. Further, 7,343 households are on waiting lists for Section 8 sites (privately owned, federally subsidized sites) and over 3,000 households are on waiting lists for Low Income Housing Tax Credit (LIHTC) sites.[55]

Meanwhile, Delaware's existing housing stock is aging and becoming less energy efficient than comparable new construction.

- Forecasts indicated that by 2012, 59% (8,058) of the current inventory of assisted rental housing in Delaware is over 20 years old, and that "between 50% and 70% of this stock may be in need of substantial rehabilitation."[56]

- Thirty percent of the state's assisted rental units are estimated to be in need of rehabilitation. Most of these units are assumed to need only moderate rehabilitation. [57,58]

New multi-family construction offers a great opportunity for Energy Efficiency investment. The Delaware Energy Plan of 2009-2014 listed achieving "energy self-sufficiency and carbon neutrality in

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[53] Delaware State housing Authority Low income Tax Credits 2010 QAP Points Worksheet. 2010. http://www.destatehousing.com/Developers/lihtc/2010/2010_qap_points_sheet.xls

[54] Delaware State Housing Authority, Strategic Plan 2013-2015, pp. 6. http://www.destatehousing.com/FormsAndInformation/Publications/fy2013_strategic_plan.pdf

[55] Delaware State Housing Authority, Strategic Plan 2013-2015, pp. 6. http://www.destatehousing.com/FormsAndInformation/Publications/fy2013_strategic_plan.pdf

[56] At least 4,814 are rental units, or 5.8% of the State's occupied rental inventory is estimated to be in substandard condition, meaning that a unit is deficient in at least two structural systems and is in need of substantial rehabilitation in order to make it structurally sound, safe and habitable. Delaware 2012 Low Income Housing Tax Credits Qualified Allocation Plan, http://www.destatehousing.com/Developers/lihtc/2012/2012_qap.pdf, pg 8.

[57] Delaware 2012 Low Income Housing Tax Credits Qualified Allocation Plan, http://www.destatehousing.com/Developers/lihtc/2012/2012_qap.pdf, pg 8.

[58] Approximately, 4,031 of 13,615 units were estimated to be in need of rehabilitation by 2012. Delaware's Five-Year Consolidated Plan for Housing and Community Development for 2010-2014, pg 4.http://destatehousing.com/FormsAndInformation/Publications/ds_fy2010actionplan.pdf

Delaware's built environment by 2030" as a primary goal, in part through "residential and commercial buildings" that "are energy and carbon neutral, from their construction through their useful lifespan[59]." According to the same plan[60], both the number of customers and consumption by residential users grew 8% between 2003 and 2007. As of 2005, Delaware used more energy in the residential sector (23% of use by sector) than the national average[61]. A Low-Income Multifamily program can be a cost effective way to both ease the economic burden on low-income tenants, and to help Delaware achieve these energy savings goals.

Entities Serving the Low Income Multifamily Market

Based upon a cursory review, the evaluation team encountered a series of entities that provide services seeking to upgrade Low Income Multifamily buildings, or provide services to their inhabitants, in the Delaware market. We have classified these organizations into four categories: 1) federal programs, 2) state programs, 3) local programs, and 4) utility programs.

[59] Delaware Energy Plan of 2009-2014, http://www.dnrec.delaware.gov/energy/Documents/Energy%20Plan%20Council%20report%20-%20Final.pdf, pg 9.

[60] Delaware State Plan of 2009-2014, http://www.dnrec.delaware.gov/energy/Documents/Energy%20Plan%20Council%20report%20-%20Final.pdf, pg 23.

[61] Reducing Delaware's Energy Use Work Group Report, http://www.dnrec.delaware.gov/Admin/Documents/Reducing%20Delaware%27s%20Energy%20Use%20Work%20Group%20-%20Final%20Report%20rev%201-07-09.pdf, pg 7.

Table 6-10. Organizations Operating within Delaware Low Income Multifamily Market

Program Type	Overview	Examples
Federal Programs	These programs typically tie energy efficiency upgrades to financial assistance and directly target the low-income multifamily market (except WAP).	• Low Income Housing Tax Credits (LIHTCs)[a] • HUD's Notice of Funding Availability • U.S. Department of Agriculture Housing Program (Rural Housing Service Section 515) • Weatherization Assistance Program (Single-Family)
State Programs	The Delaware State Housing Authority provides myriad services to the target audience, developers, and landlords.	• Delaware State Housing Authority Programs provide financing for new development and preservation of affordable rental housing: o Low Income Housing Tax Credit Program o Housing Development Fund o Multifamily Mortgage Revenue Bond Program o Housing Rehabilitation Loan Program • Division of State Services Centers (DSSC) – Low Income Home Energy Assistance Program
Municipal Programs	Many of these programs are not directly targeted towards energy efficiency upgrades, but do provide services to the target market. These programs receive funding via DSHA or the federal government to implement programs.	• Newcastle County Community Development • City of Wilmington Department of Real Estate and Housing • Newark Housing Authority • Sussex County Community Development and Housing • Community Development Block Grants (CDBG) Kent/Sussex County
Utility Programs	Many utility programs offer bill payment assistance programs to Low-Income customers.	• Chesapeake Utilities Sharing Program • Delmarva
[a] Operated through DSHA.		

6.6 BARRIERS AND BEST PRACTICES

Below we discuss barriers that low-income multifamily programs face as well as an overview of best practices to inform future program design and implementation. While there are a number of useful sources that provide examples and best practices for low-income programs, as well as a number of sources for multifamily programs, few sources have examined both of these approaches together. Where possible, we have drawn from both of these areas of research and combined their findings in a way that is relevant to the Delaware marketplace.

Barriers to Low Income Multifamily Programs

The low-income multifamily market has many unique barriers that present challenges to any program design. The Home Performance Center 2012 Best Practices Whitepaper[62] for multifamily energy retrofit programs outlines a variety of challenges to adoption and implementation documented in **Error! Reference source not found.**.

[62] http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/BestPracticesForMultifamilyEnergyRetrofitProgramDesign.pdf

Table 6-11. Barriers of Low Income Multifamily Market

Barrier Type	Barrier	Description
Barriers to Adoption	Consumer Inertia	Similar to single family home projects, multifamily building projects face market issues including lack of awareness of the benefits and opportunities of energy efficiency and building performance retrofits, lack of access to capital to finance these improvements, and a shortage of qualified practitioners to provide these services. However, due to the complex ownership structure and multiple stakeholders, multifamily building projects have additional issues. These include requirement of data to prove positive return on investment (multifamily building owners are driven by economic rather than emotional factors); most buildings are understaffed (building staff often view the projects as an add-on to their maintenance work requirement); and difficulty getting resource commitment from multiple stakeholders.
	Split Incentive	Many multifamily building owners are not responsible for paying the unit utility bill. Thus, there is no direct monetary incentive for the owner to invest in energy saving retrofits, making energy efficient programs difficult to implement.
	Access to Capital	Multifamily building owners make use of a wide range of financial resources, which includes traditional financing, leveraging of other assets as collateral, selling tax credits, and cash reserves set aside for specific improvements. This results in owners having limited availability of liquid assets which, in turn, makes it difficult to get resource commitment from the owner to fund energy efficiency projects.
Barriers to Process	Ownership Structure and Relationship to Residents	Unlike single-family homes, multifamily buildings have complex ownership structures, such as principal owner with rented units, common area owner, and multiple owners with central governance body involving several stakeholders, such as owners, residents, management, maintenance staff, contractors, and developers. This complex structure impacts the decision making process for retrofit projects as it becomes difficult to distinguish who benefits from the improvements and who receives the incentives.
	Significant Capital	Multifamily buildings require large investments per project from both the owners and the program. This means that it is important to minimize risks associated with the project, such as ensuring accurate energy saving predictions; hiring trained and educated energy auditors, consultants, and contractors; and ensuring an effective quality assurance process.
	More Variables and Complexity	Given the ownership structure and multiple stakeholders, multifamily building projects deal with great quantities of data and variables in the data to assess and analyze. This makes the projects more complex compared to single-family home projects.
	Limited Accessibility	Gaining access to all the units within a multifamily building is often difficult since the units are usually occupied by multiple residents and landlords/property managers require permission before they are able to enter the units. Additionally, it is time consuming and expensive to inspect each individual unit. Thus, multifamily building projects typically use a sampling approach for field inspections and data collection procedures.

Barrier Type	Barrier	Description
	Buy-in and Outreach	Given the ownership structure and multiple stakeholders, greater outreach efforts and time are required to gain buy-in (for access to the units, implementation of the project, and maintenance of measures installed) from all the stakeholders for the project.

Successful Program Examples

The evaluation team reviewed a series of white papers on low-income multifamily best practices, as well as case studies of successful program designs. Overall, there are a variety of alternative program designs delivered to the low-income multifamily sector that can be categorized into two approaches: 1) programs that offer energy efficiency upgrades via rebates, and 2) programs that offer energy efficiency upgrades via financing[63]. Notably, some programs offer a combination of these two services.

Based upon our review, the first approach, encouraging low-income multifamily building owners to upgrade energy efficiency of the facility via rebates, is the most frequent type of program. Financing programs are typically offered to multifamily buildings, but rarely target low-income multifamily building owners.

Overall, programs that provide energy efficiency services to low-income multifamily buildings are typically coupled with other programs to help keep administrative costs for the program low. These programs, both rebate and financing, are usually prescriptive based and target families with less than 80% of median income. Further, eligibility criteria are generally consistent with other program offerings. Additionally, these programs make use of a network of organizations, both public and private, to administer, implement, and finance the programs. Below, we provide a summary:

- Rebate program services include rebates (free for renters), in addition to ancillary services such as technical assistance, access to financing, and a central point of contact for the participating customer. Programs that offer financing services tend to provide lower interest loans and other financial incentives, such as tax credits offered to owners and developers who agree that low- or moderate-income families will occupy a certain proportion of the units in their buildings.[64]

- Access to financing is typically coupled with direct install and incentive offerings to reduce the split-incentives market barrier. Besides incentives, programs offer a variety of non-financial benefits such as better/healthier living conditions.

- Typical rebate program measures range from direct install "free" measures (i.e., Compact Fluorescent Lamps (CFLs), faucet aerators, and low-flow showerheads), to whole-building retrofits (i.e., envelope and shell, HVAC, etc.) Generally, an audit is conducted first to determine the most cost-effective measures to be installed. During the audit, direct install measures are installed in common areas and/or in rental units. For financing programs, measures reflect a comprehensive whole building approach, including insulation, HVAC,

[63] Brown, M., Wolfe, M., "Energy Efficiency in Multifamily Housing: A profile and Analysis" 2007. http://betterbuildings.dev.webascender.com/Portals/0/Images/energy_efficiency_in_multi-familyFINAL-1.pdf (accessed 6-7-2012).

[64] Cohen, R., Richardson, M., Lubell, J. "Financing Residential Energy-Efficiency: Assessing Opportunities and Coverage Gaps in the American Recovery and Reinvestment Act of 2009" 2009. http://www.nhc.org/media/documents/Financing_Residential_Energy-Efficiency.pdf (accessed 6-7-2012).

windows, mechanical systems, shell, and building envelope. Typically, a point system or list of prescription measures is used to qualify projects.

- Marketing and outreach efforts tend to leverage existing multifamily building networks, conducting outreach, primarily through community-based outreach, contractor networks, and building owner associations.

- Low-income multifamily programs typically work with a variety of partners, including housing authorities and federal programs, and in the case of financing programs, can also work with financing partners such as banks and private lenders.

- Rebate programs may have higher net-to-gross ratios in terms of attribution of energy savings. Financing programs can have unclear attribution, as construction financing is typically part of a package of loans. Future program designs should consider the energy efficiency requirements for financing, and determine whether these requirements are incrementally more energy efficient than what otherwise would have occurred absent the financing.

Appendix G provides an overview of programs that offer services to low-income multifamily programs via rebates and financing, respectively. In many states, utilities play a role in the delivery of low-income multifamily programs, finding effective ways to complement other programs offered to this sector. Within each of these tables, we provide an overview of the program, some key aspects to program implementation, and best practices employed for program delivery.

6.7 RECOMMENDATIONS

We provide recommendations to inform future design and implementation of low-income multifamily programs. These are based on evaluation results for the program and on best practices were derived from the Home Performance Center 2012 Best Practices Whitepaper[65], and Best Practices Benchmarking for Energy Efficiency Programs[66].

Program Goals & Management

- *Clearly define program goals*: Identify program goals that meet stakeholder needs to provide support for the program and incorporate metrics for measuring success within program design and implementation.

- *Ensure Proper Project Management:* Multifamily building projects have two key distinctions that set them apart from single-family projects; the complexity of closing the deal and the potential for significantly longer projects (due to the multiple stakeholders) and less predictable construction phases (due to the need for a multi-layered team of design professionals and construction workers to complete the job). Dedicate a resource to serve as part of the owner/contractors project team. This can be more costly, but maintaining a strong and consistent role throughout the project can lead to higher rates of completion and greater energy savings.

[65] http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/BestPracticesForMultifamilyEnergyRetrofitProgramDesign.pdf

[66] Best practices were selected from "Best Practices Benchmarking for Energy Efficiency Programs, R4 and R5", multi-family and single-family energy efficiency programs respectively. http://eebestpractices.com/Summary.asp?BPProgID=R5 ; http://eebestpractices.com/Summary.asp?BPProgID=R4

Coordinate and Leverage Other Programs and Resources

Coordinating program design with existing programs and frameworks can ensure that the program does not provide redundant services to the market. Below are some key best practices regarding partnering and coordinating with other programs:

- *Leverage Other Funds*: Coordination between program administrators can leverage funding opportunities for customers and help reduce duplication of paperwork.
- *Consistency and Coordination of Programs:* In regions where multiple overlapping programs are in play, it is important for programs to collaborate to reduce customer confusion and increase participation. One effective method is the formation of ad hoc committees tasked with coordination of programs including representation from all program sponsors, contractors, and government oversight bodies. Another approach is to create a uniform set of standards and guidelines at the state level that programs will be accountable to uphold.
- *Consider Requirements of Existing Programs and/or Statutes and Seek to Harmonize Program Elements*: New programs introduced into a market with existing programs should be designed so as not to create redundant work for vendors or conflicting pathways for participants.

Incentives, Rebates, and Financing Models

Affordable housing, market rate multifamily buildings, and moderate-income households offer significant opportunities for energy efficiency programs. However, these sectors require special handling in their incentive structure, marketing, and coordination. Below we present an overview of various models to support energy efficiency upgrades in these markets.

- *Low-Income and Moderate Income Incentives:* Collaboration between programs can help address the needs of both the low- and moderate-income sectors (including leveraging program funds). For example, the low-income Weatherization Assistance Program can be leveraged to allow very low-income buildings to receive a wider range of services, and moderate-income programs should be designed with additional incentives to help stimulate participation among building owners who often do not have the same competitive drivers to improve their buildings as do market-rate building owners.
- *Incentives and pricing:* Incentives should be designed to get maximum participation from qualified players in the market. By having price fixing or limited enrolment of contractors/consultants, the program creates artificial barriers that limit the options available to multifamily building stakeholders.
- *Offer an attractive mix of eligible measures and integrated services:* Tie rebates for the most popular measures to those less likely to be considered and installed. Due to the split-incentive nature of the low-income multifamily market, as well as the reduced economic incentive for owners to invest in properties with low rent, the most effective measures will be those that are cost-effective, that lower the building operation cost for the owner, and increase the comfort and property value of the building (see more here[67]). Conduct energy audits to determine the most cost-effective measures for installation.

[67] http://www1.eere.energy.gov/wip/solutioncenter/pdfs/residential_retrofit_program_design_guide.pdf, pg 24

- *Downstream Incentives*: Offering downstream incentives to owners can help reduce financial risks and increase participation from multifamily building owners.
- *Use Milestone-Based Rebate Pay-out Schedules*: To reduce financial barriers, consider a structured or phased rebate payment schedule. This helps pay costs to the building owner as they are incurred and encourages full participation in the program, helping avoid attrition prior to construction.

Marketing & Outreach

- *Build Relationships with Market Actors*: Build relationships with maintenance and equipment firms responsible for system operations and maintenance. In addition, develop network with building owner associations and entities that service the target market.
- *Branding and Labeling*: As customers become increasingly more energy-conscious and aware of energy efficient brands, such as ENERGY STAR, using the recognizable brands and labels can help increase program awareness. Brands and labels can also be used as a marketing tool by building owners.
- *Post-retrofit Tenant Outreach*: Tenant education on the changes made to the building and how the changes impact their lives can help maximize the savings achieved with an energy efficient retrofit project.

Participation Processes

- *Understand building and owner needs*: Given the multiple stakeholders, it is important for the project to understand the needs and budgets of a particular building and create a value proposition that will resonate not only with the building owner but also the tenants, maintenance staff, and other stakeholders.
- *Whole-building approach to achieve maximum energy savings:* Whole-building strategies may fit better in a comprehensive program that includes other market segments besides low-income multifamily, to maximize potential return on investment.
- *Offer a single point of contact for customers*. For financing programs, this can be the program underwriter (i.e., DSHA), or for rebate programs, develop a network of local installers committed to high quality standards. A single point of contact is best, as it makes the program much more attractive to developers/landlords. Building owners typically look for one-on-one interactions with the auditor/consultant. Program implementers should be involved with the program participants as early as possible, and continue the relationship through the entire process. A program can encourage direct relationships between the "auditor" and the building owners.
- *Understand the financial and ownership structure of the local multifamily market and the relationships among various market actors*: Tailor the program to the needs of the low-income multifamily market. Findings indicate that the program should focus on the retrofit market given Delaware market needs; however, if programs consider new construction, incorporate more comprehensive measures to achieve greater savings.[68] If future programs focus on new construction, we suggest a whole building approach for these efforts.

[68] http://destatehousing.com/FormsAndInformation/Publications/tb_housingneeds_full.pdf

- *Streamline Processes and Requirements*: Streamlining processes and procedures can help reduce administrative burden and make the process easier to follow and complete for program partners and participants, minimizing the data reporting requirements and eliminating redundancies. This leaves more of the overall budget for incentives. In this respect, the program should seek to streamline the application process and eligibility criteria. For programs that work with partners, requirements should be as simple as possible, ideally an addendum to an existing process that contractors and landlords are already familiar with.

Program Tracking

- *Track Efforts to Demonstrate Success:* Track all energy efficiency measures implemented as part of each retrofit, including a description of the baseline and retrofit measures, quantities and/or sizes of the measures, and indicators of the measure's pre and post efficiency levels. The types of indicators tracked vary based on the type of measure being installed, and sometimes as many as three indicators need to be tracked to specify a measure. The tracking system should allow room for three pieces of information about each efficiency indicator: the name of the indicator, an indicator value, and the units for this value.

- *Track how savings were estimated for each measure.* We recommend using one of the following three methods:

    - When possible, find residential savings from the deemed values listed in the Delaware Technical Reference Manual for the measures being implemented. The April 2012 version of the TRM includes single-family savings estimates for air sealing, attic insulation, and new windows, as well as efficient refrigerators, AC systems, heat pumps, and clothes washers.

    - For measures that are not in the Delaware TRM, another useful source of efficiency information is the US EPA ENERGY STAR program. This program provides calculators for many types of HVAC equipment, water heating equipment, and household appliances. Information is listed by product type at www.energystar.gov. There are calculators for dishwashers, lighting, heating and cooling systems, water heaters, and many other types of appliances.

    - Energy modeling for each building is not always feasible, given the level of expertise of the projects' contractors. However, if energy modeling is used to estimate savings, make sure electronic input and output files are saved and submitted. Modeling should also include a summary sheet listing all measures, and how the baseline and efficient characteristics were defined for each measure in the energy model. Common energy models include eQuest, RemRate, EnergyGauge, and EnergyPro.

Quality Control & Verification

Multifamily buildings have a unique set of challenges that require specialized expertise to address, mainly due to the range of technologies that exist in a wide range of buildings. Thus, there is a need for contractors and consultants to gain expertise, training, and certification within this sector. To do so:

- *Enforce Worker Qualification*: Multifamily building projects have a distinct set of technical challenges, which makes proper qualification of workers and proper project management very important to moving a project forward.

- *Apply Quality Assurance at Multiple Levels*: Quality assurance programs should include review of eligibility criteria at the application stage, thorough review of building energy modeling outputs, and on-site inspections conducted throughout the construction process.

- *Engage Program Partners in QA*: A successful program views energy raters, consultants, and contractors as partners. Collaboration among them can help improve program performance and tease out systemic problems to be addressed in future program design modifications. Thus, the program should have rules and incentives that promote interaction between these vendors and the building owners to ensure that improvements are correctly designed and installed.

7. ENERGY STAR APPLIANCES

7.1 KEY FINDINGS

The ENERGY STAR® Appliance rebate program incentivized the purchase of approximately 16,000 appliances in Delaware between September 2009 and December 2010. The goal of the evaluation is to examine the integrity of the program data, assess per measure savings, and determine overall program gross savings. We summarize key findings below.

- **Data Integrity.** Based on this analysis, the evaluation team finds that the implementer database matched the administrator spreadsheet with 99.8% accuracy. The implementer-tracking database included all of the necessary information to conduct this evaluation including customer information, equipment purchased, and application dates. One enhancement we would recommend is to clearly label the measure types. While the measure types in the database were coded, they could be more descriptive of the actual equipment rebated (i.e., more intuitive to the uninitiated reviewer). For example, in the database, dishwashers are listed as "AG 2008"; without knowing the codes, it is impossible to know which appliance a given customer purchased.

- **Per Measure Savings Values.** In the future, the Delaware Technical Reference Manual (TRM) should be used as the source for deemed savings values. These values were developed specifically for Delaware and, although most appliances do not differ significantly from national savings numbers (like those prescribed for the American Recovery and Reinvestment Act State Appliance Rebate Program), they do vary enough to make a large difference in the higher volume measures. Additionally, data captured during the 2012 Residential Baseline study can be used going forward when calculating energy savings for measures not addressed in the TRM[69]. In absence of the Delaware TRM, the program could have used the Mid Atlantic TRM for some of the included measures, which would have provided more nuanced savings for the region than the federal assumptions.

- **Gross Savings.** This evaluation was limited to reviewing gross savings values. By applying the per measure savings calculations in the new Delaware TRM and Delaware-specific baseline conditions found in the 2012 baseline study, the evaluation team found that gross electric savings were 41% higher than what was reported and gross natural gas savings were just 73% of what was reported. This was primarily, but not exclusively, due to the baseline study providing more accurate fuel shares (electric vs. natural gas) for water heating and clothes drying. This fuel share information is a major input to the savings realized for clothes washers, which accounted for approximately 50% of all rebates. The baseline study found a much higher penetration of electric water heating and electric clothes dryers than initially assumed, resulting in the savings from the installation of new clothes washers shifting from assumed natural gas saving to electricity.

[69] At the request of the Delaware Department of Natural Resources and Environmental Control (DNREC), Opinion Dynamics Corporation and subcontractor Nexant, Inc. conducted a residential baseline study of 70, single-family homes in Delaware.

This evaluation did not include an analysis of free ridership or spillover. However, given that the market share for the ENERGY STAR qualified refrigerators, clothes washers, and room air conditioners ranges from 30 to 50%[70], future program approaches would need to be considered very carefully – to avoid high levels of freeridership. Further, the high levels of free-ridership have the potential to impact

7.2 PROGRAM DESCRIPTION AND OBJECTIVES

The ENERGY STAR Appliance program was managed by the Delaware State Energy Utility (SEU) under the "Energize Delaware" brand. This program provided mail-in rebates ranging from $25-$100 for ENERGY STAR qualified refrigerators, freezers, clothes washers, dehumidifiers, room air conditioners, water heaters, and dishwashers. The program initially launched in September 2009 with funding from the Regional Green House Gas Initiative (RGGI) and ARRA State Energy Program (SEP) grant. The RGGI program offered incentives for ENERGY STAR qualified appliances including clothes washers and refrigerators. In December 2009, the US Department of Energy created the State Energy Efficient Appliance Rebate Program (SEEARP), and the Delaware SEU transitioned the already-existing RGGI appliance program to the new SEEARP program.

Two changes occurred with the funding source change. First, the program was able to add incentives for water heaters, dishwashers, and room air conditioners. Second, because the SEEARP program could not offer tiered incentives, the clothes washer rebates changed from $100 for front loading machines and $75 for top loading machines to $100 regardless of what type of clothes washer was purchased. Appliance rebates were offered in Delaware from September 2009 through August 2010 either through the SEEARP or RGGI programs. This evaluation examined the ENERGY STAR Appliance rebate programs as a whole; however, because of the transition of the program from RGGI and ARRA (SEP) to SEEARP, there is no program-developed final report for the appliance program overall. This evaluation provides a review of the tracking database provided by the program implementation contractor[71] titled "Energize Delaware_DOE_20120508" (referred to in this report as the "implementer database") compared to the program tracking spreadsheet provided by the program administrator titled "Energy Savings – Appliance Rebate Program" (referred to in this report as the "administrator tracking spreadsheet").

Table 7-1 lists the appliances that were rebated along with the start and end dates of the rebates. It should be noted that the appliance rebate dates vary with some measures being introduced later in 2010 and many of the incentives ending in early 2010, while others continued through August 2010[72].

[70] Data from US DOE on ENERGY STAR market share shows refrigerators at 30%, clothes washers at 30-40%, room air conditioners at 50%. Other appliances had much lower market share including freezers at 3% and water heaters at 0-4% depending on the type.

[71] Two firms were involved with the implementation of this program; the first APT handled the program delivery and field work, the second, Ohana acted as the fulfillment contractor. Interviews with representatives from both organizations were included in the program evaluation activity.

[72] Start and end dates by appliance vary based on the funding source and availability of those funds as programs proceeded.

Table 7-1. Appliance Rebate Amount

ENERGY STAR Appliance	Incentive	Start date	End Date
Refrigerator	$100	9/1/09	1/31/10
Freezer	$50	9/1/09	1/31/10
Dehumidifier	$25	9/1/09	1/31/10
Clothes Washer (front-load)	$75	9/1/09	2/28/10
Clothes Washer (top-load)	$50	9/1/09	2/28/10
Room Air Conditioner	$25	12/1/09	8/31/10
Water heater-storage	$50	12/1/09	8/31/10
Water heater-condensing/demand	$200	12/1/09	8/31/10
Dishwasher	$30	12/1/09	8/31/10

The program used a mail-in rebate approach whereby customers could print the rebate application or visit one of 50 participating retailers to receive an application. Application forms and appropriate documentation were mailed to the implementer for processing. Customers received the incentive in the form of a debit card rebate. Over the course of the program, about 16,000 residential ENERGY STAR qualified appliances were incentivized.

7.3 METHODS AND APPROACH

This evaluation focused primarily on verifying the savings tracked by the program administrator and implementers. Our primary source of data for verifying the program savings was the implementer-tracking database. We used this data to verify the unit quantities of the measures incentivized through the program and to ensure that the proper savings were attributed to those measures. We compared the implementer database to the administrator tracking spreadsheet. Additionally, we reviewed the electric and therm savings that were claimed per unit, comparing those to the newly developed Delaware TRM and data available through the 2012 Delaware Residential Baseline Study.

Figure 7-2. Summary of the Appliance Program Evaluation Activities

Method	Approach
Program Database Review	We received a program tracking database from Ohana, the fulfillment contractor for this program. The implementer database included customer information, measures installed, and date of purchase. We compared this database to the tracking spreadsheet that was provided by the program administrator – Applied Energy Group (AEG). The primary purpose of the database review was to establish the number of rebates paid – by appliance type – through the program, and to verify the unit counts of the different measures incentivized through the program to those reported.

Method	Approach
Energy Savings Review	We reviewed the savings per unit that were claimed by the program. The program used the US DOE SEEARP Program Prescriptive Savings values[73] for most appliances and used the California DEER Database for the dehumidifier savings. As a part of the evaluation scope of work, the evaluation team has drafted a Delaware TRM and conducted a residential baseline study; however, we did this after the appliance program ended. The use of the Delaware TRM and Residential Baseline data for energy savings verification is an attempt to quantify gross savings that Delaware could achieve for programs going forward. For this evaluation, we used savings values for measures that are defined within the TRM to verify the program energy savings. We used the SEEARP savings values for measures that the TRM did not address. It is also important to note that this evaluation did not include an analysis of "net" energy savings. Net energy savings are adjustments to gross energy savings made to account for customers that would have purchased an appliance without the incentive program (free riders) and customers that were influenced to make the purchase because of the program but did not actually participate (spillover). Generally, net savings are calculated by the following equation: Net savings = gross savings – (free riders) + (participant spillover). Calculating net energy savings requires additional research into customer decision making that was outside the scope of this evaluation.

The most common way to obtain insights into consumer behavior is to conduct participant and non-participant surveys. However given the amount of time that had lapsed between the program and the evaluation (i.e., well over a year), we concluded that survey data would not be reliable[74] and it would not be appropriate to attempt to calculate net savings for this program at this time. Further research into the possible net energy savings from such an effort should be done prior to launching a similar appliance rebate program.

7.4 RESULTS

Database Review

Program staff worked with the implementation contractor (Ohana) to obtain the full program tracking database. Measure counts were verified and compared to the administrator tracking spreadsheet. One significant difference was found in the water heater measure counts. Water heaters are divided into two types: storage and tankless/gas condensing. The administrator tracking spreadsheet lists 260 storage and 118 tankless/gas condensing water heaters as being incentivized through the program. However, the implementer database indicates that 118 storage and 259 tankless/gas condensing water heaters were incentivized. The savings for these measures also appear to match

[73] The State Energy Efficient Appliance Rebate Program prescribed savings were developed for the US Department of Energy by D&R International. The program implementers used the savings adjusted values for Delaware.

[74] After this length of time it would be unlikely that customers would recall what influence the program had on their decision making process.

the administrator tracking spreadsheet. One possible explanation for this could be that the measure codes were inadvertently switched. The evaluation team corrected the measure counts for the water heating measures to align the implementer database with the administrator tracking spreadsheet. The table below lists the units rebated through the program. Ultimately, the evaluation team used 118 units for tankless/gas condensing and 259 for storage for calculating the overall program impacts of water heaters.

Table 7-3. Verified Measure Counts

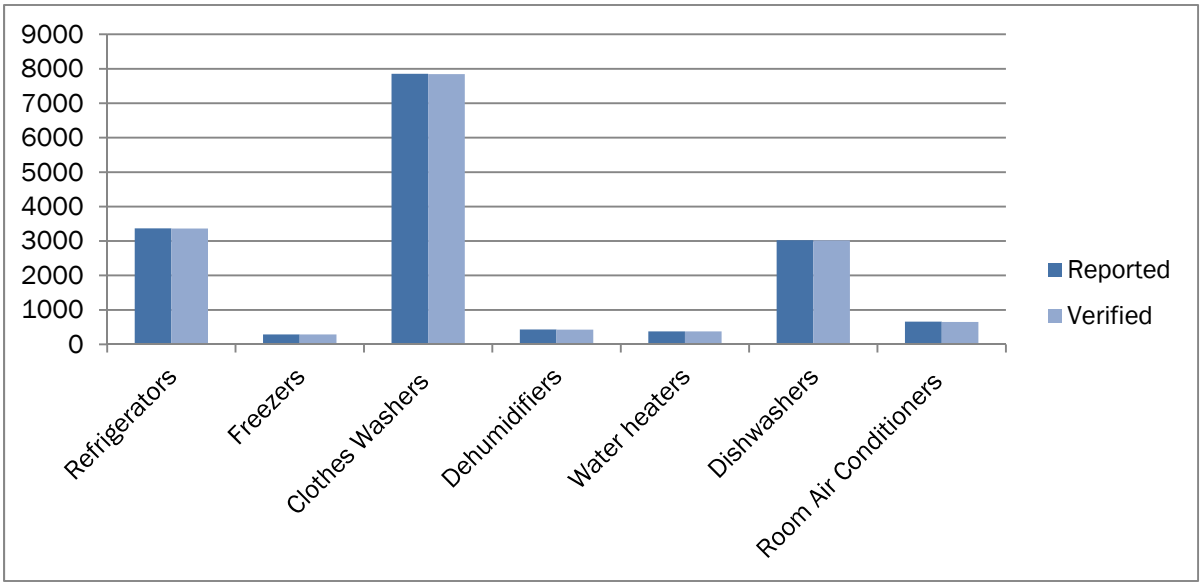
Units Rebated through Program		
Appliance	Reported	Verified
Refrigerators	3369	3362
Freezers	289	289
Clothes Washers	7855	7847
Dehumidifiers	433	430
Water heaters-Storage[75]	260	118
Water heaters-Tankless or Gas Condensing	118	259
Dishwashers	3022	3019
Room Air Conditioners	658	651
Total	16,004	15,975

Aside from the water heaters, the reported and verified measure counts matched closely. The following differences were found: 7 more refrigerators, 8 more clothes washers, 3 more dehumidifiers, 3 more dishwashers, and 7 more air conditioners were reported in the administrator tracking spreadsheet when compared to the implementer database. Over ninety-nine (99.8) percent of the units reported to DNREC by the administrator were in the implementer tracking database.

Clothes washers were the most popular measure rebated through the program, accounting for 49% of the measures rebated. On the opposite end of the spectrum, freezers, dehumidifiers and water heaters were rebated the least accounting for 1.8%, 2.7%, and 2.4% of the measures rebated, respectively.

[75] We believe that the measure counts for the two different water heater categories may have been inadvertently mislabeled. For the purposes of this evaluation we are adjusting the measure quantities to align with what was reported in the program spreadsheet.

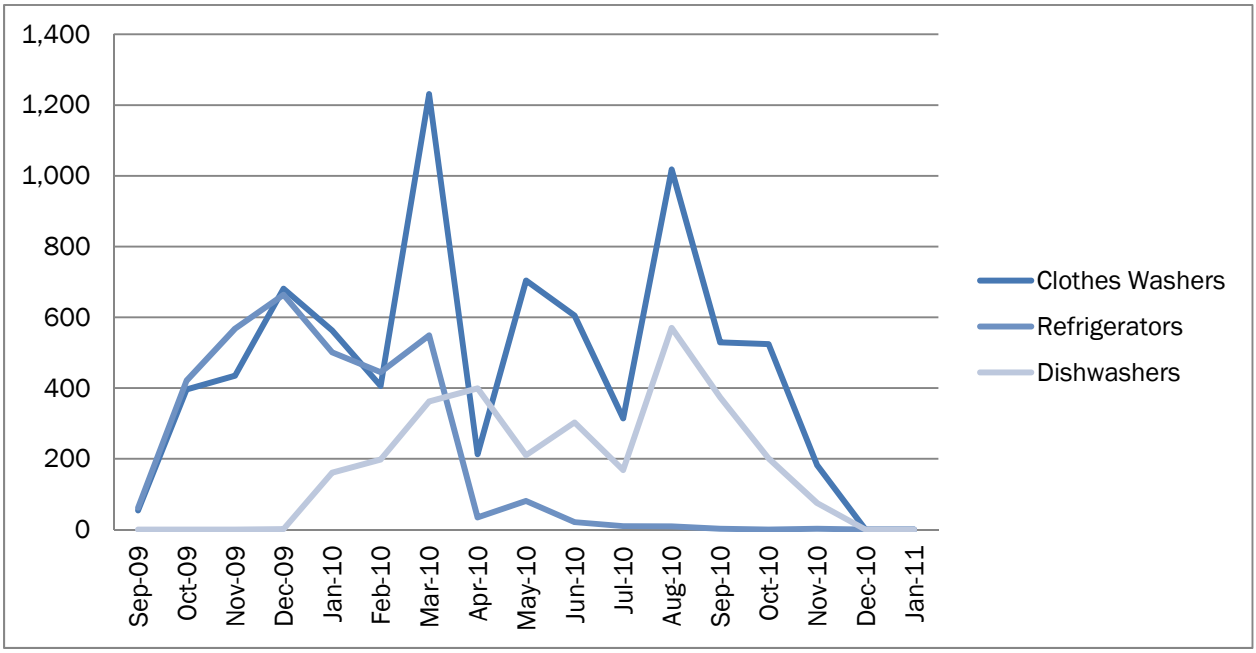
Figure 7-1. Types of Measures Incentivized



Month-by-Month Throughput

Measure offerings varied throughout the duration of the ENERGY STAR Appliance rebate program. When the program was transitioned to SEEARP, additional measures were added and, throughout the course of the year, other measures were dropped from the program. Figure 7- shows the month-by-month throughput for the most commonly rebated measures (clothes washers, refrigerators, dishwashers). For example, the figure shows a sharp drop in refrigerators incentivized through the program, which coincides with the discontinuation of refrigerator incentives.

Figure 7-2. Units Rebated Per Month



Engineering Review

In addition to the database review, the evaluation team also reviewed the savings values that were used by the program to make sure they were appropriate for Delaware. The implementation contractor for the ENERGY STAR Appliance program used US Department of Energy SEEARP values for refrigerators, freezers, washing machines, hot water heaters, dishwashers, and room air conditioners and the California DEER (Database for Energy Efficient Resources) database for dehumidifiers.

During the drafting of this evaluation report, the evaluation team completed a TRM document specific to Delaware for use in future programs as well as a residential baseline study. For this evaluation, we compared the SEEARP prescribed savings to those in the Delaware TRM and made fuel-type adjustments based on the baseline research. The purpose of this was to help inform DNREC about the gross savings a program like this would achieve given the savings values that have been developed specifically for Delaware.

In cases where measures were not addressed by the Delaware TRM, the SEEARP value was used and the final savings adjustments were made based only on the measure count variances found during the database review. The table below indicates measure-by-measure which source was used to determine the verified energy savings. Although KW were not tracked by the program or claimed in any way; we have included this information in reporting where available.

Table 7-4. Verified Energy Savings Sources

Appliance	Claimed Savings Values		Verified Savings Values			Source
	kWh	Therms	kWh	Therms	KW	
Refrigerators	105	0	117	0	0.019	Delaware TRM
Freezers	48	0	48	0	0.007	Implementer/ENERGY STAR value
Clothes Washers	164.97	2.26	200.73	1.17	0.023	Delaware Baseline
Dehumidifiers	79	0	79	0	NA[76]	Implementer/ENERGY STAR value
Water heaters-Storage	0	18.91	0	18	0	Delaware TRM
Water heaters - tankless or gas condensing	0	77.85	0	63	0	Delaware TRM
Dishwashers	60.3	0.63	60.3	0.63	NA	Implementer/ENERGY STAR value
Room Air Conditioners	93.54	0	26	0	0.045	Delaware TRM

Energy Savings

Based on adjustments made as a result of the database and engineering review, the program realization rate for kWh was 1.38. Aside from minor measure count adjustments, there are two primary reasons for this difference. First, the implementer value claimed for refrigerators was 12 kWh lower than the value in the Delaware TRM and because there were over 3,000 refrigerators incentivized through the program, the program realized 112% of the reported savings for that measure. The second major difference between the reported and verified savings was for clothes washers. The SEEARP savings value for clothes washers is based on the fuel types available in the 2005 Residential Energy Consumption Survey whereas the verified savings were calculated using similar information from the residential baseline study[77] and the algorithm used in the Delaware TRM. The percentage of electric clothes dryers[78] and the use of electricity for domestic hot water (as indicated by the Delaware Residential Baseline Study) is higher in Delaware than in other parts of the country and, as a result, there is greater opportunity to save kWh. Additionally, the energy savings claimed for room air conditioners was higher than the value in the Delaware TRM. Finally,

[76] The KW values for Dehumidifiers and Dishwashers are not available in the Delaware TRM or in the ENERGY STAR program documentation.

[77] The Delaware residential baseline found that 56% of domestic hot water use is electric and 34% is natural gas. This is higher than other parts of the country. Additionally 93% of the dryers in Delaware are electric and only 7% are natural gas; which is also higher.

[78] Even though there were no incentives for clothes dryers, ENERGY STAR washers save energy by drying clothes more at the end of the wash cycle thereby reducing the demand on the dryer.

there were eight clothes washers included in the administrator scorecard that did not appear in the implementer database. The table below shows the measure-by-measure kWh results.

Table 7-5. Verified kWh Savings

Units Rebated through Program			kWh Savings Values		Total kWh Savings		Realization Rate
Appliance	**Reported**	**Verified**	**Claimed**	**Verified**	**Reported**	**Verified**	
Refrigerators	3369	3362	105	117	353,745	393,354	
Freezers	289	289	48	48	13,872	13,872	
Clothes Washers	7855	7847	121.6	200.73	955,168	1,575,128	
Dehumidifiers	433	430	79	79	34,207	33,970	
Water heaters-Storage	260	118	0	0	0	0	
Water heaters - tankless or gas condensing	118	259	0	0	0	0	
Dishwashers	3022	3019	60.3	60.3	182,227	182,046	
Room Air Conditioners	658	651	93.54	26	61,549	16,926	
Total	**16,004**	**15,975**			**1,600,768**	**2,215,296**	**1.38**

Therm Savings

Based on adjustments made to the measure count and deemed savings values, the ENERGY STAR Appliance program achieved a gross therm savings realization rate of .69. This is largely because electricity usage is higher in Delaware and natural gas usage is lower than the assumptions used in the SEEARP values. The energy savings for the highest volume measure, clothes washers, was reduced by almost 50% based on Delaware-specific fuel mix data.

Table 7-6. Verified Therm Savings

Units Rebated through Program			Therm Savings Values		Total Therm Savings		Realization Rate
Appliance	**Reported**	**Verified**	**Claimed**	**Verified**	**Reported**	**Verified**	
Refrigerators	3369	3362	0	0	0	0	
Freezers	289	289	0	0	0	0	
Clothes Washers	7855	7847	2.26	1.17	17,752	9,181	
Dehumidifiers	433	430	0	0	0	0	
Water heaters-Storage*	260	259	18.91	18	4,917	4,662	
Water heaters-tankless or gas condensing*	118	118	77.85	63	9,186	7,434	
Dishwashers	3022	3019	0.63	0.63	1,904	1,902	
Room Air Conditioners	658	651	0	0	0	0	
Total	**16,004**	**15,975**			**33,759**	**23,179**	**0.69**

7.5 RECOMMENDATIONS

In addressing the key findings from the evaluation, the evaluation team recommends the following:

- Clearly label the measure types in program tracking databases. While the measure types in the database were coded, they could be more descriptive of the actual equipment rebated (i.e., more intuitive to the uninitiated reviewer). For example, in the database, dishwashers are listed as “AG 2008”; without knowing the codes, it is impossible to know which appliance a given customer purchased.

- Delaware Technical Reference Manual (TRM) should be used as the source for deemed savings values. In absence of the Delaware TRM, the program can use the Mid Atlantic TRM for measures.

- Future programs should be carefully planned in light of the high market share for ENERGY STAR Appliances[79] which lends itself to the potential for high free-ridership and a low benefit costs.

[79] As identified by Energystar.gov and in the 2012 Delaware Residential Baseline Study

8. EFFICIENCY PLUS BUSINESS

8.1 KEY FINDINGS

The Efficiency Plus Business program was a comprehensive incentive program offered to non-residential customers in the state of Delaware. The program, launched in December 2009 and ran through September 2011, offered both prescriptive and custom incentives to customers that implemented energy efficiency projects. The program faced a number of challenges that are common for new non-residential programs including building the market for the energy efficient technologies and generating program awareness. Additionally, as with many new C&I programs most projects completed through the Efficiency Plus Business program were prescriptive lighting. This is because prescriptive lighting projects can be implemented quickly, with relatively little planning and have short payback periods.

The goals of this evaluation were to determine the gross energy savings that were achieved as well as to gain insight into program processes and customer satisfaction. Although the evaluation team did not do a full net-to-gross analysis, we did survey customers to gain an understanding of how much influence the program had on their project.

- Gross Savings Review. Although the overall realization rates for KW and kWh savings were close to 1, there was significant variation in the project level ex post evaluated savings compared to the ex ante. Some projects greatly underestimated savings while some overestimated savings. In aggregate, these over/under estimations balanced out – keeping ex post results close to the original ex ante savings claims. However, the wide variance impacted the precision of the evaluation results. The ex post natural gas savings were significantly lower than the ex ante savings (a 0.69 realization rate) due to calculation errors found in the project sample.

- Free ridership. Data obtained through customer surveys indicates that the program did reach customers, for the most part, early in the decision-making process. While many customers learned of the incentives while the projects were in early stages, many reported that the incentive did not influence the timing of the project or the efficiency level of the equipment chosen. This is indicative of a high level of program free ridership (note: free riders are considered to be customers who would have installed the same efficiency level of equipment in absence of the program).

- Timing. As noted above many customers learned of the incentives while projects were in early stages, but often they opted to wait to apply for the program until the project was complete. This made it appear that projects were completed before they were made aware of the program but it does not appear this was this case. Instead this was done to avoid Davis-Bacon requirements from kicking in. If applications came in on a completed project they were not required to meet Davis-Bacon, if they applied before complete they had to adhere to Davis-Bacon which included stringent reporting and labor resource requirements that often became a barrier to participation. A program change in 2010 helped address this early issue.

- Satisfaction. Customers reported high satisfaction with the program. They were most satisfied with the incentive and measures offered through the program and they were least satisfied with communication from program staff.

- Selection of baseline. The implementer based savings calculations on estimated baselines;

meaning they made assumptions about the equipment that existed before the project was completed instead of basing the energy savings on the actual pre-existing equipment. This is a common practice for prescriptive programs where the energy savings for each measure are stipulated or deemed. However, in the Efficiency Plus Business program, this was one of the primary reasons for large discrepancies between ex ante and ex post savings values.

- **Application of algorithms.** The evaluation team also identified issues with the way in which savings algorithms were applied. Consider the project in the evaluation sample, which consisted of the installation of LED lamps in the guest rooms and hallways of a hotel. The reported savings calculation assumed that both types of lamps were on 8,736 hours per year with a coincidence factor of 1.0. This is a logical value for the hallway lamps, but not for the rooms, which are frequently empty or have a guest sleeping in them. Typical TRM values for hotel guest rooms are about 1,000 hours annually. The Delaware TRM calls for a value of 914 annual hours with a coincidence factor of 0.09. This misapplication of the savings algorithm returned a considerable overestimation of energy and demand savings. The assumed hours of operation in a lighting retrofit savings algorithm are based on the building type. We observed a number of projects where the building type selected was not the most appropriate choice.

  In another example, the energy savings calculated for one of the HVAC projects was based on the number of units but actually should have been based on the savings for the whole building. Because the savings were calculated based on individual units, the aggregate savings claimed for all of the units was higher than the building's entire annual electric consumption. A process that compared the savings estimate to the square footage of the building would have flagged the reported savings estimate as unrealistic.

- **Lost Opportunity.** The evaluation team observed significant lost opportunity in several of the projects where Variable Frequency Drives (VFDs) were installed on HVAC motors. In one case, VFDs were installed on the supply and return air fans in a building that had pneumatic vent controls on its duct system. Because the vents were not controlled electronically, the customer was unable to leverage its Energy Management System to produce electric savings from the VFDs. The supply and return air fans were still operating at the same loading patterns that were used prior to the retrofit. The building engineer indicated that the company hoped to retrofit the vent controls in the future so that fan motor savings could be realized, but had no immediate plans to do so.

8.2 Program Description and Objectives

The Efficiency Plus Business program was a comprehensive non-residential program that offered incentives to encourage the installation of high efficiency equipment and building improvements to reduce energy costs. Customers could apply for both incentives and financing for their projects. This evaluation only examines the incentive portion of the program; it did not include financing projects. The program offered both a prescriptive and custom measure path for incentives. Prescriptive incentives address lighting, HVAC, motors and drives, and commercial cooking equipment. Custom incentives were offered for projects that were more complicated in scope or unique to the facility. Table 8-1 shows the time period when rebates were available and the maximum rebate amount for both the custom and prescriptive measure path.

Table 8-1: Effective Dates and Rebate Limits by Measure Path

Measure Path	Pre-approval required	Audit required	Effective dates	Limits
Custom Incentives	No	Until June 2011	December 2009-September 2011	Up to $20,000 ($26,000 for non-profits) through July 2011 and then increased to $50,000 ($65,000 for non-profits)
Prescriptive Incentives	No	Until June 2011	December 2009-September 2011	

The Efficiency plus Business program launched in December of 2009 and underwent a redesign in June of 2010. The redesign was intended to address some of the program barriers that were a result of the ARRA funded program having to comply with the Davis-Bacon Act. For example, under the initial program rules, weekly reporting about the project status was required as soon as the project was pre-approved. Customers reported that the reporting requirements were a significant barrier. As a result, the program dropped the pre-approval requirement. A total of 253 rebates were issued to Delaware businesses through the program. The majority of the rebate participants used prescriptive incentives, with lighting being the most frequently installed measure. This is common for young programs because prescriptive projects are generally easier for customers to implement. Custom projects are often larger and more complex and take a much longer time horizon to complete. Programs often rely largely on prescriptive projects to generate most of the savings for the first few years. For the Efficiency Plus Business program, only 34 projects followed the custom path, but these projects accounted for a large share of the reported savings. Table 8-2 presents the rebate amounts and the ex ante savings values, by measure path.

Table 8-2: Rebate Amounts, Ex-Ante Energy, Demand and Gas Savings by Measure Path

Measure Path	Number of Rebates	Incentive Amount	Electric Savings (kWh)	Demand Savings (kW)	Gas Savings (MMBTU)
Custom	34	$420,548	4604444	634	3528
Prescriptive	219	$1,304,688	8598426	1391	3991
Total	**253**	**$1,725,235**	**13202870**	**2025**	**7520**

The program implementer conducted outreach activities to distributors and contractors (trade allies) as well as end users. Rebate aggregators reportedly also played a significant role, bringing a variety of projects to the program. The program implementer indicated that a few lighting contractors were very active in the program.

8.3 METHODS AND APPROACH

In support of the process and impact analyses, the evaluation team implemented a variety of data collection and research efforts. In Table 8-3 below, we describe each of the activities and the intended outcome.

Table 8-3: Evaluation Activity and Outcome

Activity	Process	Ex Post Verification	Outcome
Program Material review	X		• Gain understanding of program processes and procedures • Gain knowledge of program marketing strategy and tactics
Database Review	X	X	• Capture tracked savings numbers and compare with reported results
Program and Implementation Staff Interviews	X	X	• Gain knowledge of program design and implementation • Develop understanding of processes and procedures
Participating Customer Interviews	X	X	• Explore a variety of process-related aspects including program marketing implementation and customer satisfaction • Gain understanding of how the program changed customer behavior • Review of technical aspects of implemented projects
Desk Review of Prescriptive and Custom Projects (33)		X	• Review the project application, supplied calculations, and additional information available in the project files • Determine the appropriateness of assumptions • Create a site-specific M&V plan
Participating Customer Site Visits (33)	X	X	• Confirm site conditions and equipment installation • Gather information about the building characteristics and technical aspects of the implemented projects so that a verified savings estimate can be produced

Impact Evaluation

The impact evaluation activities were undertaken to verify measure installations and persistence of savings and included a review of the engineering assumptions and methodologies used to calculate savings. For each evaluated project, the evaluator reviewed the accuracy and reasonableness of the Measurement and Verification (M&V) approach used by the contractor/trade ally and approved by the program implementation contractor. We used the on-site inspection to verify measure inputs and assess the independent variables used to calculate savings. We also used the on-site visits to collect information on “lost-opportunity” and identify measures that can be targeted by future programs.

For purposes of the impact evaluation, each distinct rebate number was considered its own project. A stratified random sample was drawn from all program participants and the type of evaluation activity performed for each project was a function of the stratum. The stratification is based on total project size (kWh savings and MMBTU savings), and a Neyman Allocation was used to determine the number of sampled projects in each stratum. As a result, the impact evaluation sample is focused heavily on the projects with the largest contribution to program savings. We sampled 33 projects to provide a targeted precision of ±15% at the 90% confidence level. Table 8-4 provides the stratum breakpoints, the number of projects from each measure path that fall in each stratum, the required sample size from each stratum, and the level of rigor of the audit activities.

Table 8-4: Efficiency Plus Business Impact Evaluation Sample Design

Stratum	Prescriptive Projects in Population	Custom Projects in Population	Stratum Boundaries	% of Program Savings in Stratum	Prescriptive Projects in Sample	Custom Projects in Sample	Audit Activities
1	177	16	0 to 55,000 kWh	15.5%	2	2	Engineering Review and Low Rigor On-Site Inspection
2	32	11	55,000 kWh to 291,000 kWh	31.9%	12	2	Engineering Review and Low Rigor On-Site Inspection
3	10	7	Greater than 291,000 kWh	52.6%	8	7	Engineering Review and High Rigor On-Site Inspection

For Stratum 3 (representing the largest projects), we selected a census of custom projects and 80% of prescriptive projects for evaluation. For Stratum 3 projects, we conducted a detailed engineering review of the project files and a site inspection, which included spot measurements and/or short-term metering. In several cases, the participant was conducting metering activities and we used that data instead of installing separate metering equipment.

Audit activities for Stratum 1 and 2 projects included a basic rigor desk audit of project documentation and a site inspection to verify the measure installation and record operating characteristics, which affect the savings calculation. We deployed metering equipment for one Stratum 2 project where the evaluator identified a parameter that required logging to return a reliable savings estimate.

Process Evaluation

We gathered data for the process evaluation through surveys and interviews with program participants. In many cases, an individual was associated with a number of projects in the database (e.g., a chain participated in the program and installed measures in multiple locations across the state). As a result, the total number of individuals available for process interviews was 113 even though the number of projects in the database was 253. We conducted the process evaluation concurrently with the impact evaluation. First, Nexant conducted process interviews with customers during the on-site visits. Nexant was able to complete 25 interviews during the 33 project site visits.

After completion of the on-site visits, Opinion Dynamics contacted the remaining 80 customers for phone surveys, with 31 customers completing the survey. The combination of efforts (on-sites and phone survey) resulted in feedback from 56 individuals, which are slightly more than half of the unique individuals associated with projects in the database.

Measurement and Verification Activities

We used a number of M&V approaches in the impact evaluation to generate ex post savings estimates. We used each of the four International Performance Measurement and Verification Protocol (IPMVP) approaches to evaluate project savings. Table 8-5 shows the frequency of each M&V technique, the measure categories it was used for, and the number of logging devices deployed to measure key parameters.

Table 8-5: Impact Evaluation M&V Approach

IPMVP Approach	Measure Category	Count of Projects	Number of Loggers Deployed
Option A - Partially Measured Retrofit Isolation	Lighting	21	18
	Building Envelope	1	0
Option B - Retrofit Isolation	Computer Room Air Conditioning (CRAC)	2	0
	Refrigeration Motors	1	0
	Variable Frequency Drive (VFD)	5	14
Option C - Whole Facility Billing Analysis	HVAC (Boiler)	1	0
Option D – Calibrated Simulation	HVAC	1	0
	New Construction	1	0

The most commonly used approach was an Option A analysis, where a combination of measured and stipulated values are used to calculate savings. Option A is an ideal approach for lighting retrofit projects. This is because accurate stipulated wattage values are available for most fixture types so it is typically not necessary to meter power consumption. The uncertainty in a lighting retrofit project comes from the hours of operation, so this parameter is measured with lighting loggers or calculated based on the building operating schedule.

We deployed a total of 18 lighting loggers to capture fixture run times for lighting retrofit projects. We deployed the lighting loggers for 3-4 weeks and extrapolated the data to return an annual hours-of-operation figure. Short-term logging was especially critical for projects where occupancy sensors were installed because they provided insight into how often the sensors were shutting off lights in a given building zone.

We used an Option B analysis for seven projects in the evaluation sample. The measure category for five of these projects was a variable VFD on HVAC system motors. A total of 14 loggers were installed on these motors to measure AC current (amps) for 3-4 weeks. We took spot power measurements prior to logger installation to collect the voltage and power factor of the motor under retrofit operating conditions. We used these values to calculate power consumption over the logging period and subtracted them from an estimate of the power consumption under the baseline operating

conditions. One of the participants who implemented a computer room air conditioning (CRAC) measure had metered each of the 30 CRAC units in the facility separately for approximately 18 months prior to measure installation and the 12 months since measure installation. This allowed the evaluator to perform an Option B analysis without installing any logging equipment.

We used an Option C analysis as the primary approach for only one project in the impact evaluation, although we conducted a billing analysis for several other projects to confirm results found using other methodologies. An Option C analysis is a good fit if data is available both before and after the retrofit, the savings are greater than 10% of the total facility consumption, and the data can be weather normalized. We conducted a billing analysis on one project where a gas boiler was replaced by a new high-efficiency gas boiler. Because the building's heating and water-heating systems were the only gas loads in the building, the monthly consumption was highly correlated to local weather patterns. We performed a regression analysis with monthly gas consumption as the dependent variable and Heating Degree Days (HDD) as the independent variable for both the baseline and retrofit periods. We used the difference in the coefficients on the HDD term and 30-year average weather patterns to calculate the average annual savings of the measure. All billing data that was available for the evaluation was volunteered by the participant. An Option C analysis would have been a good approach for several other projects in the impact evaluation sample if the data had been available through the participant's electric or gas utility.

The M&V approach for two projects utilized eQUEST building energy simulation software. This is an Option D approach and requires that two models be created for each project, one for the baseline condition and one for the retrofit condition. In the case of new construction, the baseline condition is what is required by local building code. We used information collected during the site inspection to make the simulation as accurate as possible. Next, we calibrated these models using historical billing data and local weather patterns. The verified savings estimates for the project are the difference in the annual electric, peak demand and annual gas consumption between the baseline model and the retrofit model. Details about the projects selected for evaluation can be found in Appendix I to this report.

8.4 RESULTS

We developed ex post savings estimates for each project in the evaluation sample and compared them to the ex ante savings to calculate a project-level realization rate. We aggregated these project-level realization rates at the stratum level and applied the aggregated values to all projects in the stratum whether they were part of the evaluation sample or not.

Program Goals and Results

As illustrated in Table 8-6, the overall program-level ex-post savings for KW and kWh closely matched the reported ex ante savings; however, it is important to note that although the final, program-wide values matched, there was a significant amount of variance in ex post and ex ante savings at the project level. In some cases, the savings were significantly overestimated and in others, the savings were significantly underestimated. Even though, in aggregate, these over and under estimations balance out to bring the realization rates for KW and kWh close to one, there was some room for improvement regarding the accuracy of the engineering work. Additionally, this wide variance decreased the precision of the overall program-wide measurement as discussed in the key findings.

The ex post natural gas savings (reported in MMBTU) were significantly lower than the ex ante savings, resulting in a realization rate of .69. This was the result of serious errors discovered in the

reported gas savings calculations for two of the three evaluated projects in Stratum 3.

Table 8-6. PY1 Program Goals and Results

	Ex-Ante Gross Savings	Ex-Post Gross Savings	Realization Rate
kWh	13,202,870	13,280,201	1.006
KW	2,024.5	2,132.1	1.053
MMBTU	7,519.5	5,209.1	0.69

Table 8-7 provides the ex ante and ex post kWh savings, the kWh realization rate and coefficient of variation for each stratum, as well as the Efficiency Plus Business program as a whole. Notice that the savings from Stratum 1 and Stratum 3 were under realized, but the savings from Stratum 2 were over realized. As a result, the ex post energy savings of the program were very close to the ex ante savings. This shows that, while there was considerable variation in the relationship between reported and verified savings at the project level, the differences were minimal when averaged out and applied to the program population.

Table 8-7. Comparison of Ex Ante and Ex Post Electric Energy Savings

Stratum	% Lighting Projects in Evaluation Sample	Ex Ante kWh Savings	Ex Post kWh Savings	Realization Rate kWh	Coefficient of Variation (C_v)
1	75%	2,291,145	1,274,106	0.556	0.732
2	80%	4,414,295	6,506,671	1.474	0.582
3	40%	6,497,429	5,499,424	0.846	0.559
Total	**64%**	**13,202,870**	**13,280,201**	**1.006**	**0.593**

The ex ante peak demand (kW) savings values were generated using a deemed coincidence factor which allocates a percentage of the in-use demand savings to the peak demand period. This can produce artificial peak demand savings from measures such as streetlights that operate only at night because these lamps are not actually on during a period of peak demand. The ex post demand savings analysis used actual building operating schedules, when available, to estimate the demand reduction which occurs during the PJM defined peak window. PJM Manual 35 includes the following definition. “The Summer peak period is defined as June through August non-holiday weekdays from 14:00 to 19:00.” Table 8-8 presents the ex ante and ex post kW savings, the peak demand realization rate, and coefficient of variation for each stratum and the entire program. The relationship between the reported and verified peak demand impacts follows a similar pattern to the energy impacts. The ex post peak demand savings estimate for the program is approximately 108 KW higher than the ex ante peak demand savings figure.

Table 8-8. Comparison of Ex Ante and Ex Post Peak Demand Savings

Stratum	Ex Ante kW Savings	Ex Post kW Savings	Realization Rate KW	Coefficient of Variation (C_v)
1	419.36	254.13216	0.606	0.616
2	675.55	1107.36156	1.639	0.691
3	929.62	770.65498	0.829	0.463

Stratum	Ex Ante kW Savings	Ex Post kW Savings	Realization Rate KW	Coefficient of Variation (C_v)
Total	2024.5	2132.1	1.053	0.559

Only twelve projects completed through the Efficiency Plus Business program reported natural gas savings. Four of these projects, representing 78% of the programs natural gas savings, were selected as part of the impact evaluation sample. The population of the gas projects was limited and the evaluation team focused its efforts on large projects that represented the greatest amount of natural gas savings. About 74% of the natural gas savings achieved through the program was concentrated in Stratum 3. All projects in Stratum 3 were evaluated, one in Stratum 2 was evaluated and no projects in Stratum 1 were evaluated. The stratum of the sample is illustrated in Table 8-9.

Table 8-9. Energy Savings and Projects by Stratum

Stratum	Number of projects	Percent of ex-ante savings	Number of projects evaluated
1	4	3%	0
2	5	23%	1
3	3	74%	3

None of the projects completed in Stratum 1 were evaluated and the ex post savings are equal to the ex ante savings. One Stratum 2 project evaluated, and resulted in a Stratum 2 realization rate of 1.04. Serious errors were discovered in the reported gas savings calculations for two of the three evaluated projects in Stratum 3[80]. These two projects alone account for 16% and 35%, respectively, of the reported natural gas savings for the program. The realization rate and ex post savings values for Stratum 3, and the program as a whole, are significantly impacted by these two projects. Table 8-9 presents the ex post natural gas savings, the natural gas realization rate, and coefficient of variation for each stratum and the entire program. The ex-post gas savings estimate for the Efficiency Plus Business program is approximately 2,300 MMBTU lower than the ex ante natural gas savings estimate.

Table 8-9. Comparison of Ex-Ante and Ex-Post Savings

Stratum	Ex-Ante Gas Savings (MMBTU)	Ex-Post Gas Savings (MMBTU)	Realization Rate Gas Savings	Coefficient of Variation (C_v)
1	240.6	240.6	*1.00	NA**
2	1,743.6	1,813.3	1.04	NA**

[80] One project claimed gas savings for heating but the site inspection revealed it to have electric heat yielding a realization rate of 0.0. The ex post savings for the second project was impacted by an incorrectly applied algorithm. In this project the rebates were paid for the replacement of seven gas heat rooftop units (RTUs). The savings claimed was based on the square footage of the entire building instead of the area conditioned by the RTUs incentivized.

Stratum	Ex-Ante Gas Savings (MMBTU)	Ex-Post Gas Savings (MMBTU)	Realization Rate Gas Savings	Coefficient of Variation (C_v)
3	5,535.3	3,155.1	0.57	0.653
Total	**7,519.5**	**5,209.1**	**0.69**	**0.653**

*None of the evaluated projects in Stratum 1 reported natural gas savings so the ex post gas savings estimate was assumed equal to the ex ante savings estimate.

**No Coefficient of Variation is reported for Stratum 1 because no projects from this stratum were in the sample and for Stratum 2 because only one project was evaluated.

DNREC was also interested in exploring any potential differences between the custom measure path and the prescriptive measure path. Table 8-10 shows the realization rate and the coefficient of variation for energy savings, demand savings, and gas savings. It is important to note that while the sample design for the impact evaluation targeted 90% confidence and 15% precision at the program level, the statistical significance of the realization rate estimates contained in Table 8-10 are lower due to reduced sample size.

Table 8-10. Realization Rates and Coefficients of Variation by Measure Path

Measure Path	% Lighting Projects in Evaluation Sample	Realization Rate kWh	C_v kWh	Realization Rate kW	C_v kW	Realization Rate of Gas Savings	C_v Gas Savings
Custom	55%	0.919	0.638	0.986	0.430	1.05	0.370
Prescriptive	68%	1.008	0.642	1.093	0.907	0.16	0.383

Energy and demand savings from the custom measure path were realized at a slightly lower rate than energy savings and demand from the prescriptive measure path for the Efficiency Plus Business program. Ex post energy and demand savings estimates were very similar to ex ante savings estimates at the measure path level, despite significant variation at the project level. As Table 8-10 shows, the realization rate of gas savings for the prescriptive measure path was extremely low. This is a function of the small number of gas savings projects in the prescriptive evaluation sample and the low verified savings numbers of those two projects.

The expectation is that ex ante estimates of prescriptive savings would be more accurate than the ex ante estimates of custom savings because there is less uncertainty associated with the savings from prescriptive measures. This was not the case with the Efficiency Plus Business program. We observed considerable variation in the energy savings estimates for both measure paths, and the demand savings estimates for the custom measure path were actually much more consistent than the demand savings for the prescriptive path.

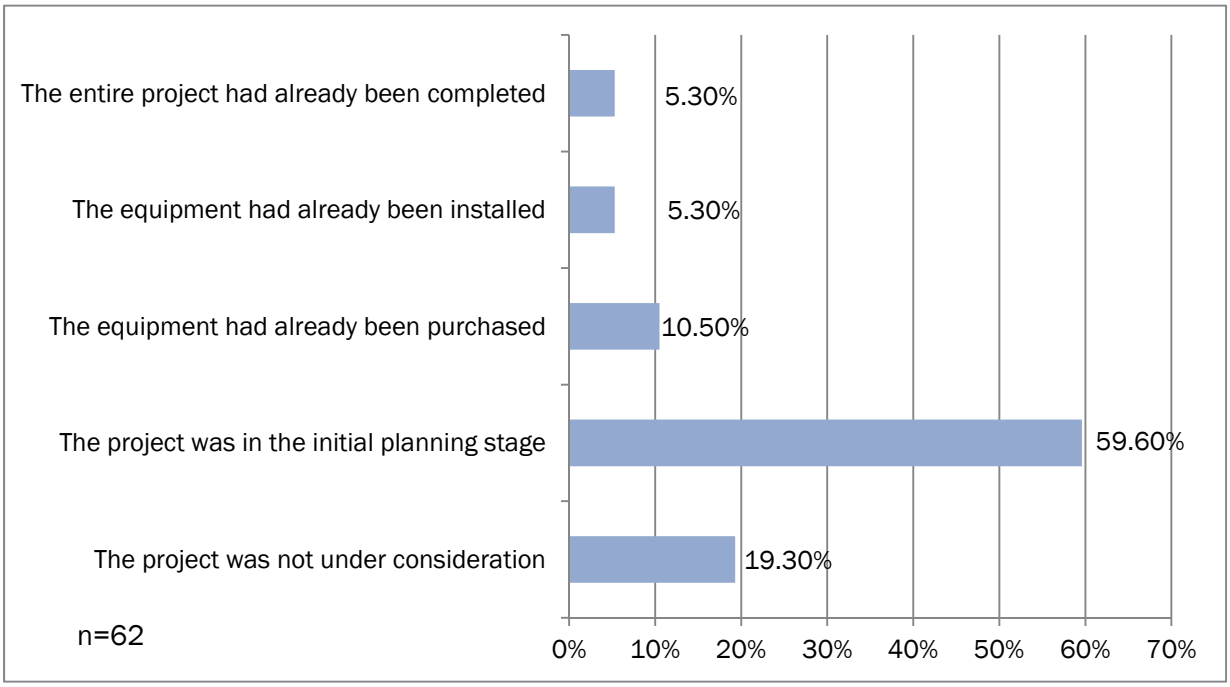
Impact of Incentives

In addition to the gross savings review, the evaluation team conducted a survey of participants to determine how much the program impacted their decision to implement projects. The program can influence the timing of projects, by expediting projects that would have otherwise been put off into the future, and the efficiency level of the equipment purchased, by encouraging customers to go beyond standard practice. Net savings, the energy savings that can be attributed to the program, were not calculated. However, customer responses obtained through the participant survey and on-site customer interviews provide insight into the impact the program had on their decision to

complete projects.

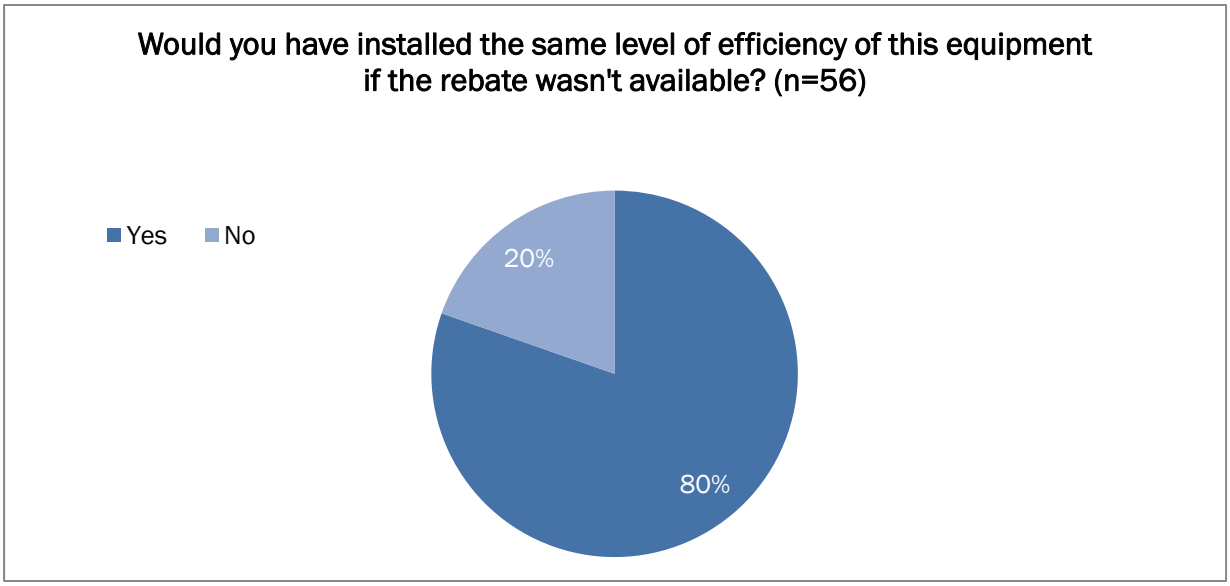
As illustrated in Figure 8-1, most customers (almost 80%) reported their project was either in the initial planning stage or that the project was not under consideration when the customer learned of the incentive. This is significant because it reveals that the implementer was able to reach customers at the time when they were making decisions about the purchase of energy efficient equipment. Twenty percent of the customers reported that they had already made the purchasing decisions when they learned of the incentive and this could be indicative of freeridership. Five percent reported that the project was complete and another five percent reported the equipment had already been installed when they learned about the incentive.

Figure 8-1. Project Stage When Learned of Incentive



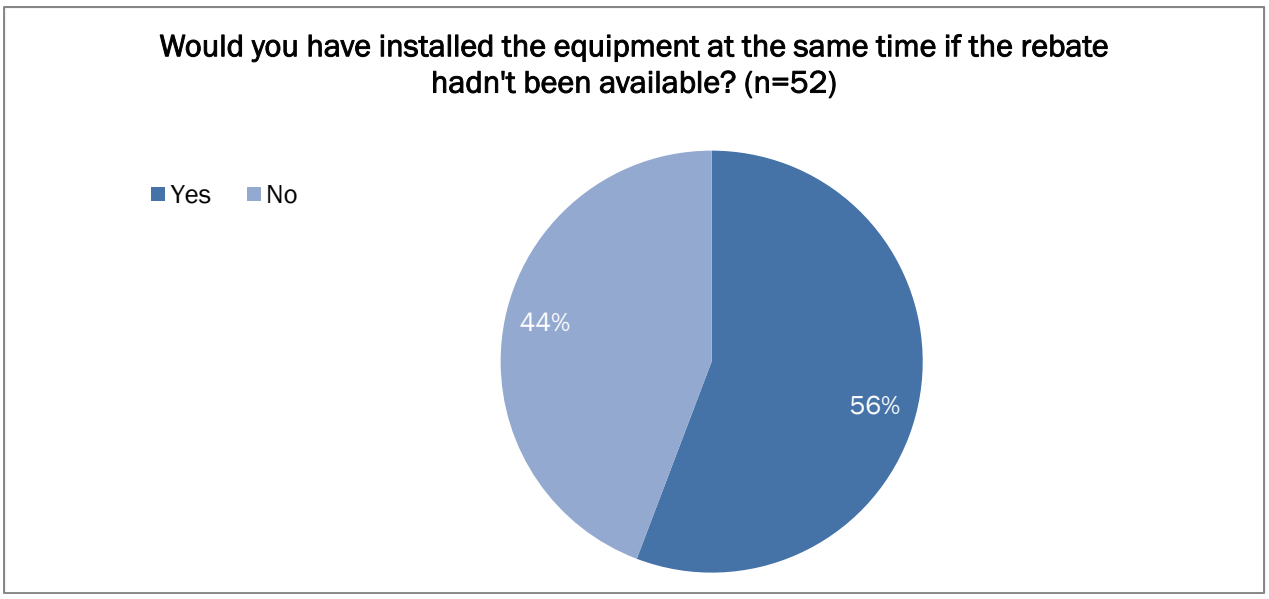
Although, in most cases, the program implementer was in discussions with the program participant early in the process, customers reported that the incentive did not influence or change the efficiency level of the equipment that they installed (Figure 8-2). Assuming their program experience did not influence their answer to this question, this is indicative of a high level of program freeridership (note: freeriders are considered to be customers who would have installed the same efficiency level of equipment in absence of the program). Given that the program did reach customers, for the most part, early in the decision-making process, the primary way to mitigate freeridership going forward is to raise the energy efficiency requirements for equipment incentivized through the program.

Figure 8-2. Influence of Incentive on Efficiency Level



More than half of customers reported that they would have installed the equipment at the same time. This is significant because it means that the program did not necessarily induce customers to complete projects sooner, which decreases the influence of the program on projects.

Figure 8-3. Influence of Program on Project Timing

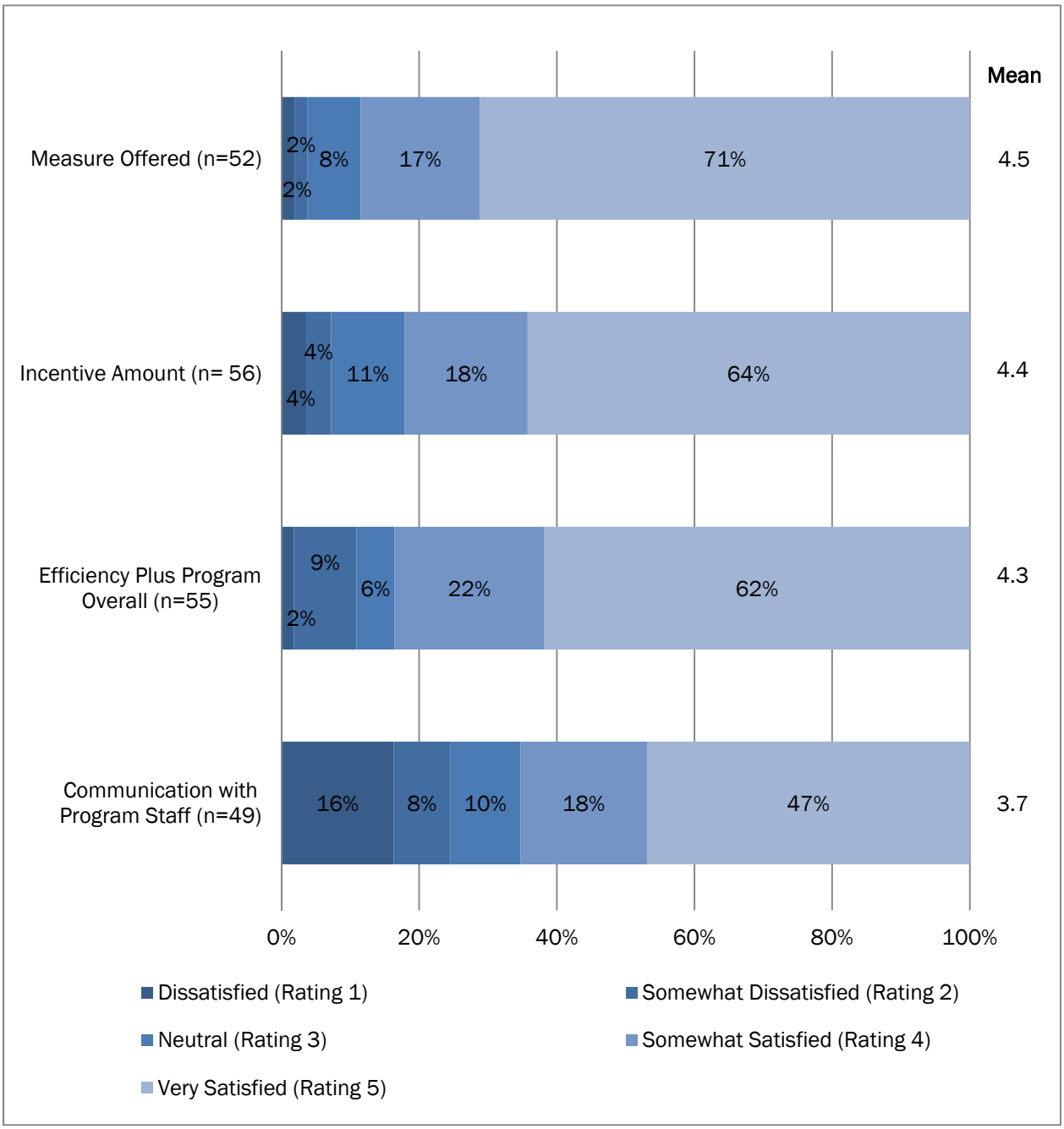


As previously mentioned, calculating actual net savings was not in the scope of this evaluation. However, the survey data would appear to be indicative of high free ridership. Future efficiency programs for businesses customers will need to directly address this issue.

Customer Satisfaction

Overall program satisfaction was high with customers reporting that they were most satisfied with the measures and incentives offered through the program and least satisfied with the communication with program staff.

Figure 8-4. Efficiency Plus Business Program Satisfaction



8.5 RECOMMENDATIONS

In addressing the key findings from the evaluation, the Evaluation Team recommends the following to improve the performance and achievements of the Efficiency Plus Business program:

- Accurate and reliable ex ante savings estimates reduces discrepancies between the reported and verified savings figures and increases the precision of the evaluation results. It is not always practical to get actual baseline equipment information in prescriptive programs, but we would recommend that actual pre-existing conditions be required as a part of the application process for custom projects. The evaluation team recommends that savings values for prescriptive measures require the use of the baseline data from the Delaware baseline study and algorithms provided in the Delaware TRM to determine energy savings values. The TRM requires specific baseline fixture wattages and provides Delaware-specific deemed values or algorithms for calculating electric energy savings, peak demand savings, and fossil fuel energy savings on a per measure basis. A transition to more specific savings algorithms and proper application of these algorithms will be critical in the future.

- It is recommended that savings values and calculations be subjected to a Quality Assurance/Quality Control (QA/QC) process prior to being finalized. This would apply for prescriptive savings as well as custom calculations.

- Interviews with customers revealed that many customers would have completed the projects without the program. Given that, the program did reach customers, for the most part, early in the decision-making process. In order to mitigate freeridership going forward would be to raise the energy efficiency requirements for equipment incentivized through the program and/or to put a QA/QC process in place to ensure that projects completed before the customer learned of the incentive are not incentivized.

- Several onsite inspections revealed that some customers were not using their new energy efficient equipment appropriately and that there were still opportunities for energy efficiency improvements at the sites. In order to not lose those opportunities, the evaluation team recommends that technical support be offered to participating customers in future.

A. Home Performance HVAC Equipment Path Evaluation

The HVAC Equipment Path of the Home Performance Program provided incentives for installing efficient central AC systems, heat pumps, furnaces, and boilers. Savings are based on equations from the Mid-Atlantic TRM, assuming equipment is replaced at the end of its useful life. Savings are therefore calculated based on comparing the energy and demand of new equipment to equipment that just meets federal efficiency standards. Table A-1 lists the federal minimum standards and the program minimum standards for the equipment installed under the HVAC Equipment Path.

Table A-1 Federal and Home Performance Program Minimum Efficiency Standards

Equipment Type	Federal Minimum Standards	Program Minimum Standards
Central AC Systems	SEER 13 EER 11	SEER 16 EER 13
Heat Pumps	SEER 13 EER 11 HSPF 7.7	SEER 15 EER 12.5 HSPF 8.5
Gas Boiler	80% AFUE	90% AFUE
Gas Furnace	80% AFUE	92% AFUE
Oil Boiler with temperature reset	80% AFUE	86% AFUE
Oil Boiler with thermal purge	80% AFUE	86% AFUE
Oil Furnace	80% AFUE	86% AFUE

Key: SEER = Seasonal Energy Efficiency Ratio; EER = Energy Efficiency Ratio; HSPF = Heating Seasonal Performance Factor; AFUE = Annual Fuel Utilization Efficiency

Our evaluation of this path of the program included reviewing the equipment and savings information in the program tracking spreadsheet. We checked 1) the sizes of equipment to see if they were reasonable, and 2) whether equipment met the efficiency standards listed in Table A-1, above. We found 14 pieces of ineligible equipment. Savings for this equipment was set to zero, and they were removed from the equipment counts:

- Two Central AC Systems had SEER less than 16
- Five Central AC Systems had EER less than 13

- Four Heat Pumps had EER less than 12.5
- Two Heat Pumps had HSPF less than 8.5 and EER less than 12.5
- One gas furnace had a capacity of zero Btuh (the tracked savings were already equal to zero)

We also checked the savings algorithm for each type of equipment. We found these to be reasonable.

Tables A-2, A-3, and A-4 show the tracked and evaluated gross program savings for electricity, natural gas, and gallons of oil. The small reductions in evaluated savings are the result of the 14 pieces of ineligible equipment.

Table A-2. HVAC Equipment Path Electric Cooling Measures

Electricity Measures	Gross Tracked				Gross Evaluated				Realization Rates	
	Number	Tons	kWh Savings	kW Savings	Number	Tons	kWh Savings	kW Savings	kWh	kW
Air Source Heat Pumps	677	1,900.5	647,213	183.0	671	1,881.5	643,367	181.8	0.994	0.994
Central A/C Systems	625	1,889.0	188,708	220.4	618	1,863.0	186,173	218.3	0.987	0.990
TOTAL	1,302	3,789.5	835,920	403.5	1289	3,744.5	829,541	400.1	0.992	0.992

Table A-3. HVAC Equipment Path Natural Gas Heating Measures

Natural Gas Measures	Gross Tracked			Gross Evaluated			Realization Rates
	Number Installed	MBTUh Installed	Therm Savings	Number Installed	MBTUh Installed	Therm Savings	
Gas Boilers	46	5.41	6,129	46	5.41	6,129	1.000
Gas Furnaces	1,850	153.92	192,890	1,849	153.92	192,779	0.999
TOTAL	1,896	159.33	199,019	1,895	159.33	198,909	0.999

Table A-4. HVAC Equipment Path Oil Heating Measures

Oil	Gross Tracked	Gross Evaluated	Realization

Measures	Number Installed	MBTUh Installed	Gallon Savings	Number Installed	MBTUh Installed	Gallon Savings	Rates
Oil Boilers (temperature reset)	13	1.39	562.0	13	1.39	562.0	1.000
Oil Boilers (thermal purge control)	1	0.08	31.4	1	0.08	31.4	1.000
Oil Furnaces	6	0.59	274.1	6	0.59	274.1	1.000
TOTAL	20	2.06	867.5	20	2.06	867.5	1.000

B. Home Performance Standard and Performance Program Evaluation Process & Results

The Standard and Performance Path projects were evaluated by reviewing a sample of 43 projects. For each project, we received the following pieces of information:

- The program tracking database for the Standard and Performance Path projects, which includes measure types, demand savings, energy savings by fuel type (kWh, therms, gallons of oil, and gallons of propane), and program rebates.
- Beacon reports – output files from ICF's proprietary Beacon energy modeling tool, which includes information about the home and its equipment characteristics, current levels of energy use, air leakage test information, recommended efficiency measures, and estimated energy savings by end use of the packet of recommendations.
- Invoices for equipment purchase and/or installation.
- Certificates from AHRI listing equipment efficiency.
- Post-installation test and inspection reports, listing air leakage test results, and listing installed measures.

Tracking Database Review

There are a few characteristics about the tracking database for Performance and Standard Path projects, which made it challenging to understand and work with:

- Gallons of propane are tracked in the "Annual Cords" field. For clarity, this field should be named "Annual Propane Gallons" and the "Annual Gallons" field named "Annual Oil Gallons".
- There are many more fields available to track information about the installed equipment, but these fields were blank in the version of the database we received. For example, for air conditioning equipment, tons, EER values, or hours of use were not recorded. Make and model numbers were only recorded in a few instances. For heat pumps, the database contains SHPF, but not SEER, EER, tons, or Btu.
- The database also included HVAC Equipment Path projects, but not their energy savings.
- Measures that engendered both heating and cooling savings were tracked as two individual measures. For example, all heat pumps were tracked as both a heat pump and a central AC system, with winter heating energy savings tracked under the heat pump measure, and summer cooling savings tracked under the central AC system. Thermostats and ECM fans were also tracked using separate heating and cooling measures.

  While the energy savings were estimated correctly, care had to be taken to not double count measures in this evaluation. Any projects that had both a heat pump and a central AC system were assumed to have installed just a single heat pump. Projects that installed a Heating Thermostat and a Cooling Thermostat were assumed to have installed a single programmable thermostat that controlled both heating and cooling systems. Projects that

installed an ECM Fan/Heating plus an ECM Fan/Cooling were assumed to have installed a single fan that worked year-round to deliver hot or cold air from the heating and cooling equipment through a home's ductwork.

It is unclear why these measures are tracked this way. We recommend that this practice be discontinued, as it does not reflect actual equipment installations. A simple count would over-state the incidence of these measures.

- Many projects tracked negative energy savings for heating or water heating equipment. These negative savings were due to a fuel switch. A home replacing an oil furnace with a gas furnace would show a large positive oil savings, and a large negative gas savings. A home replacing a gas water heater with an electric water heater would show positive gas savings, and negative electricity savings. The negative savings are essentially penalties that are accrued to the new fuel type. This type of accounting is the correct way to track the fuel switch savings.

  However, savings from other measures in projects with fuel switching were often tracked incorrectly. Measures that generate heating savings (insulation, air sealing, duct sealing, and insulation), and measures that generate water heating savings (tank wrap, pipe insulation, low flow faucet aerators, and low flow showerheads) have their savings tracked in the old system fuel. If the heating or water heating equipment is replaced with equipment using a different fuel, then savings of all associated heating or water heating measures should be tracked in the new fuel type.

  Fuel switching is a big part of the Performance and Standard Path programs. Table B-1 shows that fuel switching occurred on 38% of heating and water heating installations. The most common types of fuel switches for each type of equipment are also listed in Table B-1, but there are switches occurring between fuels of all types for all of this equipment. And even if natural gas, oil, and propane are not the primary concern of any future program, many of the fuel switches are to or from electricity. It is important to track the impacts of fuel switching correctly.

Table B-1. Fuel Switching of New Heating and Water Heating Equipment in Standard and Performance Path Projects

Equipment	Total Installed	% with Fuel Switch	Number of Switches	Most Common Switch
Heat Pump	483	61%	300	to electricity from gas (159) or oil (93)
Furnace	514	16%	85	to gas from oil (59)
Boiler	45	33%	15	to gas from oil (11)
Water Heater	163	35%	60	to gas (19) or propane (12) from electricity
Total	1,205	38%	459	

Beacon Report Review

We reviewed information from the Beacon reports about the characteristics of each home and of the recommended efficiency measures, checking if they seemed reasonable. No obvious errors were found.

Neither the Beacon program itself nor inputs were made available to us. In addition to characteristics about the home's configuration and systems, we assume that monthly utility bill information and initial leakage rates are input to Beacon. A set of recommended efficiency measures is also input.

The Beacon report also includes estimates of overall project energy savings, broken down by end use, but not by each particular measure. Implementation staff reported that there is a second output file used to populate the program database with individual measure savings. These files were not shared with us.

Program procedures require that once work in a home is complete, a final Beacon report is run, including only those measures that were actually installed (and not including measures recommended but not installed). This is the data that should be recorded in the tracking database. Our review of project files found that invoices and post-installation reports were lacking for one or more measures in a number of sampled projects. It is unclear whether this is the result of insufficient documentation or if some of the Beacon reports included in the program files represent recommended rather than installed measures.

Given that we were not provided with the Beacon software nor with all inputs and outputs, a detailed assessment of assumptions and algorithms embedded in Beacon was not possible. However, our review of project savings found significant differences between Beacon-generated tracked savings and estimates that are reasonable, based on deemed savings and other reputable sources.

We recommend that any software used in future programs be thoroughly reviewed and vetted to ensure that assumptions and algorithms are reasonable.

Verification of Measure Installation

In order to verify measure installation, we reviewed all project invoices and the post-installation test and inspection sheets. If a measure did not have either a supporting invoice or a listing on the inspection sheet, we noted this difference.

Table B-2 shows how many projects had measures that could not be verified. We were able to verify all the measures in 17 of our 43 sample projects. In 22 projects, there were 44 measures we could not verify. Analysis of four projects found four measures that were not tracked.

Table B-2. Verified Measure Installations by Project

	# Projects	Tracked Measures	Verified Measures	Difference
All measures installed	17	97	97	0
Not all measures installed	22	188	144	44
Extra measures installed	4	18	22	-4
Total	43	303	263	40 (13%)

Table B-3 shows that hot water,[81] insulation, and CFLs are the measures for which documentation was missing most often.

Table B-3. Verified Measure Installations by Measure Type

Measure Type	Tracked Measures	Verified Measures	Difference
Hot Water	46	22	24
Insulation	85	76	9
CFLs*	35	29	6
Windows / Doors	11	9	2
Heating	30	29	1
Cooling	48	48	0
Appliances	5	5	0
Air Seal / Ducts	43	45	-2
Total	303	263	40

* The number of CFLs in this table represents projects that included CFLs. Review of program files verified the installation of 714 out of 794 CFLs in our sample of 43 projects. Based on the participant survey, 76% of CFLs could be verified as being in place at the time the survey was conducted.

Calculation of Measure Savings

Our analysis of the measure savings calculations is presented in Appendix C.

[81] Thirteen of the 24 water heat measures with missing information are temperature turndown.

C. Home Performance Standard and Performance Program Measure Evaluation

Summary of Evaluated Measures

This appendix details the savings estimates developed for the evaluation of the sample of 43 Performance and Standard projects. Table C-1 summarizes the per unit savings (in MMBtu as well as kW) of each measure. Tracked savings are those contained in the program tracking database; evaluated savings are those we estimate are likely to be achieved by the installed measures. The table also presents two sets of realization rates. For both energy savings (expressed in a fuel-neutral value of million Btu, or MMBTU) and demand savings (in kW), the table presents three different realization rates:

- The installation realization rate (Install) reflects the percentage of tracked savings the program realized based on whether we could verify the installation of claimed measures. As explained above, to qualify as "verified" either an invoice or the post-inspection report has to show that the measure was installed.
- The measure savings realization rate reflects the difference in per unit savings between the tracking database and our estimates.
- The overall realization rate is the product of the installation rate and the savings rate. This rate reflects the total adjustment to tracked savings as a result of installations that could not be verified and of different per unit savings assumptions.

For this evaluation, we did not take into account the installation rate. As a result, the realization rate applied to program tracked savings was the Savings rate, rather than the Overall rate. However, the low installation rates for some measures indicate potential concerns about data tracking and documentation procedures.

Table C1: Summary of Tracked and Evaluated Savings and Realization Rates, by Measure

	Tracked Savings per measure			Evaluated Savings per measure			MMBTU RR			kW RR		
Measure	#	MMBTU	kW	#	MMBTU	kW	Install	Saving	Overall	Install	Saving	Overall
Cooling												
Cooling Systems	14	4.17	1.74	14	2.79	0.99	1.00	0.67	0.67	1.00	0.57	0.57
Cooling Tune-Ups	3	3.95	1.15	3	0.51	0.23	1.00	0.13	0.13	1.00	0.20	0.20
ECM Fans cooling	16	0.17	0.17	16	0.61	0.11	1.00	3.49	3.49	1.00	0.66	0.66
Thermostats - Cooling	14	0.24	-	14	0.15	-	1.00	0.61	0.61	--	--	--

Measure	Tracked Savings per measure			Evaluated Savings per measure			MMBTU RR			kW RR		
	#	MMBTU	kW	#	MMBTU	kW	Install	Saving	Overall	Install	Saving	Overall
Window AC	1	0.60	0.17	1	0.77	0.48	1.00	1.30	1.30	1.00	2.84	2.84
Heating												
Boilers	2	75.23	-	2	28.33	-	1.00	0.38	0.38	--	--	--
Furnaces	17	9.08	-	17	8.46	-	1.00	0.93	0.93	--	--	--
Heat Pumps	8	24.88	-	8	33.02	-	1.00	1.33	1.33	--	--	--
ECM Fans heating	14	1.58	-	14	0.82	-	1.00	0.52	0.52	--	--	--
Thermostats - Heating	7	14.10	-	7	12.15	-	1.00	0.86	0.86	--	--	--
Duct Work												
Duct Sealing Insulation	12	7.03	0.56	11	1.68	0.36	0.92	0.24	0.22	0.92	0.64	0.58
Air Sealing												
Air Sealing	31	8.74	0.08	34	6.43	0.32	1.10	0.74	0.81	1.10	4.17	4.58
Insulation												
Attic Insulation	27	10.57	7.55	27	9.74	0.08	1.00	0.92	0.92	1.00	0.01	0.01
Base/Crawl Insulation	11	5.60	0.08	9	5.54	0.07	0.82	0.99	0.81	0.82	0.94	0.77
Cantilever Insulation	2	0.37	0.01	1	0.31	0.00	0.50	0.83	0.41	0.50	0.48	0.24
Ceiling Over Garage	1	10.91	0.16	1	7.47	0.06	1.00	0.68	0.68	1.00	0.42	0.42
Exterior Wall Insulation	2	1.05	0.07	2	8.09	0.13	1.00	7.73	7.73	1.00	1.85	1.85
Floor over Crawl Insulation	4	1.26	0.01	6	2.93	0.03	1.50	2.33	3.50	1.50	1.94	2.91
Knee Wall Insulation	14	9.19	0.06	11	4.19	0.03	0.79	0.46	0.36	0.79	0.46	0.36
Rim Joist Insulation	23	0.98	0.02	20	0.72	0.01	0.87	0.74	0.65	0.87	0.40	0.35
Windows & Doors												

Measure	Tracked Savings per measure			Evaluated Savings per measure			MMBTU RR			kW RR		
	#	MMBTU	kW	#	MMBTU	kW	Install	Saving	Overall	Install	Saving	Overall
Windows & Doors	11	3.15	0.06	9	3.43	0.03	0.82	1.09	0.89	0.82	0.60	0.49
Hot Water												
Water Heaters	4	3.61	0.06	2	5.35	0.09	0.50	1.48	0.74	0.50	1.45	0.72
Pipe Insulation	9	0.21	0.00	5	0.44	0.00	0.56	2.07	1.15	0.56	1.20	0.67
Tank Wrap	7	0.72	0.01	3	0.30	0.01	0.43	0.41	0.18	0.43	0.47	0.20
Low Flow Showerheads	7	0.69	0.02	7	0.65	0.01	1.00	0.93	0.93	1.00	0.47	0.47
Faucet Aerators	5	0.16	0.00	5	0.33	0.00	1.00	2.04	2.04	1.00	1.31	1.31
Temp Turndown	13	6.19	0.08	0	-	-	-	0.14	-	-	0.10	-
Appliances												
Appliances	5	3.16	0.14	5	0.76	0.05	1.00	0.24	0.24	1.00	0.37	0.37
Lighting												
CFLs	794	0.36	0.02	714	0.20	0.01	0.83	0.61	0.51	0.83	0.50	0.41

The following sections provide more detailed information about the measures evaluated in our sample of 43 projects. For each measure, we explain the methodology used to determine evaluated savings and present a summary table that shows tracked savings, evaluated savings, and the savings realization rate. We note the number of measures that were tracked and the number of measures we could verify. However, the evaluated numbers are based on all tracked measures. They do not include a reduction in savings because installation could not be verified. As such, they represent our assessment of the per unit savings estimates used by the program.

It should be noted that for many measures, the sample size was very small. While our measure-level realization rates are not statistically significant, our evaluated savings estimates were made in accordance with well-documented references that represent a consensus about the average energy savings expected for a particular measure. Large variations from the evaluated savings are cause for concern about the tracked savings estimates.

We used the following energy conversion factors: 1 kWh = 3,413 Btu, 1 therm = 100,000 Btu, one gallon of oil = 139,000 Btu, and one gallon of propane = 91,000 Btu.

Cooling Equipment

The tracking database tracks cooling and heating savings separately, even if they are from the same heat pump measure. Our sample of 43 projects included 14 new central cooling systems, three cooling system tune-ups, 16 ECM Fans, 14 programmable thermostats, and one project where window AC units were replaced with a mini-split system. We were able to verify all of these installations.

New Cooling Systems

The 14 new cooling systems may have been central air systems or heat pumps, but only their cooling savings are evaluated here. Energy savings were estimated using equations from the Mid-Atlantic TRM. In addition, we used TRM assumptions about baseline equipment if this was not found in the project paperwork. Below are the total tracked and evaluated savings for these projects. We find both the energy and demand savings were overestimated in the tracking database, compared to the TRM assumptions.

Tracked Savings (14 units)		Evaluated Savings	
kWh	kW	kWh	kW
17,103	24.4	11,438	13.8
Saving Realization Rate		0.669	0.567

Cooling System Tune-ups

Our sample included three cooling system tune-ups. This measure is not included in the Mid-Atlantic TRM, but many other programs assume a tune-up reduces the annual energy use of a system by 5%. We used basic annual energy use equations and information on the existing systems to calculate energy and demand savings. We also used 10% savings instead of the typical 5%. Still, the tracked savings were much higher than our savings estimates.

Tracked Savings (3 units)		Evaluated Savings	
kWh	kW	kWh	kW
3,472	3.5	451	0.69
Saving Realization Rate		0.130	0.199

ECM Fans on Cooling Systems

Sixteen cooling systems in our sample included ECM fans. The tracked savings for these measures varied from project to project. The Mid-Atlantic TRM allocates savings of 178 kWh and 0.112 kW for each ECM fan used on a cooling system. Applying these values, evaluated energy savings are much higher than the tracked savings, but evaluated demand savings are lower.

Tracked Savings (16 units)	Evaluated Savings

kWh	kW	kWh	kW
817	2.7	2,848	1.8
Saving Realization Rate		3.486	0.659

Cooling System Programmable Thermostats

The sample included 14 programmable thermostats on cooling systems. The program assigned varying amounts of energy savings to each project, but no demand savings. Some of these thermostats were installed on new systems, and some on existing systems.

The Mid-Atlantic TRM assumes that a programmable thermostat reduces heating system energy use by 6.8%, but does not specify a cooling energy savings percentage. The New York State EEPS also refers to the 6.8% savings for heating, and quotes a 3% savings value for cooling (based on an Energy Star calculator). We used 3% of the annual energy savings of the new or existing systems, based on equations from the Mid-Atlantic TRM. When we had no information about the existing system, we used average characteristics for all existing systems with sufficient information in our sample of projects. Our savings estimates were lower than the tracked savings.

Tracked Savings (14 units)		Evaluated Savings	
kWh	kW	kWh	kW
1,001	--	608	--
Saving Realization Rate		0.607	--

Window AC

One project replaced window AC units with a mini-split system with very high SEER. We used the window AC calculations from the Mid-Atlantic TRM, and assumed that the system runs at full capacity when it is in use. The 17.5 SEER mini-split system is assumed to have a 13.5 EER.

Tracked Savings (1 unit)		Evaluated Savings	
kWh	kW	kWh	kW
175	0.17	226	0.48
Saving Realization Rate		1.295	2.843

Heating Equipment

Our sample included the installation of 2 boilers, 17 furnaces, 8 heat pumps, 14 ECM fans on heating systems, and 7 programmable thermostats controlling heating systems. There was also a significant amount of fuel switching, with 5 furnaces and 6 heat pumps using a different fuel from the heating system it replaced. We were able to verify all of these installations.

Boilers

The two boilers used natural gas and oil for fuel. We used the Mid-Atlantic TRM equations and assumptions to estimate their evaluated savings.

Because we did not know the size of the heating systems, we assumed that a 100,000 Btu/hour system would heat a typical 2,400 square foot home. We thus estimated the system size based on the home's square footage. Evaluated savings were lower than tracked savings for the natural gas boiler but higher for the oil boiler.

Tracked Savings (2 units)		Evaluated Savings	
therms	Oil gallons	therms	Oil gallons
1,358	106	389	127
Saving Realization Rate		0.287	1.208

Furnaces

Our sample included 17 new furnaces. Four of them switched from using oil to using natural gas, while one project switched from using an electric heat pump to natural gas. We used the Mid-Atlantic TRM equations and assumptions to develop evaluated savings.

Similar to boilers, we did not know the size of the heating systems and used the home's square footage to estimate the size of each furnace.

Tracked Savings (17 units, 5 fuel switches)				Evaluated Savings			
kWh	therms	Oil gallons	Propane gallons	kWh	therms	Oil gallons	Propane gallons
1,208	-1,361	2,046	21	4,067	-2,303	2,406	138
Saving Realization Rate				3.367	(1.693)	1.176	6.724

Heat Pumps

Our sample included eight heat pumps. Three of these involved switching from natural gas, two switched from oil, and one switched from propane. The program tracks cooling savings for these heat pumps separately, under AC systems. The demand savings of heat pumps occur during the cooling season, and are tracked under cooling systems. We used the Mid-Atlantic TRM equations and assumptions to estimate evaluated heating savings.

Similar to boilers and furnaces, we did not know the size of the heating systems and used the home's square footage to estimate the size of each heat pump.

Note that negative savings means that more of one type of fuel was used than before the project, due to fuel switching. Only two heat pumps were replacements of old heat pumps; the rest were switching fuels. Therefore, overall kWh savings of all eight heat pumps were negative. Our evaluated savings (and fuel switching penalties) were significantly higher than tracked values.

Tracked Savings (8 units, 6 fuel switches)				Evaluated Savings			
kWh	therms	Oil gallons	Propane gallons	kWh	therms	Oil gallons	Propane gallons
-18,362	1,295	752	303	-29,307	1,892	1,068	291
Saving Realization Rate				(1.596)	1.460	1.420	0.961

ECM Fans on Heating Systems

Our sample included 14 heating system ECM fans. The tracked energy savings for these measures varied from project to project. The Mid-Atlantic TRM allocates savings of 241 kWh and 0 kW for each ECM fan used on a heating system. Our evaluated energy savings are about half of tracked savings.

Tracked Savings (14 units)		Evaluated Savings	
kWh	kW	kWh	kW
6,479	--	3,374	--
Saving Realization Rate		0.521	--

Heating System Programmable Thermostats

Our sample included seven programmable thermostats on heating systems. The program assigned varying amounts of energy savings to each project, but no demand savings. Some of these thermostats were installed on new systems, and some on existing systems. The Mid-Atlantic TRM assumes that a programmable thermostat reduces heating system energy use by 6.8%. We used the Mid-Atlantic TRM equations and assumptions to estimate the systems' annual energy use, assuming 620 heating full load hours for all heating system types.

Because we did not know the size of the heating systems, we used the home's square footage to estimate the size of each system.

Not all of the projects correctly attributed thermostat savings to the correct fuel type. Incorrect assignment occurred most often on homes where new heating systems with a different fuel type were installed.

Tracked Savings (7 units)				Evaluated Savings			
kWh	therms	Oil gallons	Propane gallons	kWh	therms	Oil gallons	Propane gallons
8,012	418	154	90	2,515	490	127	109
Saving Realization Rate				0.314	1.172	0.826	1.208

Duct Sealing and Insulation

Our sample included 11 projects with duct sealing, and 1 project with both duct sealing and duct insulation. Two of these projects did not include any verification of installation, but one additional project recorded duct sealing in the post-installation inspection report, even though it was not tracked in the database.

We used equations and assumptions from the Mid-Atlantic TRM for duct sealing and insulation. We followed Method 2, which assumes some increase in duct efficiency due to sealing and insulation measures. We assumed that ducts that were sealed increased their efficiency from 66.5% to 79%, and ducts that were both sealed and insulated increased their efficiency from 63.5% to 80%.

If available, we used the SEER value of the existing or newly installed system, and if not we used a SEER of 10. For heat pumps, we used the HSPF of the existing or new heat pump to find the coefficient of performance (COP = HSPF/3.412). If the HSPF was unknown, we assumed a COP of 2.0. For furnaces and boilers, we used the AFUE of the new or existing system. If AFUE was unknown, we assumed 82%.

We used the actual cooling system tons when available, and assumed tons depending on the home's square footage when needed. We adjusted the sizes of furnaces or boilers by assuming a 2,400 square foot home is heated by a 100,000 Btu/h furnace, and used ratios to adjust heating capacity based on actual square footage of each home. When we did not know the square footage of a home, it was assumed to be 2,400 square feet.

Realization rates for duct sealing and insulation are quite low.

Tracked Savings (12 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
13,293	6.8	10	61	325	5,644	4.3	3	--	7
Saving Realization Rate					0.425	0.637	0.265	--	0.022

Air Sealing

Our sample included 31 projects with air sealing tracked in the database. However, a total of 34 sample projects recorded the implementation of various air sealing measures and performed the accompanying pre and post blower door tests to measure differences in building leakage; all 34 should have had energy savings tallied. Note that Sealing Attic Bypasses, Sealing Attic Access, and Sealing Recessed Lighting measures were tracked individually by the program, but no energy savings were directly associated with these measures. These projects contributed to the overall air sealing of each house, which was assessed by the use of blower door testing before and after air sealing was done.

We evaluated the energy savings of the air sealing projects using the equations and assumptions in

the Mid-Atlantic TRM. We assumed an N-factor of 18 for all homes. If available, we used the SEER value of the existing or newly installed system, and if not we used a SEER of 10. For heat pumps, we used the HSPF of the existing or new heat pump to find the COP (COP = HSPF/3.412). If the HSPF was unknown, we assumed a COP of 2.0. For furnaces and boilers, we used the AFUE of the new or existing system. If AFUE was unknown, we assumed 82%.

The evaluated energy savings tended to be lower than the tracked savings estimates; evaluated demand savings were higher.

Tracked Savings (31 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
9,842	2.4	1732	368	143	11,321	9.9	1,124	284	99
Saving Realization Rate					1.150	4.171	0.649	0.772	0.693

Insulation Measures

Our sample included various insulation measures, including insulation added to attics, walls, rim joists, knee walls, basement or crawlspace walls, floors over crawlspaces, ceilings over garages, and below cantilevered areas.[82]

We calculated energy savings for all insulation measures using the equations laid out in the Mid-Atlantic TRM for attic/roof/ceiling insulation. Baseline insulation R-values were set to a minimum of 5, or higher if the project paperwork gave evidence of existing insulation levels. Savings were determined based on the known efficiencies of the cooling and heating equipment installed in each home. If available, we used the SEER value of the existing or newly installed system, and if not we used a SEER of 10. For heat pumps, we used the HSPF of the existing or new heat pump to find the COP (COP = HSPF/3.412). If the HSPF was unknown, we assumed a COP of 2.0. For furnaces and boilers, we used the AFUE of the new or existing system. If AFUE was unknown, we assumed 82%.

Many of the insulation projects also involved a switch from one heating fuel to another. The tracked savings always attributed the energy savings to the original fuel. Our evaluation attributes insulation savings to the new heating fuel type, when the fuel type changes.

Attic Insulation

Tracked Savings (27 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
24,855	203.9	1,281	474	72	10,532	2.0	1,875	236	74
Saving Realization Rate					0.424	0.010	1.464	0.498	1.028

[82] Installation could not be verified for some projects in most insulation categories.

Basement/Crawlspace

Tracked Savings (11 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
6,583	0.86	25	85	273	2,168	0.80	113	13	444
Saving Realization Rate					0.329	0.935	4.557	0.154	1.627

Cantilever

Tracked Savings (2 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
20	0.01	4	--	3	4	0.01	--	--	7
Saving Realization Rate					0.195	0.482	--	--	2.322

Ceiling over Garage

Tracked Savings (1 unit)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
406	0.16	--	--	105	48	0.06	--	--	80
Saving Realization Rate					0.119	0.415	--	--	0.766

Exterior Wall

Tracked Savings (2 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
613	0.14	--	--	--	3,988	0.27	26	--	--
Saving Realization Rate					6.506	1.854	--	--	--

Floor over Crawlspace

Tracked Savings (4 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
114	0.06	46	--	--	498	0.11	100	--	--
Saving Realization Rate					4.377	1.938	2.159	--	--

Knee Walls

Tracked Savings (14 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
1,788	0.87	862	259	4	425	0.40	396	120	11
Saving Realization Rate					0.237	0.456	0.460	0.462	3.093

Rim Joist

Tracked Savings (23 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
936	0.41	104	42	33	548	0.16	88	14	43
Saving Realization Rate					0.624	0.400	0.844	0.336	1.315

Window and Door Measures

Our sample tracked seven window replacement measures, two door replacements, and the addition of two storm doors. Only five of the seven windows could be verified through invoices or the post-installation inspection report.

We calculated energy savings for window and door measures using the equations laid out in the Mid-Atlantic TRM for Energy Star windows. However, we used different baseline U-values for these measures.

The existing baseline windows were assigned a U-value of 1.0 in summer and 0.8 in winter (an average of 1.0 and 0.6, where the 0.6 U-value reflects the use of wintertime storms on half of the windows). Energy efficient windows were assigned a U-value of 0.32.

Existing baseline doors were assigned a U-value of 0.46, and new doors were given a U-value of

0.14. Doors without storms were assigned a U-value of 0.40 in summer and winter, while doors with new storm doors had U-values of 0.40 in summer and 0.25 in winter.

Savings were determined based on the known efficiencies of the cooling and heating equipment installed in each home. (We used the same methodology to determine or estimate efficiency as described in the duct sealing and insulation sections above.)

Only one of the window and door projects involved a switch from one heating fuel to another. The tracked savings for this project were attributed to the original fuel, but the evaluated savings were assigned to the new heating fuel type.

Tracked Savings (11 units)					Evaluated Savings				
kWh	kW	therms	Oil gallons	Propane gallons	kWh	kW	therms	Oil gallons	Propane gallons
720	0.63	301	10	8	453	0.38	287	43	17
Saving Realization Rate					0.629	0.597	0.955	4.364	2.082

Domestic Hot Water Measures

Our sample included numerous hot water conservation measures, including new hot water heaters, a heat trap, pipe insulation, tank wraps, low flow faucet aerators and showerheads, and temperature turndowns.

New Hot Water Heaters

Our sample included four new water heaters. Fuel switching is an important consideration for this measure. In our sample, one gas water heater and one electric storage water heater were replaced with new water heaters using the same fuel. The new electric water heater was a heat pump water heater. The other two water heaters replacements switched from electric to gas, and from oil to electric fuels.[83]

We used the equations from the Mid-Atlantic TRM to calculate energy savings of water heaters. However, the new gas water heater's efficiency was listed as 0.9. This may be the thermal efficiency of this water heater, but we need to use an Energy Factor to determine savings (the Energy Factor takes standby losses into account). We used a more realistic Energy Factor of 0.80 for an efficient gas water heater.

Tracked Savings (4 units, 2 fuel switches)				Evaluated Savings*			
kWh	kW	therms	Oil gallons	kWh	kW	therms	Oil gallons
-542	0.24	-28	137	1,436	0.17	58	--
Saving Realization Rate**				n/a	0.72	n/a	--

[83] The electric to gas and oil to electric water heaters were recorded in the Beacon reports, and savings were tracked in the program database. But there was no evidence of their purchase or installation.

* Note that the two projects with fuel switches are not represented in the evaluated savings. Including these would result in negative overall evaluated savings for new hot water heaters.

** Realization rates were not calculated for kWh and therms since tracked savings were negative and evaluated savings positive.

Pipe Insulation

Our sample included nine projects with pipe insulation, six on gas water heater pipes and three on electric water heater pipes. We could only verify installation on four gas water heaters and one electric water heater.

We used the Mid-Atlantic TRM savings values for this insulation, which assumed 4 feet of pipe get insulated. The tracked savings per unit varied, but were generally lower than the evaluated savings.

Tracked Savings (9 units)			Evaluated Savings		
kWh	kW	therms	kWh	kW	therms
125	0.02	15	187	0.02	33
Saving Realization Rate			1.492	1.200	2.230

Tank Wrap

Our sample included seven projects with tank wraps on water heaters, four on electric heaters and three on gas water heaters. We could only verify installation on two electric water heaters and one gas water heater.

We used the Mid-Atlantic TRM savings values for tank wraps, which assumed 79 kWh and 0.009 kW for electric water heaters. There was no savings assumption for gas water heaters, but we used electric to gas savings ratios from pipe insulation to determine tank wrap savings for a gas water heater: 79 kWh x 4.6 therms / 104 kWh = 3.5 therms. The tracked savings per unit varied, but were generally higher than the TRM savings.

Tracked Savings (7 units)			Evaluated Savings		
kWh	kW	therms	kWh	kW	therms
601	0.09	30	369	0.04	8
Saving Realization Rate			0.613	0.472	0.274

Low-Flow Showerheads

Our sample included the installation of low-flow showerheads for seven projects, four associated with electric heaters and three with gas water heaters. We were able to verify all of these installations.

We used the Mid-Atlantic TRM savings values for these showerheads, which assumed 168 kWh and 0.014 kW for electric water heaters, and 7.5 therms for gas water heaters. The tracked savings per

unit varied, but tracked electric savings were generally higher than evaluated savings, and gas savings were comparable.

Tracked Savings (7 units)			Evaluated Savings		
kWh	kW	therms	kWh	kW	therms
813	0.12	21	672	0.06	23
Saving Realization Rate			0.826	0.468	1.077

Faucet Aerators

Our sample included the installation of faucet aerators for five projects. Two homes with electric water heaters received five aerators, and three homes with gas water heaters received three aerators. We were able to verify all of these installations.

We used the Mid-Atlantic TRM savings values for these faucet aerators, which assumed 29 kWh and 0.0034 kW for aerators installed in houses using electric water heaters and 1.3 therms for aerators installed in houses with gas water heaters. The tracked savings per unit varied, but tended to be lower than the evaluated savings.

Tracked Savings (5 homes, 14 units)			Evaluated Savings		
kWh	kW	therms	kWh	kW	therms
89	0.01	5	145	0.02	12
Saving Realization Rate			1.621	1.308	2.290

Temperature Turndown

Our sample included 13 projects with a recorded temperature turndown measure. Temperatures were reduced to 115°F on four projects, to 125°F on three projects, and to an unspecified setting for the remaining six projects. Savings for this measure ranged from 705 to 2,276 kWh, 0.107 to 0.34 kW, and 32 to 239 therms. There is no documentation in the project files that would allow us to verify that these turndowns were actually implemented.

Turning down the water heater temperature can save energy by reducing heat transfer from the storage tank and water heater pipes. Insulating tank and pipes reduces this savings significantly. Savings will occur only when the lower temperature of the hot water does not require the use of more hot water. As such, there are no savings for showers or faucets since water temperatures at showerheads and faucets are set by mixing cold and hot water at the tap. To get the same temperature with a lower temperature setting, you have to mix more hot water, increasing the amount of water that needs to be heated. This sometimes means that storage tanks also run out of hot water and cause homeowners to adjust temperatures back up again to compensate. Additionally, this measure may increase a dishwasher's electricity consumption due to the lower hot water supply temperature and the internal electric equipment possibly being used to increase the temperature.

However, we expect that equipment such as clothes washers will save energy as there is no internal heating element for the water in a clothes washer.

There are no efficiency programs we are aware of that have measures savings for temperature turndown. We used an algorithm from a recent technical reference manual in the Northeast to perform due diligence on the level of tracked savings.[84] The evaluation team made several assumptions about the units within our analysis:

- We assumed that all homes in our sample have clothes washers and therefore generate savings. We did not account for any reduction in savings from possible dishwashers, but acknowledge that this could reduce the savings.
- The program tracking database did not provide the starting temperature for any of the sampled sites. The evaluation team made conservative assumptions of a difference in temperature of either 10 or 15 degrees, depending on the new temperature in the tracking database. If the new temperature was 115, we assumed a reduction of 15 degrees (from 130), if the new temperature was 125, we assumed a reduction of 10 degrees (from 135). If there was no new temperature in the database, we assigned it a conservative 10 degree change.

While the team made conservative assumptions that reduced the expected savings, the per-unit savings in the program tracking database were also very high, leading to a low realization rate. For example, the savings from one temperature turndown site of 2,276 kWh is larger than all but one per-unit savings from installing a high efficiency air conditioner (which ranged from 486 to 2,341 kWh). The tracked gas savings (from 32 to 238 therms) were all higher than what we consider the maximum likely gas savings (23 therms).

Tracked Savings (13 units)			Evaluated Savings		
kWh	kW	therms	kWh	kW	therms
7,928	1.1	534	1,112	0.11	79
Saving Realization Rate			0.140	0.102	0.147

Appliances

Our sample included savings from numerous appliance measures. Appliances installed as part of this program included refrigerators, freezers, dishwashers, clothes washers, and room air conditioners.

Refrigerators

The evaluation sample included just one refrigerator installation, presumably a replacement of an existing refrigerator with an energy efficient model. Project files included an invoice for the refrigerator. Tracked savings for this measure are 1,287 kWh and 0.194 kW. The Energy Star program refrigerator calculator estimates annual savings of only 116 kWh for a bottom-mount

[84] UI and CL&P Program Savings Documentation for 2011 Program Year. p. 196.

refrigerator with ice maker, and the Mid-Atlantic TRM assumes savings of 117 kWh and 0.019 kW. We assigned savings from the Mid-Atlantic TRM to this measure.

Tracked Savings (1 unit)		Evaluated Savings	
kWh	kW	kWh	kW
1,288	0.19	117	0.02
Saving Realization Rate		0.091	0.098

Freezers

Our sample included one freezer and one freezer turn-in, with savings of 629 kWh and 1,940 kWh, respectively, and 0.095 kW and 0.292 kW respectively. There is no confirmation via invoices or a post-inspection report that these freezers were replaced and turned in. The Mid-Atlantic TRM does not include a freezer measure. But the Energy Star program has a calculator that estimates savings of 67 kWh for an upright freezer with automatic defrost, and an annual energy use of 673 kWh for a conventional freezer. Assuming similar ratios of kWh and kW for a freezer and a refrigerator, the new freezer demand is estimated to be 67*0.019/117=0.011 kW, and the removed freezer demand is 673*0.019/117=0.109 kW.

Tracked Savings (2 units)		Evaluated Savings	
kWh	kW	kWh	kW
629	0.10	67	0.01
Saving Realization Rate		0.107	0.115

Dishwashers

Our sample included one dishwasher, with savings of 262 kWh and 0.04 kW. There was no receipt or post-inspection check to verify that a new dishwasher was installed. The home in which the dishwasher was installed uses natural gas water heating. The Energy Star program estimates savings of 33 kWh for an efficient dishwasher using gas water heat. At four loads a week, with each load running at high power for a quarter of an hour, the demand savings is estimated to be 33/(52*4*4)=0.039 kW.

Tracked Savings (1 unit)		Evaluated Savings	
kWh	kW	kWh	kW
262	0.04	33	0.04
Saving Realization Rate		0.126	0.992

Clothes Washers

Our sample included one clothes washer, and a receipt was included in the project files. The program tracked 511 kWh and 0.057 kW for this measure. The home uses electric water heating. For a home with electric water heating and an electric dryer, the Energy Star clothes washer calculator estimates savings of 224 kWh, which includes the energy used to heat water for washing. At 392 loads a year, with an eighth hour of peak use per load, the demand savings is estimated as 224/(392*8)=0.071 kW.

Tracked Savings (1 unit)		Evaluated Savings	
kWh	kW	kWh	kW
511	0.06	224	0.07
Saving Realization Rate		0.438	1.253

Smart Strips

Our sample included one smart strip, but no savings were tracked, and there was no documentation of its purchase or installation. As a result, we are not evaluating any savings for this measure. The Mid-Atlantic TRM allows 56.5 kWh and 0.0063 kW for a 5-outlet smart strip, and 102.8 kWh and 0.012 kW for a 7-outlet strip.

Compact Fluorescent Lamps

Our sample included 35 projects with 794 CFLs. We could only verify the installation of 714 of these lamps, either because there was no receipt and no mention of installation on the post-install inspection report. The receipt for one project with 25 lamps is for PAR 38 halogen bulbs, not CFLs.

We estimated savings for these CFLs using the Mid-Atlantic TRM assumptions and the following equations:

kWh savings = # of lamps x 2.95 x lamp wattage x hours of use x in service rate x waste heat factor on energy

kW savings = # of lamps x 2.95 x lamp wattage x in service rate x waste heat factor on demand x coincidence factor

where:

lamp wattage = average wattage of lamps found on all receipts = 16 W

hours of use = 1,088 hours

in service rate = 1.0[85]

waste heat factor on energy = 1.14

[85] An in service rate of 100% likely overstates CFL savings. Results from the participant survey indicate that close to a quarter of incented CFLs might not have been in service at the time of the participant survey.

waste heat factor on demand = 1.39

coincidence factor = 0.11

The resulting savings are 59 kWh and 0.009 kW per installed CFL. The tracked data assumes savings of 105 kWh and 0.015 kW per installed CFL. The energy savings difference seems to be mostly due to the assumption of higher hours of use on average (1,979 tracked to 1,088 evaluated). The demand savings difference might be due to different assumptions about waste heat or coincidence factors.

Tracked Savings (794 units)		Evaluated Savings	
kWh	kW	kWh	kW
83,499	12.6	50,974	6.3
Saving Realization Rate		0.610	0.499

D. REMRATE ANALYSIS – GREEN FOR GREEN

Analysis work focused on obtaining information on a sample of homes within the Green for Green program and creating a baseline for the purpose of comparison. The baseline considered the typical building practices across the state. Construction of the baseline provided specific measure values (insulation, HVAC, appliances, etc.) for home components, and use of simulation models in REM/Rate™ software version 12.99 also provided the ability to reconstruct each individual home in the sample using baseline-adjusted measure values. Direct comparison between the Program Home REM/Rate™ models and the various baseline REM/Rate™ models quantified the energy use consumption differences between different types of homes.

Program Homes REM/Rate models

To evaluate the Green for Green program a sample of 27 Program Homes was randomly selected from the program population. As discussed above, simulation models were requested for each of the 27 homes to give the evaluation team an accurate representation of the home construction specifics. We received 19 REM/Rate™ models from local Delaware HERS Raters and verification companies who worked directly with the program. In addition to the 19 models we received 4 REM/Rate™ output reports (3 ENERGY STAR® verification reports and 1 home energy rating certificate) from HERS Raters/verifiers that allowed the home models to be accurately re-created. We were unable to obtain simulation models or output reports for the remaining 4 homes in the sample because these homes either followed a prescriptive building approach that did not include the HERS rating process, or the models/related information was unavailable.

In order to build accurate simulation models of the 4 remaining homes, we relied on three primary sources of information. The Program Home sample provided by the Home Builders Association of Delaware (HBADE) listed basic home information including address, builder, conditioned square footage, foundation type, HVAC system type, and HVAC fuel. Additional information for the 4 homes was pulled from each home's specific National Green Building Standard (NGBS) score sheet, which was also provided by HBADE. Data from the NGBS score sheets included house type, floors above grade, third-party verified insulation grade, window U-value and solar heat gain coefficient (SHGC), eave and gable overhangs, HVAC system type/fuel/efficiency, domestic hot water (DHW) type and fuel, if a programmable thermostat was installed, the percentage of lighting that is high efficiency, and installation of ENERGY STAR® refrigerators, dishwashers, or washing machines.

The scoring system for the NGBS program often provided a varying amount of points based on how efficient a segment of the home was. For example, in Delaware's prescribed IECC climate zone a home will receive five points for a U-value of 0.30 or less and ten points for a U-value of 0.25 or less. This resulted in a home with a U-value between 0.26 and 0.30 receiving five points, but the score sheet does not provide the exact U-value. In these cases the most conservative U-value (0.30) was selected. This method was used for any component of a home where the exact value was unknown but the score sheet verified its potential range. Any remaining unidentified information was filled by averages of homes in the Program Home sample. Each of the 4 remaining homes received the Silver NGBS Certification. Due to the significant difference between building practices on Gold and Silver Homes, we used an average of the 12 remaining Silver Homes in the sample to determine the outstanding data. The data collected from all three sources described above was used to construct REM/Rate™ models for each of the remaining projects, leading to one model for each of the 27 homes in the Green for Green program sample.

Developing the Baseline

The baseline considered building practices throughout the State of Delaware and was based on information acquired from publically available building permits and associated documentation. 14 of 30 reporting jurisdictions across the state of Delaware were contacted to request one building permit, and associated documentation, per month for each month between March 2011 and March 2012. This request was made to increase the variation in building types by preventing the receipt of similar or identical plans filed by a single builder while also providing the evaluation team with a list of homes in mid-construction to contact for site visits. Plans and associated documentation were provided to evaluation team electronically, mailed in hard copy form, or collected on site at the jurisdiction office by a member of the evaluation team. The most commonly received and useful documentation included building permits, REScheck certificates, floor plans, elevations, and building sections. A thorough review of all available documentation was completed for each project in order to determine crucial building parameters including conditioned square footage, foundation type, insulation details, HVAC specifications, and glazing area.

Based on the data collected, the evaluation team compiled a list of building energy measure values representing Program Homes and baseline homes and how each group compared on average to the IECC 2009 energy code. Measure values for Program Homes were presented by Silver and Gold homes, as the evaluation team found this level of resolution most appropriate to represent the program. Program Home measure values were derived from a weighted average of measure values provided in the REM/Rate models. Similarly, measure values for baseline homes were derived from the weighted average[86] of observed measure values based on building plans and site visits. The measure values of the Program Homes were also incorporated into the baseline but weighted based on the proportion of total homes built in the Green For Green program compared to the total 2011 permits issued in Delaware. Green For Green builders were estimated to represent 6.6% of new home construction in Delaware.

Measures and their respected values were not always discernible in the collected data. Specifically, rim joist insulation R-values were not always determined yet were necessary inputs for REM/Rate models. For homes where the value of rim joist insulation was unavailable, an assumption based on common building practices was used. All rim joists were assumed to be insulated at the same level of the above grade walls in the home, except for homes with wall insulation greater than R-19 in which case R-19 was used as the rim insulation. Thus, rim joist values were primarily stipulated values for the baseline. In cases where information of data could not be obtained for a particular sample, the data cells were intentionally left empty and not filled with an expected or average value. This step ensured that the data used to create the baseline was based on observations of the permit and associated documents, rather than stipulated values or code minimum requirements.

A final review of baseline measures was conducted to ensure each was accurate, realistic, and not outside a range of possible values. The review found two questionable window specifications claiming SHGC's of 0.65 and 0.70 with associated u-values of 0.35 and 0.33 respectively. Research into the window manufacturer verified that windows with that spec combination are not available, so those data points were removed from the analysis.

Once the data was reviewed and verified, a weighted average was taken across each measure to determine the baseline values for home size, foundation type, insulation level, and HVAC equipment. HVAC equipment is built into every home but HVAC systems vary among homes. Heating can be accomplished with a furnace or heat pump and the model needs to be able to accommodate all

[86] Weighted average based on the number of permits issued by county in 2011.

variations in HVAC equipment, foundation type, and construction style. The baseline considers each of these components separately allowing it to be applied across homes with differing designs and equipment requirements. All insulation averages were analyzed to determine if a lack of insulation was a choice or dictated by the home design. For example, crawlspaces do not have slabs, therefore slab edge insulation is not applicable for these types of homes and that baseline input is not impacted by homes that do not have slabs. This process was followed for all measures in the baseline.

Table AA-1 below presents the findings of measure values used in Green For Green Silver and Gold homes and the baseline. The observed measure values show Gold homes were built to very high standards ranking the highest standard for all but one measure category.[87] Silver homes, however, had significantly lower measure values relative to Gold Homes. In fact, in several instances Silver homes had lower or equal measure values to the baseline values. These relatively lower values for Silver homes is also reflected in the overall level of compliance above the IECC 2009 energy code. While Gold homes ranked on average at 21.1% above code, Silver homes only surpassed code by 6.7% as compared to the baseline value of 7.2%.[88]

Table AA-1: Observed Green For Green and Delaware Baseline Average Building Practices

Measure	Measurement	Green For Green Silver Homes	Green For Green Gold Homes	Baseline
Percentage better than 2009 energy code[89]	%	6.7%	21.1%	7.2%
Slab foundation insulation	R-value	7[1]	N/A	10[1]
Interior foundation wall insulation	R-value	10	11	11
Exterior foundation wall insulation	R-value	N/A	N/A	9[1]
Rim joist insulation	R-value	14	17	16
Frame floor insulation	R-value	33	27[1]	24
Above grade wall insulation	R-value	15	23	17
Ceiling/Attic insulation	R-value	37	38	37
Window U-Value	U-value	0.31	0.26	0.33
Window SHGC Value	SHGC value	0.26	0.18	0.30[1]

[87] Gold homes' frame floor insulation value ranked below that of Silver homes. However, this value is based on approximately 1/3rd of the Gold home sample size, as the remaining 2/3rd of the sample did not have data on frame floor insulation.

[88] Percentage values of above code are derived from REScheck certificate outputs and/or modeling from Software Versions 4.3.1 - 4.4.3.

Measure	Measurement	Green For Green Silver Homes	Green For Green Gold Homes	Baseline
Window to wall ratio	%	18%	14%	15%
Forced air furnace efficiency	AFUE	93.2%	97.7%[1]	90.0%[1]
Heat pump efficiency	HSPF	8.3[1]	9.4	8.4[1]
A/C efficiency	SEER	14	16	14[1]

[1]Values observed for less than 50% of sample

Participating Builders' Homes Built Outside of the Program

Data for the participating builders' non-program homes were collected via phone surveys and on-site visits to homes in various phases of the construction process including framing, insulation, and final phases. (phone survey and on-site data collection forms are provided below in Appendix E).Data collected from the phone surveys were cross-referenced against on-site data. In cases where discrepancies were observed between survey responses and site visit observations, the site visit data served as the default input.

Data from the 8 phone surveys and 7 site visits were used to develop parameter inputs for participating builders' non-program homes. Builders' responses to survey questions and site visits were averaged after being weighted based on the proportion of homes the builder built outside of the Green For Green program in the 2011 calendar year[90]. In the case in which a measure only applied to a segment of the sampled builders, the weighted average was altered to reflect only those applicable builders. For instance, the slab insulation value was based on only the proportion of builders that reported building homes with slab foundations. Some measure values lacked sufficient data to develop the baseline parameter inputs. In these cases research was conducted to determine acceptable values to be used in the baseline. For example, the average heat pump HSPF and SEER was not available, but surveys and site visits indicated that the majority of builders installed ENERGY STAR® heating and cooling equipment. Research into ENERGY STAR® heat pumps revealed that the lowest available HSPF and SEER on a certified heat pump is 8.5 and 14.5 respectively. Consequently, these values were used for all heat pumps in this baseline. Additional research provided values for refrigerators (549 kWhr/y for ENERGY STAR® certified, 688 kWhr/y for uncertified), dishwashers (295 kWh/y and 328 kWh/y) and washing machines (177 kWhr/y and 253 kWh/y).

Comparing Program Homes and the Statewide Baseline

[90] Phone surveys and on-site surveys asked builders to estimate how many homes their company had constructed in the 2011 calendar year.

Comparison of Program Homes to the baseline was completed by modifying individual REM/Rate models and taking a weighted average the impacts across all 27 homes. Averaged impacts were weighted based on each builder and the quantity of homes constructed in the Green for Green program. Due to the variation of energy savings expected between Gold and Silver homes, comparisons occurred at the certification level.

The REM/Rate model for each Program Home was analyzed before any modifications to provide a simulation of energy related outputs based on the home's design and construction. Factors of interest include heating, cooling, hot water heating, lights and appliances, and winter/summer peak demand. These data points were all recorded and converted into a single value representing a home's annual energy consumption in MMBTU, except for peak demand which falls outside the scope of annual consumption. With the estimated usage of the home captured the REM/Rate model was recalibrated with specific data from the baseline to represent how the home would operate if constructed to baseline conditions. It is important to note that changes to the model did not modify the size, shape, foundation type or orientation of the home. All the details that create the shell of the building such as number of stories, ceiling type, glazing area and orientation were unchanged. Only the insulation levels of the shell and performance specifications such as window U-values and SHGC were altered. HVAC equipment was also modified to match the efficiency levels of the baseline, but system type, fuel source, and sizing were always kept the same as installed in the initial Program Home model. This process allowed the analysis to consider any type of home, while at the same time maintaining each home's specific design.

Once the model of each home was modified the annual consumption simulation provided annual values for therms of natural gas, gallons of propane, and kWh of electricity. The data provided by the modified simulation was then directly compared to the outputs from the Program Home models. The difference in energy consumption reported by the model provided insight into the performance of Program Homes as compared to the baseline.

E. LOW INCOME MULTIFAMILY BIBLIOGRAPHY

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F. Low Income Multifamily Energy Efficiency Measures Guidelines

Table 8-11. Comparison of EE Requirements for SEU and DSHA Loans

Measure	DSHA LIMFTC Basic (a)	DSHA LIMFTC EE (b)	SEU LIMF EE Standards (c)	Notes
Lighting	Energy Star	Energy Star	Energy Star	Same as LITC/QAP program standards
Non-Mercury programmable thermostats	Yes	Yes	Yes	Same as LITC/QAP program standards
Appliances	Energy Star	Energy Star	Energy Star	Same as LITC/QAP program standards
HVAC	SEER 13	SEER 14-16	SEER 14-18	SEER meets the current Energy Star requirement. LIMF SEER is better than the minimum required by LITC/QAP program
Weather Sealing	Energy Star or DOE "Building America Best Practices"	Energy Star or DOE "Building America Best Practices"	Leakage does not exceed 5 air changes per hour when pressurized to minus 50 Pascals using a blower door test.	New Construction Only Metric is highly dependent on the square footage
Insulation	Current building codes	25%-50% better than minimum standards	25%-50% better than minimum standards, Energy Star Thermal Bypass Checklist	Same as LITC/QAP program standards
Duct Sealing and Insulation	None	None	R-6 minimum duct insulation in unconditioned spaces, duct leakage does not exceed 4 CFM to outdoors per 100 sq. ft.	Duct insulation is not required for LITC/QAP program.
Windows	Below 0.33 U-factor	Below 0.33 Low E U-Factor, Argon Gas	Below 0.33 Low E U-factor, Argon Gas	Same as LITC/QAP program standards
Entry doors	Below 0.33 U-factor	Below 0.14 U-Factor	Below 0.14 U-Factor	Same as LITC/QAP program standards
Hot water heater	0.82 to 0.91EF.	R=16 or greater, 0.82 and 0.91 EF	R=20 or greater Electric Storage >= 0.93 Gas Storage >= 0.67 Gas On Demand >= 0.82 or Gas Condensing >= 0.8	R value is greater that LITC/QAP program standard
Gas Warm Air Furnaces	Energy Star	AFUE 90% or higher	AFUE 93% or higher	AFUE % value is greater that LITC/QAP program standard

a) DSHA LIMTC: Delaware State Housing Authority Low Income Multifamily Tax Credits. These are the basic standards required to receive LIMF tax credits from the DSHA
b) DSHA QAP EE Standards: Delaware State Housing Authority Qualified Allocation Plan Energy Efficiency Standards. These are the standards needed to gain extra points for Energy Efficiency when competing for DSHA LIMF tax credits.
c) SEU LIMF EE Standards: Sustainable Energy Utility Low Income Multifamily Energy Efficiency Standards. These are the standards needed to compete for the SEU LIMF EE financing.

G. Low Income Multifamily Best Practices Review

Overview of Successful Low Income Multifamily Programs with Rebate Component

Program	Efficiency Vermont[a]	California Statewide Multifamily Energy Efficiency Rebate Program	NYSERDA Multifamily Performance Program	Ohio Electric Partnership Program
Description	Efficiency Vermont partners with a wide variety of partners to become a one-stop EE service for property owners, developers, and managers. EVLIMF ties incentives to the overall energy efficiency (EE) of the project, not individual measures, and prioritizes flexibility in offering EE incentives.	The California Statewide Multifamily Energy Efficiency Rebate Program is a collaboration among California's four major investor-owned utilities to encourage energy-efficiency upgrades by providing equipment rebates to owners and tenants of multifamily housing.	The Multifamily Performance Program provides a single point of entry for multifamily building owners and developers interested in improving the energy efficiency of new and existing buildings.	The Ohio Universal Service Fund's Electric Partnership Program (EPP) is designed to improve the electric efficiency of low-income households who participate in PIPP Plus (Percentage of Income Payment Plan) by performing in-home audits and installing appropriate electric base load and thermal energy efficiency measures.
Successes	1,486 MWh in 2009, Total Resource Benefits $3,121,229. Cost-Benefit ratio of 3.5 to 1, Home Performance with ENERGY STAR contractors increased by 50%, to over 70.	51.3 GWh and 1,072,478 therms in 2006.	Observed avg. savings of 19.7%	15,027,782 kWh per/year, Annual CO_2 reduction 15,779 tons (as of 2005)
Goal	Resource Acquisition, emphasis on long-term savings	Resource Acquisition. Each utility has specific installation, kW, kWh, and therm goals	Market Transformation. Reduce each participant's energy consumption by 20%	Carbon emissions, Resource Acquisition
Eligibility	LIMF project of 5+ units, at least half for tenants at or below 80% AMI	Apartment buildings, mobile home parks, condominium complexes of 2 or more units	5+ residential units, with less than 50% of the gross heated square footage being commercial	Enrolled in the PIPP Plus (Percentage of Income Payment Plan), allows <150% of poverty customers to maintain service for fixed % of income.
Services	Technical support, rebates	Rebates for owners and tenants	Retrofit or New, Rebates for owners	Full grants for measure replacement
Measures	Building shell, lighting, appliances, space heating and cooling, water heaters, ventilation, and fuel substitution	HVAC, lighting, water heating, dishwashers, clothes washers, insulation, windows.	Variety, focus on cost-effectiveness	Various, determined by usage base load
Marketing	Targeted community based approach. Most participants came through partner or network referrals. PMs build relationships with owners. Focus on long-term EE: short term-payback measures packaged with long-term investments make whole package more attractive.	Targeted, and contractor driven, as well as through building owner and manager trade groups	Variety of channels, including contractor network, building owner associations	Direct contact to schedule audit (eligibility is established based on monthly bill before contact)
Implementer	Vermont Energy Investment Corporation	Each utility administers the program in its own service territory.	NYSERDA	Ohio Department of Development's Office of Community Services

Program	Efficiency Vermont[a]	California Statewide Multifamily Energy Efficiency Rebate Program	NYSERDA Multifamily Performance Program	Ohio Electric Partnership Program
Best Practices	**Easy participation** • One clear point of contact EV and WAP • Comprehensive services: including audits, feasibility analysis, collaboration with architects, bid review, and ongoing assistance. **Extensive Partnerships** • Low-income WAP, affordable housing funders, low-income housing developers, nonprofit low-income housing owners, for-profit / private owners. **Flexibility** • New construction, retrofit, fuel switching, and EE specific projects are all eligible.	**Easy Participation** • Quick standard enrollment process. • A reservation system replaced first-come-first-served to avoid a bottleneck of committed funds towards contractors who had heard of the program early. **Flexibility Addresses Split incentive** • Common area measures to lower operational costs for owners (lighting, weatherization), and high (yet cost-effective) rebates on tenant unit measures. **Documenting Success** • Each utility recorded measures, allowing tracking of savings, funding, popularity of measures, and marketing needs.	**Performance Based Approach** • Pre- and post- energy benchmarking for 12 months, tracking 20% reduction goal per participant, using weather-normalized total source energy reduction value. **Easy participation** • One clear point of contact for the program. Energy Analysts coach owners through each phase. • Fixed incentive schedule by building size is easy to understand. **Flexibility Addresses Diverse Market** • A wide variety of measures are covered, allowing owners to choose any cost-effective set of measures that will bring them to 20% savings.	**Tiered Incentives for Cost-Effectiveness** • Eligibility for measures is determined by base load: High electrical receive comprehensive, Moderate Electrical receive same but with streamlined energy audits, and High Heating/Cooling receive weatherization. **Detailed analysis** • Detailed audits identify cost-effective end uses. • Challenging high-detail audits have been streamlined through program experience. **Documenting Success & Lessons** • Comprehensive impact, process, and technical evaluations commissioned at program inception as part of design. **Partnering to Reduce Administrative Costs** • The EPP is part of another program, adding services to existing infrastructure. • Reduces time and money spent in outreach as eligibility is established before customers are contacted.

[a] Curtis, N. & Shapiro, A. "Energy Efficiency in Multifamily: A Roadmap" AIA continuing education. (2012) http://passthrough.fw-notify.net/download/821623/http://efficiencyvermont.com/docs/for_partners/bbd_presentations/2012/Feb8_Session3_PDFs/EnergyEfficiencyinMultifamilyRoadmap_Curtis.pdf (accessed 5 17, 2012).

Overview of Successful Low Income Multifamily Programs with Financing Component

Program	Chicago Energy Savers Program	NYSERDA - Energy $mart Multifamily Performance Program (Part of the NYSERDA Multifamily Performance Program)	Example of Weatherization Assistance Program: Illinois Home Weatherization Assistance Program (IHWAP)
Description	This Low Income Multifamily program "provides a one-stop energy efficiency shop where owners of multifamily buildings can access technical assistance, financing, and construction oversight, plus annual performance monitoring."	The program provides loans to owners of multifamily buildings (new construction and existing buildings) to encourage the installation of equipment that will result in energy savings. Loans are available for a wide variety of cost-effective improvements. Additional incentives are available for projects that serve or are expected to serve low-income tenants, as well as income-qualified housing that meets certain sustainability guidelines.	The Illinois Home Weatherization Assistance Program (IHWAP) enables low-income families to permanently reduce their energy bills by making their homes more energy efficient. Funds are used to improve the energy performance of dwellings of low-income families using the most advanced technologies and testing protocols available in the housing industry.
Successes	Average 30% savings, $10,000 per-year per-owner, 75 jobs as of May 2011, 165 expected (2013).	Resulted in savings of over $14 million for low-income tenant housing from 2006-2011.	Resulted in savings of over $14 million for low-income tenant housing from 2006-2011.
Goal	Job creation, Resource Acquisition. 30% reduction in energy use from baseline.	Reduced energy bills and health and safety benefits for occupants.	Reduce energy costs, conserve energy, increase comfort in the home, improve safety and health standards, preserve housing stock, and provide jobs.
Eligibility	Landlords with tenants below 80% Area Median Income (AMI).	Multifamily building owners in the state of New York. However, to be eligible for affordable housing incentives, the building owner must demonstrate that the property is publicly-subsidized or that at least 25% of residents receive public assistance or earn below 80% of the State Median Income.	Households, including multifamily building units, with incomes at or below 150% of poverty reduce energy consumption and high utility bills.
Services	Free energy audits, technical support, contacts to energy retrofit financing resources.	Loans to multifamily building owners (new construction / retrofit), additional incentives for low-income projects, designating label of "New York Energy $mart Building" for buildings that successfully achieve energy reduction goals.	Free energy audit, free installations, and quality assurance.
Measures	Insulation, air sealing, HVAC systems, hot water, and lighting.	Clothes Washers, Dishwasher, Refrigerators, Dehumidifiers, Lighting, Furnaces, Boilers, Heat pumps, Central Air Conditioners, Building Insulation, Windows, Doors, Comprehensive Measures/Whole Building, Custom/Others pending approval, Geothermal Heat Pumps, Other Distributed Generation Technologies.	Air sealing, attic and wall insulation, furnace repairs or replacements, electric baseload reduction (lighting and refrigeration), and window and door work.

Marketing	Through a network of community partnerships. Most participants came through partner or network referrals. PMs build relationships with owners. Focus on cost-effectiveness. Simple financing, experienced lender.	Variety of channels, including contractor network, building owner associations.	Variety of channels including, utility staff, contractors, website, networking, and a quarterly mailing.
Implementer	CNT Energy	State run program	State run program - A network of 35 local community action agencies / community-based organizations delivers the program statewide.
Best Practices	**Easy participation** • One clear point of contact for the program. Energy Analysts coach owners through each phase. **Competitive Financing & Rebates** • Financing at half of prime rate (with a 2% floor) fixed for seven years. The region's electric utility provides complimentary rebates and grants. **Documenting Success** • Demonstrated positive results make the program more attractive to utility, philanthropic, and public funding sources that look for effectiveness.	**Easy participation** • One clear point of contact for the multifamily building owners, which includes low-income multifamily buildings. **Competitive Financing & Rebates** • NYSERDA will provide 50% of the principal, up to $5,000 per apartment up to $500,000 per project, at 0% interest, and the lender will provide the remaining portion at market rate. This helps the building owners get competitive rate for energy efficient improvements. **Incentives for Low-income Buildings** • Low-income multifamily building owners are encouraged to implement energy efficient improvements in the units as they are provided.	**Easy participation** • All services, including the energy audit, are provided free of charge to eligible households. • The home is inspected after installation to maintain quality and assure energy savings.

H. INTERVIEW GUIDES

ENERGY STAR Lighting

DNREC Energy Participating Retailer Interview Guide

FINAL

May 2012

Hello, may I please speak with [CONTACT NAME]? My name is _____. I am from Opinion Dynamics Corporation and am calling on behalf of DNREC.

We are evaluating the Energize Delaware Lighting Program and would like to ask you a few questions about your store's participation in the program. We are looking to speak with the person most knowledgeable with your company's participation in the program. Are you the best person to talk about this or is there someone else that would be better to talk to?

[WHEN CORRECT PERSON IS REACHED] This interview should take approximately 15 minutes of your time and all of your responses will remain confidential. Is now a good time, or is there a more convenient time for me to call you back? [CONTINUE WITH SURVEY OR MAKE AN APPOINTMENT TO CALL BACK.]

Before we start, I would like to ask for your permission to tape-record this interview, so that I won't have to take notes while we talk. I would like to once again assure you that all of your responses will remain confidential.

Effectiveness of Program Design and Processes

I have few questions about Energize Delaware Lighting Program design, processes and implementation.

1. Were the participation processes and program requirements clearly explained?
   a. [IF NO] What has not been explained?
2. Was your store kept up-to-date on program changes and updates?
   a. [IF NO] Why do you say that?
3. As you may know, the Energize Delaware Lighting Program ended earlier than planned. Did the program's early ending affect your store in any way? If so, how?
   a. How effective were program representatives (APT/EFI staff) at communicating the early termination of the program and taking necessary actions (IF NEEDED: such as removing point-of-sale materials, etc.)?
4. How frequently did you get reimbursed for participating lighting products that you sell? Is that a reasonable amount of time? Why not? What would you like that time to be?
5. Did the program provide payment for rebated lighting products in an accurate and timely manner?
   a. [IF NO] What problems did you experience? How frequently did those problems occur? How effectively, if at all, were those problems addressed?
6. Did the program supply all the necessary materials such as marketing materials and rebate application forms in a timely manner?
   a. [IF NO] Why do you say that?
7. Did the verification procedures for rebated lighting products present a barrier to participation or a burden for your organization? By verification procedures, I mean the process used to ensure that participating products are being sold by retailers and are properly labeled and promoted. [IF PROCEDURES ARE A BARRIER] Why do you say that?
8. Are there additional energy efficient products that the Energize Delaware Lighting Program should promote in the future? What are they? Why do you say that?

Program Marketing and Product Promotion

Next, I'd like to talk more specifically about program marketing and product promotion.

9. When selling products discounted through the program, did you ever place them in a

more prominent spot at the store?

a. [IF YES] What lighting products did you place in a more prominent spot? Why those products and not the other discounted lighting products? [PROBE SPECIFICALLY FOR CFLS VS. LEDS]

b. [IF YES] How frequently during the time the program was active did you do that?

10. Did you use Energize Delaware Lighting program signage to promote the lighting products incented through the program?

a. [IF NO] Why didn't you use program signage?

b. [IF YES] How often did you have the signage up?

c. [IF YES] What signage did you find most helpful in promoting incented lighting products? Did any specific types of signage work best for some products but not the others? If so, why?

d. [IF YES] Overall, how satisfied are you with the signage? Why do you say that?

11. Did Energize Delaware Lighting Program field representatives provide you with marketing materials that promoted products other than energy efficient lighting or were the marketing materials focused primarily on lighting?

a. [IF YES] To the best of your knowledge, what programs did those marketing materials promote?

12. Are there any marketing materials that you would like to have seen the program provide? If so, what are they?

13. Did you have any events at your store aimed at promoting the Energize Delaware Lighting Program ?

a. [IF YES] What events were they? What products were promoted during those events? Who facilitated the events? How helpful were the events in selling the featured products? Why do you say that?

14. Did your store do anything on its own, without the help of the Energize Delaware Lighting Program to promote energy efficient lighting products? [PROBE SEPARATELY FOR CFLS AND LEDS]

a. What did your store do on its own to promote energy efficient lighting products? [PROBE FOR MARKETING, TRAINING, ETC.]

b. Was that done on the corporate level or at the store level?

Program Training

15. Did you or any of your staff receive training offered by the Energize Delaware Lighting

Program designated contractors)?

16. [IF YES] What type(s) of training was provided at your store by program?

    a. What was covered during the training sessions?

        i. Did you/your staff receive training as pertaining to the Lighting Program only, or did the training representative(s) discuss other programs as well? [IF DISCUSSED OTHER PROGRAMS] What exactly were you trained on as related to the other programs?

    b. Approximately, how many training sessions were held at your store?

    c. How frequently were the trainings held?

17. Overall, how helpful was the training to this store's staff's ability to explain the benefits of energy efficient lighting products and better sell those products?

    a. [IF NOT HELPFUL] Why do you say that?

18. What types of training would be helpful to provide to the store employees in the future? Why do you say that?

Program Satisfaction

I would like to also find out your level of satisfaction with the Energize Delaware Lighting Program .

I will read you a list of various program-related areas. Please rate your satisfaction with each of the areas using a scale of 0 to 10 where 0 is not at all satisfied and 10 is very satisfied. How satisfied are you with..?

19. Energize Delaware Lighting program in general?

    a. Why do you give it this rating?

20. The number of CFLs that your store could sell at program pricing? Why do you give it this rating?

21. The number of LEDs that your store could sell at program pricing? Why do you give it this rating?

22. The program tracking and verification process – that is, the process used by the program to ensure that participating products are being sold by retailers and are properly labeled and promoted?

a. Why do you give it this rating?

23. Level of rebates for [STANDARD CFL BULBS, SPECIALTY CFL BULBS, LEDs]?

    a. Why do you give it this rating? For which products specifically, why are you not satisfied with the rebate levels? What should these rebates be, from your perspective? Why?

24. The program's efforts to market program rebated lighting products? [PROBE FOR DIFFERENCE BETWEEN CFLS AND LED, IF ANY]

    a. Why do you give it this rating? What could the program do to better market the qualifying products in the future?

25. The program's efforts to coordinate with retailers on in-store product placement and promotions?

    a. Why do you give it this rating? What could program do to improve its coordination processes?

26. The way the staff involved with the program has responded to your inquiries and concerns?

    a. Why do you give it this rating?

Suggestions for Program Improvement

27. From your experience, what aspects of the program worked well? Why?

28. What aspects of the program did not work well? Why?

Program Impacts

29. If the Energize Delaware Lighting Program had not been available for [ASK FOR ALL THAT APPLY] do you think your sales of [ASK FOR ALL THAT APPLY] would have been about the same, lower, or higher?

    a. Standard CFLs

    b. Specialty CFLs

    c. LEDs

30. Why do you say that?

31. [ASK IF ANSWER IS LOWER FOR ANY OF THE PRODUCTS] In percentage terms, how much lower do you think your store's sales of [ASK FOR ALL THAT APPLY] would have been if the Energize Delaware Lighting Program discount had not been available? [PROBE FOR BEST ESTIMATE]

a. Standard CFLs

b. Specialty CFLs

c. LEDs

32. Since the program ended, have sales of [ASK FOR ALL THAT APPLY] been about the same, lower, or higher?

a. Standard CFLs

b. Specialty CFLS

c. LEDs

These are all the questions that I have for you. Thank you very much for your time and participation. Have a great day.

DNREC Lighting Program

Implementer Guide: APT

May, 2012

[Note to Reviewer] The Interview Guide is a tool to guide process evaluation interviews with utility staff and implementation contractors. The guide helps to ensure the interviews include questions concerning the most important issues being investigated in this study. Follow-up questions are a normal part of these types of interviews. Therefore, there will be sets of questions that will be more fully explored with some individuals than with others. The depth of the exploration with any particular respondent will be guided by the role that individual played in the program's design and operation, i.e., where they have significant experiences for meaningful responses. The interviews will be audio taped and transcribed.

Program Roles and Protocols

Before we get started, I need to inform you that I will be taping this phone call so that I don't have to take too many notes. Is this ok with you?

1. Can you describe your role within the Energize Delaware Lighting Program? What were your main responsibilities?
2. In your opinion, how effective was the Energize Delaware lighting program? What elements of the program worked best? What elements needed improvement?
3. Can you describe the relationship between AEG and APT and EFI with respect to the program? What was each party responsible for? What responsibilities were shared?
4. Can you describe the relationship between APT and DNREC with respect to the program? What was each party responsible for? What responsibilities were shared?

Program Operation and Implementation

5. Next I'd like to move on to Program Operation and Implementation. Can you give me an overview of the program? Can you describe the roll-out of the program? How long did it take to get going? Were there any issues in the start up?

6. Were there any challenges that have occurred in operational approaches and implementation efforts? If so, what were they, what is being to address these challenges? Have they been overcome?

Recruitment of and Interaction with Manufacturers and Retailers

7. Next, I'd like to talk about the recruitment of and interaction with manufacturers and retailers. Can you talk to me about how retailers and manufacturers were recruited to participate in the program?

8. Were you happy with the number and type of retailers that participated? Did you have goals for a mix of different retailer types? Did you feel there was sufficient geographic distribution of retail locations?

9. The program contained a mix of markdown and coupon retailers. Usually coupon retailers account for a small percentage of sales and that looks to be true in the Energize Delaware lighting program as well. What were your reasons for including the coupon retailers? (Geographic, retailer variety, etc.).

10. How did the retailer enrollment process go? Did the enrollment process differ for the markdown and coupon retailers? Did the process present any barriers to participation? If yes, what barriers?

11. In your opinion, were retailers satisfied with the process of participation and the program lighting products?

12. Now let's talk about field representatives. Can you please talk about what role the field representatives had in the program? How often did they visit the stores?

13. Did the field representatives hold special events? How often?

14. What training of retailers took place? Can you describe that training? Are there any materials for that that you could share with us? (IF NEEDED: Are field representatives tasked with training employees about the program? Please describe the training. If there are any handouts or materials that are typically given to store employees, we would love to have a copy.)

Product Mix

15. Can you describe the process used to determine the types and allocated amount of lighting products included in the program for each retailer? Were you satisfied with the mix of products supported by the program?

Rebates/Incentives

16. Can you describe the process for determine the incentive levels for the products? Was the

incentive similar across retailers? Were the retailers happy with the incentive levels?

17. Did the program discount the same products through the length of the program? Or did it bring skus in and out or turn them off and on?

Marketing and Promotion

18. Can you describe the marketing activities that took place? Was there a mix of in-store and out of store marketing?

19. Was the level of marketing and promotion sufficient? Which activities do you think have had the greatest influence on customer awareness of the measures and benefits of the program?

Payment Process

20. Did the payment process between EFI, manufacturers and retailers run smoothly? Were there procedures in place to learn about any problems that might come up in the payment process?

21. How did this process differ for coupon versus markdown retailers?

Data Tracking

22. Can you briefly describe what type of data was tracked for this program? How do you obtain the data? Is sales data updated as part of the retailer/manufacturer invoicing process? How does it differ for markdown versus coupon retailers?

23. What data does APT track and what does EFI track?

24. How frequently did you send AEG/DNREC updates?

Quality Assurance and Quality Control

25. What QA/QC procedures did the program have in place? Were they effective?

Program Shutdown

26. I understand that the program shutdown early due to budget issues with other programs. Is that right? Can you describe how the shutdown took place? How did retailers respond?

Thank you very much for taking the time in assisting us with this evaluation. Your contribution is a very important part of the process. We might follow-up with you by phone later, if additional questions arise.

Energize Delaware Lighting Program

Implementer Guide: EFI

May, 2012

[Note to Reviewer] The Interview Guide is a tool to guide process evaluation interviews with utility staff and implementation contractors. The guide helps to ensure the interviews include questions concerning the most important issues being investigated in this study. Follow-up questions are a normal part of these types of interviews. Therefore, there will be sets of questions that will be more fully explored with some individuals than with others. The depth of the exploration with any particular respondent will be guided by the role that individual played in the program's design and operation, i.e., where they have significant experiences for meaningful responses. The interviews will be audio taped and transcribed.

Program Roles and Protocols

Before we get started, I need to inform you that I will be taping this phone call so that I don't have to take too many notes. Is this ok with you?

27. Can you describe your role within the Energize Delaware lighting program? What were your main responsibilities?

28. In your opinion, how effective was the Energize Delaware lighting program? What elements of the program worked best? What elements needed improvement?

29. Can you describe the relationship between AEG and APT and EFI with respect to the program? What was each party responsible for? What responsibilities were shared?

Payment Processes/Interactions with Retailers, Manufacturers

30. I'd like to talk about the payment process between EFI and manufacturers and retailers for both the coupons and markdown program. What data was required from manufacturers/retailers to process incentives for the markdown program? What data was required from to process rebates for the coupon program?

31. Were there any problems with manufacturers/retailers not submitting all of the required information (as far as sales data or coupon data)? What about with submitting information on time? How did you resolve (or attempt to resolve) those problems?

32. How about missing data for the coupon program? What percentage of coupons contained missing or invalid customer contact information? Did anyone monitor the coupon sales data for missing/invalid information? Is there any feedback mechanism that provides retailers information about missing/invalid coupon data?

33. How did EFI verify that the skus retailers/manufactures requested reimbursement are the skus that on the MOU from a store location that is also stated on the MOU. Did you have you have any issues with retailers/manufacturers requesting reimbursement for skus or store locations that aren't on the MOU?

Data Tracking

34. I would like to talk a little bit about the program tracking systems. Can you briefly describe what data was tracked by EFI? How often did you receive data on the store level?

35. What data did you provide to AEG/DNREC? How frequently did you provide updates to AEG/DNREC? How about to APT?

36. Can you describe the process for populating the program tracking databases? Were you happy with the program tracking systems?

37. Did you provide any reports for AEG/DNREC to provide summary information (by retailer, store location, manufacturer and sku)? Any custom reports?

Quality Assurance and Quality Control

38. What QA/QC procedures did the program have in place? Were they effective?

Other

39. Is there anything else relevant to the program or program's progress that we have not discussed that we should know about, as far as EFI is concerned?

40. Are there any additional people with key roles that we should talk to?

Thank you very much for taking the time in assisting us with this evaluation. Your contribution is a very important part of the process. If I come up with any additional questions that come from this interview do you mind if I send you an email or give you a call?

Home Performance with ENERGY STAR

DNREC Energize Delaware Home Performance with ENERGY STAR Program

BPI Contractor Depth Interview Guide

May 21, 2012

Name of Interviewee: _____ Date: _____

Title: _____ Company: _____

[Note to Reviewer] The Interview Guide is a tool to guide process evaluation interviews with contractors who conduct audits for DNREC's Energize Delaware's HPwES programs. The guide helps to ensure the interviews include questions concerning the most important issues being investigated in this study. Follow-up questions are a normal part of these types of interviews. Therefore, there will be sets of questions that will be more fully explored with some individuals than with others. The depth of the exploration with any particular respondent will be guided by the role that individual plays in the program's design and operation, i.e., where they have significant experiences for meaningful responses. The interviews will be audio taped.

This guide will be used for:

- *BPI Certified auditors that conducted the audit, provided recommendations, and conducted final test out of upgrades*
- *BPI Certified contractors that performed audits, installed some or all of the recommended upgrades, and conducted final test out of upgrades*

PARTICIPATING CONTRACTOR FLAGS:

1 AUDITOR ONLY

2 AUDITOR AND INSTALLER

8.5.1 Introduction

Hi, may I please speak with [NAME]?

My name is _____ and I'm calling from Opinion Dynamics. I'm working on a project on behalf of the Delaware Department of Natural Resources and Environmental Control (DNREC) to help them better understand the impact of Energize Delaware's Home Performance with ENERGY STAR program that ran from July 2010 to December 2011. The program provided substantial rebates to residential customers who replaced home heating and cooling equipment, among other measures. To better develop similar programs in the future, it is critical that we talk with contractors who participated in the program.

My records indicate that you were involved with the program and I'd like to ask you some questions about your experience with it. Is that correct? [If yes:] Are you the best person to speak with at your company about your participation in the Program? [If no, obtain correct contact; if yes ask if it's a good time to talk]

The questions that I have will take about 20 minutes and your responses will be kept strictly confidential.

8.5.2 Background

To get us started, I have a few general questions about your participation in the Home Performance with Energy Star Program.

1. Are you a certified BPI contractor?

2. Were you already BPI certified before the Energize Delaware HPwES Program began? [IF NO] Did you become BPI certified in order to participate in the program?

3. Did you perform home audits on behalf of the Energize Delaware Home Performance with ENERGY STAR Program?

4. Did you make any of the installations for the Home Performance Program? [IF YES] What installations did you make? Did you install central air conditioners? heat pumps? or furnaces? Insulation?

[IF Q3=YES, CONTINUE]

[IF Q3=NO AND Q4=HVAC EQUIPMENT ONLY, SWITCH TO HVAC CONTRACTOR ONLY SURVEY INSTRUMENT.]

[IF Q3=NO AND Q4=NO, THANK AND TERMINATE]

8.5.3 Marketing and Outreach

5. What is the typical way that you find customers? How did you find customers to participate in this program in particular?

6. What was the general level of awareness of the HPwES Program among your customers? [Probe for whether they were familiar with energy audits; Probe if some types of customers that were more aware than others] Did you typically inform customers about the program, or did they already hear about it through other sources?

7. When the program was active, did you promote it to your customers?

   If so, how? Do you frequently conduct marketing or outreach in general?

8. Did you receive and use any marketing collateral from Energize Delaware to help you promote the program? [Prompt if needed: such as fact sheets, case studies, materials to help explain payback periods] [If yes:] Where they useful? Are there other materials that would have been useful? [If no:] Would they have helped?

9. Is there anything that Energize Delaware could have done to help *you* be more effective in promoting this program to your customers?

10. Do you think the level of marketing and promotion that Energize Delaware conducted for this program was appropriate and effective? [Probe for whether it occurred enough, as well as clarity of messaging, targeting the right audience, etc.]

8.5.4 Training, Technical Support, and Software

11. What type of training or technical support, if any, did you receive from Energize Delaware or ICF related to the HPwES program?

12. If you did receive training from Energize Delaware, did it adequately prepare you to use the

tools and software required by the program, such as the Beacon Home Energy Advisor (Beacon HEA) software?

13. Are there any other areas for which you would have liked to receive additional training or technical support? Less?

14. If you had a question about the program technical requirements or processes, where would you go to find the information you needed? Where your questions adequately explained or addressed? [If not] What could have been done to more effectively communicate this information to you?

15. In general, were you satisfied with the program's level of training and technical support? [If dissatisfied] How could more support be provided to you in any future programs?

8.5.5 Home Audit Process

16. Did you perform most or all of the audits yourself, or did you work with others in some instances to conduct the audits?

17. When the Energize Delaware HPwES Program was active, did you perform home energy audits or energy efficiency upgrades outside of the program? Are you still performing them now?

18. Can you briefly take me through the steps that were typically involved in the home audit, from your first to last contact with the customer? [incl. preparation, in-home, post-audit actions] [May not need to ask this of everyone depending on the extent to which the same thing is commonly repeated as the interviews progress]

19. Of the audits that you performed, what percentage of homeowners would you say went ahead with the installation of some or all of the recommended measures? [ASK IF AUDITOR AND INSTALLER] For what percentage of those did you do the installations?

20. Did you provide any verbal recommendations that were not part of the home audit report? If so, can you give me an example?

21. Did you provide any educational materials to customers during the home audit? [IF YES] Did you use any educational materials from Energize Delaware? Did you think the education that

customers received about saving energy as part of the HPwES program was adequate?

22. Do you think that the energy savings and payback calculations for the recommended measures from the audit report were presented in a clear and understandable manner to customers? How useful do you believe the audits were to customers?

23. Do you think that the home audits conducted as part of the Energize Delaware program were an effective way to increase the number of measures installed?

24. Did you have any problems or hear complaints from customers about the home audit? [Probe for areas of confusion about audit, communication issues, quality of work/measures]

25. For what percent of the projects you were involved with, approximately how many were you also responsible for the test out of the installed measures? [IF NOT RESPONSIBLE] Who was responsible for the test out?

8.5.6 Recommended Measures

26. You may recall that there were three participation "paths" within this program— the HVAC Rebate Path, the Standard Path, and the Performance Path. (If needed: The HVAC rebate path offered prescriptive rebates, and the Standard and Performance paths offered rebate based on BEACON modeling). Thinking back to the homes you worked on, which of the paths did most of your projects go through? Why?

27. Which recommended measures were customers most interested in? Least? [Probe for air sealing, insulation (attic, walls, basement, floor), heating and cooling system upgrades, duct sealing (for HVAC)]

28. Energize Delaware is interested in learning more about the uptake of shell measures. How often would you say that you recommended shell measure installations as part of the Energize Delaware program? [IF NOT OFTEN OR NEVER] Why was that the case?

29. In cases where you recommended shell measures, what percentage of customers ended up installing the recommended shell measures? [IF LOW] Why do you think customers didn't choose to install them? What could have been done to increase the uptake in shell measures?

[ASK IF AUDITOR AND INSTALLER]

30. On what percentage of the Energize Delaware Home Performance jobs did you bring in another contractor to help complete the job? What type of specialties did these other contractors have?

31. Do you think an alternative approach might be needed to encourage the recommendation and installation of shell measures than the approach used by Energize Delaware's program? If so, what would you recommend?

32. From your perspective, what were the main barriers to customers taking the actions recommended to them? [Probe for pricing/rebate amounts, financing interest rates, Energize Delaware eligibility requirements, other customer factors]. Did this vary by any particular customer characteristics? By type of measure? Anything else?

33. In your opinion, is there anything that Energize Delaware could have been done to encourage more customers to take the other recommended actions? If so, what?

34. Have you had any problems or heard complaints from customers regarding the installation of measures that were recommended during the audit and then installed? [Probe for areas of confusion about measures, pricing, scheduling, communication issues]

8.5.7 Customer Rebates and Financing

35. As you may recall, there was a financing option available for this program above and beyond the incentives offered. Did you promote the availability of a loan to your customers? [IF NO] Why not?

36. In your opinion, how important were the available rebates and financing options to customers' decision-making processes about which recommended measures to install? Were they sufficient to induce customers to adopt all or some of the recommended measures?

Opportunities for Program Improvement

37. In general, how satisfied were you with the program? Please explain.

38. What challenges did you face in performing home audits or installing recommended

measures through the Energize Delaware program?

39. Do you have any recommendations that could help to improve any potential future HPwES programs? [If not mentioned] Do you have recommendations specific to the contractor experience?

Thank you very much for taking the time to assist us with this evaluation. Your contribution is a very important part of the process. Do you mind if we follow-up with your by phone or e-mail later, if additional questions arise?

DNREC Energize Delaware Home Performance with ENERGY STAR Program

HVAC-only Contractor Depth Interview Guide

May 24, 2012

[Note to Reviewer] The Interview Guide is a tool to guide process evaluation interviews with program staff and implementation contractors. The guide helps to ensure the interviews include questions concerning the most important issues being investigated in this study. Follow-up questions are a normal part of these types of interviews. Therefore, there will be sets of questions that will be more fully explored with some individuals than with others. The depth of the exploration with any particular respondent will be guided by the role that individual played in the program's design and operation, i.e., where they have significant experiences for meaningful responses. The interviews will be audio taped and transcribed.

This guide will be used for contractors who only made HVAC installations for the program and did not perform audits.

Hello, my name is _____ and I'm calling from Opinion Dynamics. I'm working on a project on behalf of the Delaware Department of Natural Resources and Environmental Control (DNREC) to help them better understand the impact of Energize Delaware's Home Performance with ENERGY STAR program that ran from July 2010 to December 2011. The program provided substantial rebates to residential customers who replaced home heating and cooling equipment, among other measures. To better develop similar programs in the future, it is critical that we talk with contractors who install residential HVAC equipment in Delaware. Getting a better sense of what is selling in the market will help to provide future rebates in more effective ways.

Screening

I'd like to ask you some questions about your experience with your installations of residential heating and cooling equipment in Delaware. The questions that I have will take about 10 minutes and your responses will be kept strictly confidential. Are you the best person to speak with at your company about installations of heating and cooling equipment? [If no, obtain correct contact]

[IF YES] Is this a good time to talk? [IF NO, SCHEDULE A CALL BACK.]

1. To get us started, does your company install your products just in Delaware? If not, what other areas/States do you install products in?

2. Are you a certified BPI contractor?

3. Did you conduct audits on behalf of the Energize Delaware Home Performance with ENERGY STAR program? (If no: Did you work with other contractors who performed audits?)

4. Do you install residential HVAC equipment? [IF YES] Do you install central air conditioners? heat pumps? or furnaces?

[IF NO TO RES HVAC EQUIPMENT OR ALL TYPES OF EQUIPMENT, THANK AND TERMINATE]

Residential Central Air Conditioning

[Skip based on answer to Q3]

5. Let's start with residential central cooling equipment. Could you tell me approximately how many RESIDENTIAL central air conditioners you installed for customers in Delaware in 2011? [If needed: Your best estimate is fine.]] [If needed: please consider residential central air conditioners to be units with a tonnage of 2.5 or less]

6. Similarly, could you tell me how your installations of residential central cooling equipment for customers in Delaware would break down across efficiency levels? What percentage of your residential sales were:

Between 13 and 14.9 SEER?	_____ %
15. SEER to 15.9 SEER?	_____ %
16 SEER and higher	_____ %
	100

[If sell in other states: Probe for whether these efficiency breakdowns are comparable to what they might see in other states?]

[Probe for which SEER levels constitute the 16+ category; What's the range of SEER levels you see? What is most common?]

Residential Heat Pumps

[Skip based on answer to Q3]

7. Now let's turn to heat pumps. Could you tell me approximately how many RESIDENTIAL heat pumps your company installed for customers in Delaware in 2011? [If needed: Your best estimate is fine.] [If needed: please consider residential heat pumps to be units with a tonnage of 5 or less.]

8. Similarly, could you tell me how your sales of residential heat pumps in Delaware would breakdown across efficiency levels? What percentage of your residential sales were:

Less than SEER 14?	_____ %
14 SEER, 12 EER, or 8.2 HSPF up to 15 SEER, 12.5 EER, or 8.5 HSPF?	_____ %
15 SEER, 12.5 EER, or 8.5 HSPF up to 16 SEER, 13 EER, or 8.5 HSPF?	_____ %
16 SEER, 13 EER, or 8.5 HSPF and higher?	_____ %
	100

Residential Furnaces

[Skip based on answer to Q3]

9. Finally let's turn to residential furnaces. Could you tell me approximately how many RESIDENTIAL furnaces your company installed for customers in Delaware in 2011 [If needed: Your best estimate is fine.] [If needed: please consider residential furnaces to be units with firing rates of 150,000 Btu/h or less]

10. Similarly, could you tell me how your sales of residential furnaces to customers in Delaware

would breakdown across efficiency levels? What percentage of your residential sales were:

Less than 90% AFUE (non-condensing)?	_____ %
90% AFUE up to 92% AFUE?	_____ %
92% AFUE up to 95% AFUE?	_____ %
95% AFUE and higher	_____ %
	100

11. We are interested in the impact that the Energize Delaware program may have had on both your overall sales volume as well as how those sales breakout across various efficiency levels. Do you think that the Energize Delaware Home Performance with ENERGY STAR program had an impact on your overall sales while it was running? Did it have any impact on the efficiency levels of the units that you were selling? If the impact was positive, has it had a lasting impact on the efficiency levels that you sell to your customers now?

12. Is there anything else you would like to say about your installation practices or how the Energize Delaware Home Performance with ENERGY STAR program may have impacted them?

13. Could you provide the names of any distributors of residential HVAC equipment in Delaware? [If necessary: It can be hard to identify which distributors are active in Delaware, so any suggestions you might have would be greatly appreciated.]

Thank you very much for taking the time to assist us with this evaluation. Your contribution is a very important part of the process. Do you mind if we follow-up with your by phone or e-mail later, if additional questions arise?

DNREC Energize Delaware Home Performance with ENERGY STAR Program

Distributors Depth Interview Guide

May 17, 2012

[Note to Reviewer] The Interview Guide is a tool to guide process evaluation interviews with program staff and implementation contractors. The guide helps to ensure the interviews include questions concerning the most important issues being investigated in this study. Follow-up questions are a normal part of these types of interviews. Therefore, there will be sets of questions that will be more fully explored with some individuals than with others. The depth of the exploration with any particular respondent will be guided by the role that individual played in the program's design and operation, i.e., where they have significant experiences for meaningful responses. The interviews will be audio taped and transcribed.

Hello, my name is _____ and I'm calling from Opinion Dynamics. I'm working on a project on behalf of the Delaware Department of Natural Resources and Environmental Control (DNREC) to help them better understand the impact of ENERGIZE DELAWARE's Home Performance with ENERGY STAR program that ran from July 2010 to December 2011. The program provided substantial rebates to residential customers who replaced home heating and cooling equipment, among other measures. To better develop similar programs in the future, it is critical that we talk with distributors of residential HVAC equipment in Delaware. Getting a better sense of what is selling in the market will help to provide future rebates in more effective ways.

[If applicable] _____ [X Contractor] provided me with your name. He/she suggested that you would be really knowledgeable about the Delaware HVAC market and could help us understand the impact of ENERGIZE DELAWARE's programs]

Screening

I'd like to ask you some questions about your experience with your distribution of residential heating and cooling equipment in Delaware. The questions that I have will take about 10 minutes and your responses will be kept strictly confidential. Are you the best person to speak with at your company about sales in Delaware of heating and cooling equipment? [If no, obtain correct contact]

[IF YES] Is this a good time to talk? [IF NO, SCHEDULE A CALL BACK.]

1. To get us started, does your company distribute your products just in Delaware? If not, what other areas/states do you sell into?

2. Do you distribute residential HVAC equipment? [IF YES] Do you distribute: central air conditioners? heat pumps? furnaces?

[IF NO TO RES HVAC EQUIPMENT OR ALL TYPES OF EQUIPMENT, THANK AND TERMINATE]

Residential Central Air Conditioning

[Skip based on answer to Q2]

3. Let's start with residential central cooling equipment. Could you tell me approximately how many RESIDENTIAL central air conditioners you sold in 2011 to contractors who service customers in Delaware? [If needed: Your best estimate is fine.] [If needed: please consider residential central air conditioners to be units with a tonnage of 2.5 or less]

4. Similarly, could you tell me how your sales of residential central cooling equipment, to contractors installing in Delaware, would breakdown across efficiency levels? What percentage of your residential sales were:

Between 13 and 14.9 SEER?	_____ %
15 SEER to 15.9 SEER?	_____ %
16 SEER and higher	_____ %
	100

[If sell in other states: Probe for whether these efficiency breakdowns are comparable to what they might see in other states?]

[Probe for which SEER levels constitute the 16+ category; What's the range of SEER levels

you see? What is most common?]

Residential Heat Pumps

[Skip based on answer to Q2]

5. Now let's turn to heat pumps. Could you tell me approximately how many RESIDENTIAL heat pumps you sold in 2011 to contractors who service customers in Delaware? [If needed: Your best estimate is fine.] [If needed: please consider residential heat pumps to be units with a tonnage of 5 or less.

6. Similarly, could you tell me how your sales of residential heat pumps to contractors installing in Delaware would breakdown across efficiency levels? What percentage of your residential sales were:

Less than SEER 14?	_____ %
14 SEER, 12 EER, or 8.2 HSPF up to 15 SEER, 12.5 EER, or 8.5 HSPF?	_____ %
15 SEER, 12.5 EER, or 8.5 HSPF up to 16 SEER, 13 EER, or 8.5 HSPF?	_____ %
16 SEER, 13 EER, or 8.5 HSPF and higher?	_____ %
	100

Residential Furnaces

[Skip based on answer to Q2]

7. Finally let's turn to residential furnaces. Could you tell me approximately how many RESIDENTIAL furnaces you sold in 2011 to contractors who service customers in Delaware? [If needed: Your best estimate is fine.] [If needed: please consider residential furnaces to be units with firing rates of 150,000 Btu/h or less]

8. Similarly, could you tell me how your sales of residential furnaces to contractors installing in Delaware would breakdown across efficiency levels? What percentage of your residential sales were:

Less than 90% AFUE (non-condensing)?	_____ %
90% AFUE up to 92% AFUE?	_____ %
92% AFUE up to 95% AFUE?	_____ %
95% AFUE and higher	_____ %
	100

9. We are interested in the impact that the ENERGIZE DELAWARE program may have had on both your overall sales volume as well as how those sales breakout across various efficiency levels. Do you think that the ENERGIZE DELAWARE program had an impact on your overall sales while it was running? Did it have any impact on the efficiency levels of the units that you were stocking?

10. Is there anything else you would like to say about your stocking practices or how the ENERGIZE DELAWARE Home Performance with ENERGY STAR program may have impacted them?

11. Could you provide the names of any other distributors of residential HVAC equipment that operate in Delaware? [If necessary: It can be hard to identify which distributors are active in Delaware, so any suggestions you might have would be greatly appreciated.]

Thank you very much for taking the time to assist us with this evaluation. Your contribution is a very important part of the process. Do you mind if we follow-up with your by phone or e-mail later, if additional questions arise?

Energize Delaware Home Performance with ENERGY STAR

Participant Survey – FINAL

May 23, 2012

Sample Read-Ins

CONTACT NAME: First and last name of customer

RebateDate: Month and year the rebate check was issued (survey includes customers with rebate check dates on March 1, 2011 or after

MFlag1: Furnace

MFlag2: Boiler

MFlag3: Heat pump

MFlag4: Central air conditioning system

MFlag5: Insulation

MFlag6: Air or duct sealing

MFlag7: Compact fluorescent light bulbs (CFLs)

#Flag: Number of measures installed

9. INTRODUCTION

Hi, May I please speak with <CONTACT NAME>

My name is _____ from Opinion Dynamics, an independent research company, and I'm calling

on behalf of Delaware Department of Natural Resources and Environmental Control (DNREC). We're speaking with Delaware residents who have participated in the Energize Delaware Home Performance with ENERGY STAR Program. As part of this program, a certified contractor conducted an energy audit of your home, and you received a rebate for the installation of energy saving improvements.

I would like to ask you some questions about your experience with the program. This information will be used to make improvements to future energy efficiency programs offered to Delaware residents. The questions that I have will only take about 10-15 minutes and your responses will be kept strictly confidential.

C1. Are you currently talking to me on a regular landline phone or a cell phone?

1. Regular landline phone
2. Cell Phone
8. (Don't know)
9. (Refused)

[ASK IF C1=2; ELSE GO TO SURVEY START]

C2. Are you currently in a place where you can talk safely and answer my questions?

1. Yes
2. No [Schedule call back]
3. No (DO NOT CALL BACK)
8. (Don't know) [Schedule call back]
9. (Refused) [Schedule call back]

<u>Screener</u>

S1. According to our records, your household received a rebate through the Home Performance with ENERGY STAR Program in <RebateDate>. Is that correct?

1. Yes

2. No – different date

3. No – did not receive rebate

8. (Don't know)

9. (Refused)

[IF S1=3,8,9 THANK AND TERMINATE]

Program Awareness

PA1. How did you hear about Energize Delaware's Home Performance with ENERGY STAR Program? [MULTIPLE RESPONSE, UP TO 3]

1. (Contractor)

2. (Mailing/brochure/bill insert)

3. (Program website)

4. (Friends/family/word of mouth)

5. (Online social media)

00. (Other, specify)

98. (Don't know)

99. (Refused)

PA2. Were you aware of the rebate offered through the Home Performance with ENERGY STAR Program when you… [1=Yes, 2=No, 6=Did not have audit (only make option for PA2B), 8=Don't know, 9=Refused]

a. first started thinking about making energy efficiency improvements to your home?

b. decided to have an energy audit conducted for your home?

[IF PA2b=6, SKIP TO CONTRACTOR SECTION]

Home Energy Audit

My next few questions are about the home energy audit you received as part of your participation in the Home Performance with ENERGY STAR Program.

HA0. What were the reasons you decided to have the audit performed? [MULTIPLE RESPONSE, UP TO 3]

1. (To learn how my home uses energy)
2. (To identify ways to save money on utility bills)
3. (To qualify for the Home Performance rebate)
4. (To replace broken or old equipment)
5. (Part of a broader remodeling or renovation)
6. (To increase comfort in the home)
7. (To get more efficient equipment)
9. (To help the environment)
00. (Other, specify)
96. (Did not have an audit)
98. (Don't know)
99. (Refused)

[IF HA0=96, SKIP TO NEXT SECTION]

HA1. How did you find the contractor who conducted the home energy audit? [SINGLE RESPONSE]

1. (Program website)
2. (Family/friend/word of mouth)
3. (Called a contractor I knew)
00. (Other, specify)
98. (Don't know)
99. (Refused)

HA2. What was the MAIN reason for selecting this contractor?

1. (Least expensive)
2. (Positive references/highly recommended)
3. (Family/friend recommended)
4. (Used contractor before)
00. (Other, please specify)
98. (Don't know)
99. (Refused)

HA3. As a result of the home energy audit, would you say that your awareness of energy efficiency and ways to make your home more efficient increased substantially, increased somewhat, or stayed the same?

1. Increased substantially
2. Increased somewhat
3. Stayed the same
8. (Don't know)
9. (Refused)

HA4a. How clear were the estimates of energy and cost savings of recommended measures included in the audit report? Would you say…

1. Very clear
2. Somewhat clear
3. Not very clear
4. Not at all clear
8. (Don't know)
9. (Refused)

[ASK IF HA4a=3,4]

HA4b. Why do you say that? [OPEN END]

HA5. I would like to see how satisfied you were with the energy audit and the auditor who performed the audit. On a scale from 1 to 10 where 1 is "extremely dissatisfied" and 10 is "extremely satisfied," how satisfied were you with… [SCALE 1-10; 98=Don't know, 99=Refused]

a. The quality of information provided in the audit report

b. The auditor's level of customer service and professionalism

c. The auditor's ability to answer questions about the Home Performance Program

d. The auditor overall

[ASK IF HA5a<7]

HA6a. It sounds like you weren't fully satisfied with the information provided in the audit report. Why did you give that rating? [OPEN END, 98=DK, 99=Refused]

[ASK IF HA5b<7]

HA6b. It sounds like you weren't fully satisfied with your auditor's level of customer service and professionalism. Why did you give that rating? [OPEN END, 98=DK, 99=Refused]

[ASK IF HA5c<7]

HA6c. It sounds like you weren't fully satisfied with your auditor's ability to answer questions about the Home Performance Program. Why did you give that rating? [OPEN END, 98=DK, 99=Refused]

[ASK IF HA5d<7]

HA6d. It sounds like you weren't fully satisfied with your auditor overall. Why did you give that rating? [OPEN END, 98=DK, 99=Refused]

HA7. How likely is it that you would have had an energy audit, if you had not participated in the Home Performance with ENERGY STAR Program? Would you say …

1. Very likely
2. Somewhat likely
3. Not very likely
4. Not at all likely
8. (Don't know)
9. (Refused)

Contractors

My next few questions are about the contractor that made the energy saving improvements in your home.

[SKIP IF HA0=96 OR QPA2B=6]

C1. Did the same company that conducted the audit also make some or all of the energy improvements to your home?

1. Yes, all improvements
2. Yes, some improvements
3. No, none of the improvements
8. (Don't know)
9. (Refused)

[ASK IF C1=3,8,9, OR HA0=96 OR QPA2B=6, ELSE SKIP TO C4]

C2. How did you find the contractor that completed the energy improvements to your home? [SINGLE RESPONSE]

1. (Program website)
2. (Family/friend/word of mouth)
3. (Called a contractor I knew)
00. (Other, specify)
98. (Don't know)
99. (Refused)

C3. What was the MAIN reason for selecting this contractor?

1. (Least expensive)
2. (Positive references/highly recommended)
3. (Family/friend recommended)
4. (Used contractor before)
00. (Other, please specify)
98. (Don't know)
99. (Refused)

[ASK C4 IF C1=1,2, ELSE SKIP TO C5A]

[SKIP IF HA0=96 OR QPA2B=6]

C4. Did the same individual that did the home energy audit also complete the energy efficiency improvements to your home?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK ONLY C5a IF C4=1,ELSE ASK C5a-d]

C5. On a scale from 1 to 10 where 1 is "extremely dissatisfied" and 10 is "extremely satisfied," how satisfied were you with… [SCALE 1-10; 98=Don't know, 99=Refused]

a. The contractor's quality of work

b. The contractor's level of customer service and professionalism

c. The contractor's ability to answer questions about the Home Performance Program

d. The contractor overall

[ASK IF C5a<7]

C6a. It sounds like you weren't fully satisfied with the contractor's quality of work. Why did you give that rating? [OPEN END, 98=DK, 99=Refused]

[ASK IF C5b<7]

C6b. It sounds like you weren't fully satisfied with the contractor's level of customer service and professionalism. Why did you give that rating? [OPEN END, 98=DK, 99=Refused]

[ASK IF C5c<7]

C6c. It sounds like you weren't fully satisfied with the contractor's ability to answer questions about the Home Performance Program. Why did you give that rating? [OPEN END, 98=DK, 99=Refused]

[ASK IF C5d<7]

C6d. It sounds like you weren't fully satisfied with the contractor overall. Why did you give that rating? [OPEN END, 98=DK, 99=Refused]

Installations

I now have a few questions about the improvements for which you received a rebate through the Home Performance with Energy Star Program. (Note to interviewer: Measures listed include a subset of all measures installed. We are interested in the information only for those measures listed.)

I1. Our records show that you received a rebate for the following improvements, is that correct? You installed… [1=Yes, 2=No, 8=Don't know, 9=Refused]

a. a furnace [ASK IF MFlag1=1]

b. a boiler [ASK IF MFlag2=1]

c. a heat pump [ASK IF MFlag3=1]

d. central air conditioning [ASK IF MFlag4=1]

e. insulation [ASK IF MFlag5=1]

f. air or duct sealing [ASK IF MFlag6=1]

g. compact fluorescent light bulbs, or "CFLs" [ASK IF MFlag7=1]

I2. What were the reasons you decided to make the energy improvements to your home following the audit? [MULTIPLE RESPONSE, UP TO 3]

1. (To replace old/broken equipment)
2. (Part of a broader remodeling or renovation)
3. (To save money on energy bills)
4. (To increase comfort in the home)
5. (To help the environment)
00. (Other, specify)
98. (Don't know)
99. (Refused)

I3. Were the improvements you made limited at all by the rebate amount available to you?

1. Yes
2. No
8. (Don't know)
9. (Refused)

CFLs

[ASK IF I1g=1, ELSE SKIP TO NEXT SECTION]

I have a few questions about the CFLs you received through the Home Performance with Energy Star Program.

CFL1. Our records show that you received <Q_CFL> CFLs, is that correct?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF CFL1=2]

CFL2. How many compact fluorescent light bulbs did you receive? (Ask for best guess, if needed) [NUMERIC OPEN END; 0 TO 200, 998=Don't know, 999=Refused]

[GENERATE V_QCFL

IF CFL1=1,8: V_QCFL=Q_CFL,

IF CFL1=2 AND CFL2<>998,999: V_QCFL=CFL2

IF CFL1=2 AND CFL2=998,999: V_QCFL=Q_CFL]

[ASK IF CFL1=1,8 OR CFL2>0) ELSE SKIP TO FR1]

CFL3. Did the contractor who performed the energy audit install the CFLs for you?

1. Yes,all
2. No
3. (Some)
8. (Don't know)
9. (Refused)

CFL4. How many of the CFLs you received through the program are currently installed in your home? (INTERVIEWER NOTE: Number of CFLs removed should not exceed number of CFLs installed <V_QCFL>.) [NUMERIC OPEN END: CAPTURE NUMBER 1 -200]

201. All

000. None

998. (Don't know)

999. (Refused)

[GENERATE VINSTALL WHERE IF CFL4=201 MAKE =V_QCFL, IF CFL4=000,998,999 MAKE =0, ALL ELSE MAKE = QCFL4]

[GENERATE CFL_REMOVE WHERE IF CFL4=201, MAKE = 0, IF QCFL4=000, MAKE=1 AND WHERE VINSTALL<V_QCFL, MAKE =1, ALL ELSE 0] (1: REMOVED CFLS, 0: DID NOT REMOVE CFLs)

[ASK IF CFL_REMOVE=1] AND QCFL4<>998,999

CFL5. What did you do with the CFLs that are not currently installed? [MULTIPLE RESPONSE=3]

1. (In storage for later use)

2. (Gave them away)

3. (They broke)

00. (Other, specify)

98. (Don't know)

99. (Refused)

Free Ridership

[ASK IF AT LEAST ONE OF I1a-g=1, ELSE SKIP TO NEXT SECTION]

[SKIP IF HA0=96 OR QPA2B=6]

FR1. Before you had the energy audit, were you aware of the savings you could get from installing the… [1=Yes, 2=No, 8=Don't know, 9=Refused]

a. Furnace [ASK IF I1a=1]

b. Boiler [ASK IF I1b=1]

c. Heat pump [ASK IF I1c=1]

d. Central air conditioning system [ASK IF I1d=1]

e. Insulation [ASK IF I1e=1]

f. Air or duct sealing [ASK IF I1f=1]

g. CFLs (compact fluorescent light bulbs) [ASK IF I1g=1]

FR2. If you had not received the rebate from the Home Performance with Energy Star Program, would you have installed the… [1=Yes, 2=No, 8=Don't know, 9=Refused]

a. a new Furnace [ASK IF I1a=1]

b. a new Boiler [ASK IF I1b=1]

c. a new Heat pump [ASK IF I1c=1]

d. a new Central air conditioning system [ASK IF I1d=1]

e. new Insulation [ASK IF I1e=1]

f. new Air or duct sealing [ASK IF I1f=1]

g. new Lighting [ASK IF I1g=1]

[ASK IF AT LEAST ONE OF FR2a-g=1, ELSE SKIP TO FR6]

FR3. How likely is it that the improvements would have had the same level of efficiency, if you had made them without the Home Performance with Energy Star Program rebate? Would you say…

1. Very likely
2. Somewhat likely
3. Not very likely
4. Not at all likely
8. (Don't know)
9. (Refused)

FR4. Without the Home Performance with Energy Star Program rebate, when do you think you would have made the energy saving improvements to your home? Would you say…

1. At the same time
2. Earlier
3. Later
4. (Never)
8. (Don't know)
9. (Refused)

[ASK IF FR4=3]

FR5. How much later would you have made these improvements? Would you say…

1. Within six months
2. Six months to a year later
3. One to two years later
4. More than two years later
8. (Don't know)
9. (Refused)

FR6. How influential were the following factors in your decision to participate in the Home Performance with ENERGY STAR program and make the improvements to your home? Please use a scale of 1 to 10, where 1 means 'not at all influential' and 10 means 'extremely influential.' How influential was … [SCALE 1-10; 98=Don't Know; 99=Refused]

a. [SKIP IF HA0=96 OR QPA2B=6] The information provided by the auditor or the audit

report

b. The availability of the rebates

c. Access to a contractor with specific training in energy efficiency

d. The availability of a financing option at an attractive interest rate [96=Was not aware of this option]

e. Ease of participation

Shell Measures

[ASK IF MFLAG5=0 AND MFLAG6=0, ELSE SKIP TO NEXT SECTION]

SM1. Did the audit report also recommend… [1=Yes, 2=No, 8=Don't know, 9=Refused]

a. insulation for your attic, basement, or walls

b. air sealing or duct sealing

[ASK IF SM1a=1 OR SM1b=1]

SM2. Why did you not install these recommended improvements as part of your project? [MULTIPLE RESPONSE, UP TO 6]

1. (Too expensive)

2. (Too time intensive)

3. (Decided to make them later)

00. (Other, please specify)

98. (Don't know)

99. (Refused)

Spillover

SO1. AFTER receiving the rebate from the Home Performance with Energy Star Program, have you made any ADDITIONAL energy saving improvements to your homefor which you did not receive a rebate?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF SO1=1, ELSE SKIP TO NEXT SECTION]

SO2a. What improvements did you make? [MULTIPLE RESPONSE, UP TO 6]

1. (installed a furnace)
2. (installed a boiler)
3. (installed a water heater)
4. (installed a heat pump)
5. (installed an air conditioner)
6. (installed windows)
7. (installed insulation)
8. (installed air or duct sealing)
9. (installed CFLs/lighting)
00. (Other, specify)
98. (Don't know)
99. (Refused)

SO2b. Were these improvements recommended by the auditor or the audit report?

1. Yes – all
2. Yes – some
3. No
8. (Don't know)

9. (Refused)

[ASK IF SO2b=2]

SO2c. Which improvements were recommended by the auditor or the audit report? [SHOW RESPONSES FROM SO2a]

1. (installed a furnace)
2. (installed a boiler)
3. (installed a water heater)
4. (installed a heat pump)
5. (installed an air conditioner)
6. (installed windows)
7. (installed insulation)
8. (installed air or duct sealing)
9. (installed CFLs/lighting)
00. (Other, specify)
98. (Don't know)
99. (Refused)

[ASK IF SO2b=1,2]

SO3. Why did you not make these improvements as part of your Energize Delaware project?

1. (Didn't qualify for rebate)
2. (Decided to make improvements later)
3. (Exceeded maximum rebate amount)
00. (Other, please specify)
98. (Don't know)
99. (Refused)

SO4. How influential was your experience with the Home Performance with Energy Star Program in your decision to make these additional improvements? Please use a scale from 1 to 10,

where 1 is “not at all influential” and 10 is “very influential”. [SCALE 0-10, 98=DK, 99=Ref]

[ASK IF SO4<7]
SO5. Why did you give that rating? [OPEN END; 98=Don’t Know, 99=Refused]

Loan Awareness

[SKIP TO L4a IF FR6d=96]

L1. AFC First, an independent lending institution, offers a low interest loan to help finance the energy saving improvements made through the Energize Delaware Home Performance with Energy Star Program. At the time you made the energy saving improvements to your home, were you aware of the availability of this loan?

1. Yes
2. No
8. (Don’t know)
9. (Refused)

[ASK IF L1=1, ELSE SKIP TO L4a]

L2. How did you find out about the loan? [MULTIPLE RESPONSE=5]

1. (Contractor)
2. (Program website)
3. (Friends/family/word of mouth)
4. (Online social media)
00. (Other, specify)
98. (Don’t know)
99. (Refused)

L3a. Did you apply for a loan from AFC First?

1. Yes

2. No

8. (Don't know)

9. (Refused)

[ASK IF L3a=1]

L3b. Did you receive a loan from AFC First?

1. Yes

2. No

8. (Don't know)

9. (Refused)

[ASK IF L3b<>1, ELSE SKIP TO NEXT SECTION]

L4a. [READ IF FR6d=96: AFC First, an independent lending institution, offers a low interest loan to help finance the energy saving improvements made through the Energize Delaware Home Performance with Energy Star Program.] Would the availability of a loan have made a difference to the type of improvements that you made? Loans range from $1,000 to $20,000, with an interest rate between 3.9% and 6.9%.

1. Yes

2. No

8. (Don't know)

9. (Refused)

[ASK IF L4a=1]

L4b. How would the availability of a loan have changed your project?

1. (Would have made additional improvements)

2. (Would have made improvements sooner)

00. (Other, specify)

98. (Don't know)

99. (Refused)

Program Processes and Satisfaction

PP1. Since the energy improvements were made, have your energy bills gone down, gone up, or remained about the same?

1. (Bills have gone down)
2. (Bills have gone up)
3. (Bills have remained about the same)
4. (Haven't noticed)
8. (Don't know)
9. (Refused)

PP2. And has the comfort level in your home increased, decreased, or stayed the same since the energy improvements were made?

1. (Increased)
2. (Decreased)
3 (Stayed the same)
4. (Haven't noticed)
8. (Don't know)
9. (Refused)

PP3. How easy or difficult was it to participate in the Home Performance with Energy Star Program? Would you say…

1. Very easy
2. Somewhat easy
3. Somewhat difficult
4. Very difficult
8. (Don't know)
9. (Refused)

[ASK IF PP3=3,4]

PP4. Why do you say that? [OPEN END, 98=Don't know, 99=Refused]

PP5a. Overall, how satisfied were you with your participation in the program? Please use a scale of 1 to 10, where 1 means "extremely dissatisfied" and 10 means "extremely satisfied." [SCALE 1-10, 98=Don't know, 99=Refused]

[ASK IF PP5a<7]

PP5b. It sounds like you weren't fully satisfied with your participation in the program. Why did you give that rating? [OPEN END, 98=Don't know, 99=Refused]

PP6. Would you recommend the program to friends and family members?

1. Yes
2. No
8. (Don't know)
9. (Refused)

PP7. What recommendations, if any, would you have for how to improve the program? [OPEN END, 96= No recommendations, 98=Don't know, 99=Refused]

Demographics

I just have a few general questions left.

D1. What type of residence do you live in? (READ CATEGORIES)

1. Detached single-family home
2. Townhouse or duplex which shares adjacent walls
3. Apartment or condo in a 2, 3, or 4 unit building
4. Apartment or condo in a building with 5 or more units
5 Mobile home

00. (Other, specify)

98. (Don't Know)

99. (Refused)

D2. Including yourself, how many people live in your home on a full-time basis? [NUMERIC OPEN END, 98=Don't know, 99=Refused]

D3. In what year were you born? [NUMERIC OPEN END]

D4. Which of the following best describes your annual household income in 2011, before taxes? (READ CATERGORIES)

1. Less than $25,000

2. $25,000-49,999

3. $50,000-99,999

4. $100,000-149,999

5. $150,000-199,999

6. $200,000 or more

8 (Don't Know)

9. (Refused)

D5. What is the highest level of education you completed?

1. Some high school
2. Completed high school or equivalent (GED)
3. Some college
4. Completed a 2 year or technical degree/certification
5. Completed a 4 year degree
6. Completed graduate or professional degree

8 (Don't Know)

9. (Refused)

This completes the survey. Your responses are very important to Energize Delaware and will help as we design future energy efficiency programs. We appreciate your participation and thank you for your time. Have a good evening.

Green for Green

DNREC GREEN FOR GREEN

NON-PARTICIPANT BUILDER SURVEY

Draft **4/11/2012**

INTRODUCTION

[READ IF CONTACT=1]

Hello, my name is _____ from Opinion Dynamics and I'm calling on behalf of the Delaware Department of Natural Resources and Environmental Control (DNREC). We are conducting a study to help DNREC better understand general residential building practices in Delaware and speaking to builders to learn more about the homes they build.

May I speak with the person who is most familiar with your firm's building practices? (CONTINUE WITH CORRECT CONTACT)

This survey will take about 20 minutes, and we will send you $100 to thank you for your time.

SCREENING QUESTIONS

A1. Just to confirm, our records show that your firm did not participate in DNREC's Green for Green program in 2011. (IF NEEDED: This is the program where DNREC provided incentives for new homes built to certain levels of energy efficiency)

1 (No, did not participate in program)

2 (Yes, participated)

98 (Don't know)

99 (Refused)

[IF A1=2,98,99: Thank and terminate. Record dispo as "Previous participant".]

PROFILE

First, I would like to ask some general questions about your company.

P1 Approximately how many homes did your firm begin construction on in Delaware in 2011? [NUMERIC OPEN END; RANGE

1-500, DK, REF]

P2 What percentage of these were single family homes? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

P3 Approximately how many homes do you typically build annually in Delaware? [If needed: The average number for the past 5 years] [NUMERIC OPEN END; RANGE 1-997, DK, REF]

P4 Does your firm build homes outside of Delaware?
1. Yes
2. No
8. (Don't know)
9. (Refused)

P5 Approximately how many employees does your firm have in Delaware? [NUMERIC OPEN END; RANGE 1-997, DK, REF]

P6 What percentage of the homes you built in 2011 were built in… [NUMERIC OPEN END; RANGE 0-100, DK, REF] [Should sum to 100%]
a. Kent county
b. New Castle county
c. Sussex county

P7 What percentage of the homes you built in 2011 were built custom, spec, or model homes? [NUMERIC OPEN END; RANGE 0-100, DK, REF] [Should sum to 100%]
a. Custom
b. Spec
c. Model
d. Semi-Custom

P8 What percentage of the homes you built in 2011 were … [NUMERIC OPEN END; RANGE 0-100, DK, REF] [May sum to more than 100%]
a. Energy Star-certified
b. LEED or NGBS certified (IF NEEDED: LEED= Leadership in Energy & Environmental Design, NGBS= National Green Building Standard)
d. NAHB certified (IF NEEDED: NAHB= National Association of Home Builders)

P9 Did your firm make any changes to your building practices when 2009 IECC compliance began? (IF NEEDED: IECC=International Energy Conservation Code)
1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF P9=1]

P10 In what areas did your firm make changes to your building practices? [1=Yes, 2=No, 8=DK, 9=Refused]
- a. Insulation
- b. Windows
- c. Appliances
- d. Lighting
- d. HVAC

For the next series of questions, I will be asking about your construction practices of the houses built in 2011.

FOUNDATION INSPECTION PROVISIONS

F1 What percentage of the homes you built in 2011 had … [NUMERIC OPEN END; RANGE 0-100, DK, REF]
- a. Slab foundations
- b. Basements [if needed: Finished or unfinished]
- c. Crawl spaces

For the next few questions, please think of your firm's homes with slab foundations.

[ASK IF F1a>0%, ELSE SKIP TO F5]

F2a What is the insulation R-value on the slab edge? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF F2a=98, ELSE SKIP TO F3]

F2b What material do you use to insulate the slab edge? [OPEN END, 98=DK, 99=Refused]

F2c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

[ASK IF F2a<>96]

F3 What is the depth of the slab edge insulation, in inches? [NUMERIC OPEN END, RANGE 1-97, 98=DK, 99=Refused]

F4 Is the slab heated or unheated?
1. Heated
2. Unheated
8. (Don't know)
9. (Refused)

For the next few questions, please think of your firm's homes with basements.

[ASK IF F1b>0%, ELSE SKIP TO F9]

F5 What percentage of your homes have exterior insulation on the foundation wall? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

[ASK IF F5>0%, ELSE SKIP TO F9]

F6a What is the insulation R-value of the exterior foundation wall? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF F6a=98, ELSE SKIP TO F7]

F6b What material do you use to insulate the exterior foundation wall? [OPEN END, 98=DK, 99=Refused]

F6c How many inches thick of insulation do you typically install? (on the exterior foundation wall) [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

F7 Does the exterior insulation cover the entire foundation wall?
1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF F7=2]

F8 What is the depth of the insulation, in inches? [NUMERIC OPEN END, RANGE 1-97, 98=DK, 99=Refused]

For the next few questions, please think of your firm's homes with crawl spaces.

[ASK IF F1c>0%]

F9a What is the R-value of the insulation used on either the exterior or interior crawl space walls? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF F9a=98, ELSE SKIP TO FR1]

F9b What material do you use to insulate either the exterior or interior crawl space walls? [OPEN END, 98=DK, 99=Refused]

F9c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

FRAMING/ROUGH-IN PROVISIONS

Now I would like to ask you about the framing of the homes you build.

FR1 What is the glazing U-factor of windows installed in your homes? (NOTE TO INTERVIEWER: RANGE FROM .2 TO 1.20)

[OPEN END, 98=DK, 99=Refused]

FR2 What is the solar heat gain coefficient (SHGC) value of windows installed in your homes? (INTERVIEWER NOTE: Can range from 0 to 1) [OPEN END, 98=DK, 99=Refused]

FR3 Does your firm insulate all ducts throughout your home in conditioned spaces?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF FR3=1]

FR4a What is the R-value of the insulation used to insulate the ducts in conditioned spaces? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF FR4a=98, ELSE SKIP TO FR5]

FR4b What material do you use to insulate the ducts in conditioned spaces? [OPEN END, 98=DK, 99=Refused]

FR4c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

FR5 Does your firm insulate all ducts throughout your home in unconditioned spaces?
1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF FR5=1]

FR6a What is the R-value of the insulation used to insulate the ducts in unconditioned spaces? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF FR6a=98, ELSE SKIP TO FR7]

FR6b What material do you use to insulate the ducts in unconditioned spaces? [OPEN END, 98=DK, 99=Refused]

FR6c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

FR7 Does your firm insulate the piping from the home's boiler or water heater?
1. Yes
2. No
8. (Don't know)
9. (Refused)

FR8 What percentage of your homes are built with wood framing? [If needed: As opposed to steel framing] [NUMERIC OPEN END; RANGE 0-100, DK, REF]

INSULATION INSPECTION PROVISIONS

My next set of questions will ask about the insulation phase of your construction.

I1 What percentage of your firm's homes have floors above unconditioned spaces, such as garages or unconditioned basements? [NUMERIC OPEN END; RANGE 0-100, DK, Refused]

[ASK IF I1>0%, ELSE SKIP TO I3a]

I2a What is the R-value of the floor insulation above any unconditioned spaces? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF I2a=98, ELSE SKIP TO I3a]

I2b What material do you use to insulate the floors? [OPEN END, 98=DK, 99=Refused]

I2c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

I3a What is the R-value of the rim joist insulation in your homes? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF I3a=98, ELSE SKIP TO I4a]

I3b What material do you use to insulate the rim joists? [OPEN END, 98=DK, 99=Refused]

I3c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

I4a What is the R-value of the wall cavity insulation in your homes? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF I4a=98, ELSE SKIP TO I5]

I4b What material do you use to insulate the walls? [OPEN END, 98=DK, 99=Refused]

I4c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

I5 Does your firm use above grade, exterior wall insulation, sometimes called sheathing insulation? [If needed: This is rigid foam insulation used on exterior walls]

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF I5=1]

I6 What is the R-value of the sheathing insulation? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF F1b>0%]

I7a What is the R-value of the insulation on interior basement walls? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF I7a=98, ELSE SKIP TO I8]

I7b What material do you use to insulate the walls? [OPEN END, 98=DK, 99=Refused]

I7c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

I8 What percentage of your homes do you have a third party verify the insulation and air sealing? [NUMERIC OPEN END; RANGE 0-100, DK, Refused]

FINAL INSPECTION PROVISIONS

I will now be asking you about the final inspection phase and some of the equipment in the homes you build.

FI1a What is the R-value of the ceiling insulation in your homes? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 98=DK, 99=Refused]

[ASK IF FI1a=98, ELSE SKIP TO FI2a]

FI1b What material do you use to insulate the ceilings? [OPEN END, 98=DK, 99=Refused]

FI1c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

FI2a What is the R-value of the attic access hatch insulation in your homes? [NUMERIC OPEN END; RANGE 1-40, 96=No insulation, 97=No attic access hatch, 98=DK, 99=Refused]

[ASK IF FI2a=98, ELSE SKIP TO FI3]

FI2b What material do you use to insulate the attic access hatch? [OPEN END, 98=DK, 99=Refused]

FI2c How many inches thick of insulation do you typically install? [NUMERIC OPEN END, RANGE 1-50, 98=DK, 99=Refused]

FI3 Do you test for air sealing with a blower door test?
1. Yes
2. No
8. (Don't know)
9. (Refused)

FI4 Do you perform a post-construction test for duct tightness?
1. Yes
2. No
8. (Don't know)
9. (Refused)

FI5 Do you use any advanced framing techniques in your homes? [If needed: This might include techniques such as framing 19.2" or 24" off center, using 2 stud corners, using ladder blocking, or using raised heel trusses]
1. Yes
2. No
8. (Don't know)
9. (Refused)

FI6 What percent of the lamps in your homes are CFLs? [NUMERIC OPEN END; RANGE 0-100, DK, Refused]

FI7a On what percentage of your homes do you install occupancy sensors on indoor lights? [NUMERIC OPEN END; RANGE 0-100, DK, Refused]

[ASK IF Fi7a>0%]

FI7b What percentage of the lights have occupancy sensors? [NUMERIC OPEN END; RANGE 0-100, DK, Refused]

FI8 On what percentage of your homes do you install photocell controls on exterior lights? [NUMERIC OPEN END; RANGE 0-100, DK, Refused]

FI9 What percentage of your homes have tubular daylighting devices or skylights installed in rooms with no windows? [If needed: Such as interior bathrooms] [NUMERIC OPEN END; RANGE 0-100, DK, Refused]

FI10 What percentage of homes do you install programmable thermostats? [NUMERIC OPEN END; RANGE 0-100, DK, Refused]

NGBS QUESTIONS

N1 What is the average square footage of the homes you build? [NUMERIC OPEN END; RANGE 1-5000, 9998=DK, 9999=Refused]

N2 What is the average ceiling height of your homes?
1. (8 feet)
2. (9 feet)
0. (Other, specify)
8. (Don't know)
9. (Refused)

N3 What percentage of the homes you build have … [NUMERIC OPEN END; RANGE 0-100, DK, REF]
a. 1 floor above grade
b. 2 floors above grade
c. 3 floors above grade

N4 What percentage of the homes you build have … [NUMERIC OPEN END; RANGE 0-100, DK, REF]
a. Furnaces

b. Boilers [if needed: in-floor radiant or hydronic baseboard]
c. Heat pumps
d. Electric heat

[ASK IF N4a>0]

N5a What is the average efficiency of the furnaces, in AFUE? [NUMERIC OPEN END; RANGE 1-97, 98=DK, 99=Refused]

[ASK IF N4b>0]

N5b What is the average efficiency of the boilers, in AFUE? [NUMERIC OPEN END; RANGE 1-97, 98=DK, 99=Refused]

[ASK IF N4c>0]

N5c What is the average efficiency of the heat pumps, in HPSF? [NUMERIC OPEN END; RANGE 1-97, 98=DK, 99=Refused]

N6a What percentage of the homes you build have central air conditioning systems? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

N6b What is the average SEER value of the central air conditioning systems? [NUMERIC OPEN END; RANGE 1-97, 98=DK, 99=Refused]

N7 What percentage of your homes' water heaters are… [NUMERIC OPEN END; RANGE 0-100, DK, REF]
a. Tank style – standard efficiency
b. Tank style – Energy Star
c. Tankless
d. Sidearm [if needed: with no direct heating element]

IECC AND NGBS COMPARISON

IN1 What percentage of your homes have Energy Star appliances? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

IN2 In what percentage of your homes do you install induction cooktops? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

IN3 What percentage of your homes have space heating or cooling provided by ductless systems? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

[ASK IF IN3>0%]

IN4 What percentage of your homes have the following heating or cooling ductless systems? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

a. Radiant heated flooring or radiant cooling
b. Hot water baseboards
c. Mini-split AC systems

IN5 Does your home design process take into account the energy saving attributes of the home when sizing HVAC equipment?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF IN5=1]

IN6 Do you, or does your HVAC contractor, use ACCA Manual J, Manual S, or other design documents?

1. Manual J
2. Manual S
3. Other design documents
8. (Don't know)
9. (Refused)

IN7 On what percentage of your homes are balanced HVAC airflow test performed? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

IN8 In what percentage of your homes do you install return ducts or transfer grilles in every room? [If needed: Excluding bathrooms, kitchens, closets, pantries, and laundry rooms] [NUMERIC OPEN END; RANGE 0-100, DK, REF]

IN9 What percentage of your homes have solar PV or solar hot water heating systems? [NUMERIC OPEN END; RANGE 0-100, DK, REF]

IN10 Do you enroll any of your homes in utility-provided renewable energy service plans?
1. Yes
2. No
8. (Don't know)
9. (Refused)

VNAME. To ensure that your name is spelt correctly, can you please tell me the name that you would like to appear on the check? (INTERVIEWER: CONFIRM SPELLING)

(OPEN END)

Where would you like the check mailed?

QSADDR. Street address [open end]

QCITY: City [open end]

QST: State [open end]

QZIP: Zip code [open end]

SITE VISIT RECRUITMENT

SV1 As part of our analysis, we are also conducting site visits to observe installed building materials. We are offering a $125 Visa Gift Card for the completion of a site visit. Is it possible for us to visit any of your residential construction sites for a walkthrough?
1. Yes
2. No [SKIP TO INT99]
8. (Don't know) [SKIP TO INT99]
9. (Refused) [SKIP TO INT99]

[ASK IF SV1=1]

SV2 Thank you for your assistance. We will contact you within the next week to schedule a time to conduct the walkthrough. Would you be the correct person to speak to about scheduling the site visit?
1. Yes [SKIP TO SV5]
2. No
8. (Don't know)
9. (Refused)

SV3. Who should we speak with to schedule a time to conduct the walkthrough? [OPEN END, DK, REF]

SV4. Is the phone number that we dialed today, <PHONE>, the best number to reach this person?

1. Yes [SKIP TO INT99]

2. No [SKIP TO SV5A]

8. Don't know [SKIP TO SV5A]

9. Refused [SKIP TO SV5A]

SV5. Is the phone number we dialed today <PHONE>, the best number to reach you?

1. Yes [SKIP TO INT99]

2. No

8. Don't know

9. Refused

SV5A. What is the best phone number?

[OPEN END]

Thank you for your time. DNREC appreciates your help in learning about the Delaware residential building market.

On-site Builder Questionnaire

Questions in the on-site questionnaire pertain to overall building standards for the contractor, covering all homes built over the past few years. Responses will be used for verification and will help create the baseline building practices for residential homes in Delaware.

Site Data

Builder			
Site Contact		Title	
Home address			County
Program	*Participant*	*Non-participant*	

Builder Information

		Response
How many new homes did your company start in Delaware in 2011?		
What percentage of the homes were in:	Kent County	
	New Castle County	
	Sussex County	
Does your company build:	Model homes	
	Spec homes	
	Custom homes	
What percentage of your 2011 home are:	ENERGY STAR certified	
	"Green"	
	LEED or NGBS certified	
What percentage of your homes qualified for the NGBS rebate?		
What is the average conditioned square footage of homes you build?		
What percentage of the homes you build have:	1 floor above grade	
	2 floors above grade	
	3 floors above grade	
Did your company make any building standards changes to comply with 2009 IECC?		
If yes to question above, what areas were modified?	Insulation	
	Windows	
	Appliance/Lighting	
	HVAC efficiencies	
What path does your company use for IECC code compliance?	Prescriptive	
	Performance	

Low Income Multifamily

DSHA Participant In-Depth Interview Guide

Draft: 05-03-2012

This Interview Guide is a tool to guide process evaluation interviews with program participants. The guide helps to ensure the interviews include questions concerning the most important issues being investigated in this study. The interview will be conducted via telephone by the evaluation team. We expect these interviews to take no longer than 45 minutes. Discussions will be taped and transcribed for purposes of evaluation. As this is part of the process evaluation, all transcripts will remain in confidence with Opinion Dynamics and members of the evaluation team although anonymous quotes may be used in reporting.

The interviews will explore topics specific to developers who fall into one of the following two groups:

- *Group A: Program Participant (N=1).*
- *Group B: Program Applicants: These interviewees partially completed the requirements for participation, but ultimately chose not to participate (N=?).*

We will ask both groups about what initially attracted them to the program. We will explore the factors that have led to Group A's success in the program, as well as barriers within the participation process. We will ask Group B about barriers to participation.

GROUP A: PROGRAM PARTICIPANT

Name of Interviewee: _____ Date:

Title: _____ Organization: _____

The following questions are designed to learn more about the Low Income Housing Construction Financing program, including program marketing, application process, goals, and financing.

I would like to tape our call today so we can refer back to our conversation. We will keep this information anonymous. Are you OK with this? [IF NEEDED] All conversations will remain in confidence with the Opinion Dynamics evaluation team, although anonymous quotes may be used in reporting.

Program Roles and Responsibilities and Processes

- What is the name of your company/organization and what is the general scope of its activity? What is your role within the organization? How long have you held this role? How

many staff does your organization employ?

- Is anybody else at your organization involved in this program? If so, what are their roles?

Program Participation and Implementation

- Please walk me through the process of participating in the program
- How did you hear about the program?
  - DSHA LIHTCP?
  - SEU funds?
- Why did you decide to participate in the SEU's LIMFHL program?
  - What specific goals did you hope to achieve by participating?
- How did you enroll?
  - Were the program requirements clear and easy to understand?
- Please describe the communication process with DSHA? Do you have any direct contact with DNREC?
  - Who has been your contact?
  - How do you generally communicate? (i.e. ad-hoc email and telephone, regular meetings, etc).
- Have you participated in any other DSHA programs in the past? Have you participated in any Energy Efficiency programs, Federal, State, or Local? How does your experience with DSHA's EE program compare?
- Did you have to arrange any extra training for you or your organization's staff in order to be able to participate? What kind? Was this difficult to do? Was the additional training burdensome?
- Have you spoken with other developers about the program? What have they said?
- What do you think might prevent other contractors from participating in the program?

Marketing & Outreach

1. Where did you first hear about the programs?
2. What marketing materials do you remember seeing, if any? Do you think that the level of marketing and promotion of the program has been appropriate so far? Do you think promotional efforts are successful? Do you think they reach their intended audience?

Program Financing

- Please walk me through the process of receiving financing. How did you request funds for

the EE measures? Was it difficult to receive financing?

- What type of reporting is required during the loan process? Was reporting burdensome?
- How long did it take to receive the funds after you had requested them?
- Are there any barriers or challenges to the way that the SEU financing is processed?
- Are there other lending sources that you have used for similar work as this program? If so, who are these sources?
- In your role, how do you typically finance energy efficiency measures, if at all?
    - What are some common challenges or barriers for energy efficiency financing?
- Have you identified any barriers to applying for development financing within the program? (Probe for barriers related to financing for: certain EE measures only, portions of entire development cost, e.g. 20% of financing, construction phase only, etc.)

Energy Efficiency Needs

- What types of upgrades or measures are needed the most for Low Income multifamily buildings? Are there measures that would likely not be installed without outside financing or rebates?
- What is the most useful type of program; rebates or financing? Something else?

Measure Verification

[Evaluation team will field questions to support engineering review for this program, questions will include number of energy efficient measures installed]

Net-to-Gross

- How likely is it that you would have installed the Energy Efficiency measures that you did **without** the SEU funds?
- Would you have installed units of the **same level of efficiency** as you did if you did not have access to the SEU funds? [Probe for Lighting, appliances, fixtures and showerheads]
- Would you have installed the same **number** of Energy Efficient measures? [Probe for specific equipment]
- Would you have installed the Energy Efficient measures **at the same time that you did**? Would the measures that you installed have been added later? If so, when? [Probe for specific equipment]

Spillover

- Have you installed other Energy Efficiency measures at the Greenside Manor site (that were not funded by the program) after your participation in the program?

- What were these measures? How many?
- Why did you install these measures?

➢ Did the program influence your decision to use energy-efficient equipment and techniques in other projects built within Delaware?

- What were these measures? How many?
- Why weren't these projects submitted to the program?

Closing

➢ In your opinion, how successful is the program? Why? What are the strengths? What are the weaknesses?

➢ What are some of the challenges you faced? What are some of the challenges that are not related to funding? [Probe for application processes, management, program design and external barriers in marketplace]

➢ Are there elements in design, structure, and/or operation that should be modified to make the program work better? If so, what do you recommend? Why is this change needed?

➢ Is there anything else about the program that you were thinking we would talk about today that we have not covered? Probe: Are there any other comments you would like to make about the program?

➢ Is there anybody else either within or outside of your organization that you think we should speak with about this program?

Thank you very much for taking the time to assist us with this evaluation. Your contribution is a very important part of the process. Do you mind if we follow-up with your by phone or e-mail later, if additional questions arise? Thank you for your assistance.

GROUP B: PROGRAM APPLICANT

Name of Interviewee: _____ Date:

Title: _____ Organization: _____

The following questions are designed to learn more about the Low Income Housing Construction Financing program, including program the application process, marketing, and goals.

I would like to tape our call today so we can refer back to our conversation. We will keep this information anonymous. Are you OK with this? [IF NEEDED] All conversations will remain in confidence with the Opinion Dynamics evaluation team, although anonymous quotes may be used in reporting.

Program Roles and Responsibilities and Processes

1. What is the name of your company/organization and what is the general scope of its activity? What is your role within the organization? How long have you held this role? How many staff does your organization employ?

2. How long have you held these roles? Is anybody else at your organization involved in these programs? If so, what are their roles?

Program Participation and Implementation

3. How did you hear about the program?

   - DSHA LIHTCP?

   - SEU funds?

4. Why did you decide NOT to participate in the SEU's LIMFHL program? (Probe for barriers to enrollment, burdensome paperwork process, clarity of program processes, etc.)

5. Have you participated in any other DSHA programs in the past? Have you participated in any Energy Efficiency programs, Federal, State, or Local? How does your experience with DSHA's EE program compare?

6. Have you spoken with other developers about the program? What have they said?

7. What do you think might prevent other contractors from participating in the program?

Marketing & Outreach

8. Where did you first hear about the programs?

9. What marketing materials do you remember seeing, if any? Do you think that the level of marketing and promotion of the program has been appropriate so far? Do you think promotional efforts are successful? Do you think they reach their intended audience?

Program Financing

10. Are there other lending sources that you have used for similar work as this program? If so, who are these sources?

11. What does a typical financing arrangement look like, both for Energy Efficiency measures, and for Low-Income Multifamily programs?

    - What are some common challenges or barriers for this type of financing, especially concerning Energy Efficiency?

12. What do you look for in financing? What are attractive terms for EE measures?

13. What are some of the barriers to applying for development financing? (Probe for barriers related to financing for: certain EE measures only, portions of entire development cost, e.g. 20% of financing, construction phase only, etc.)

Energy Efficiency Needs

14. What types of upgrades or measures are needed the most? Are there measures that would likely not be used without outside financing or rebates?

15. What is the most useful type of program, rebates or financing? Something else?

Closing

16. What were some of the challenges you faced that ultimately caused you to no participate int he program? [Probe for application processes, management, program design and external barriers in marketplace]

17. Are there any recommendations you have for improving the program? Why, why not?

18. Is there anything else about the program that you were thinking we would talk about today that we have not covered? Probe: Are there any other comments you would like to make about the program?

19. Is there anybody else either within or outside your organization that you think we should speak with about this program?

Thank you very much for taking the time to assist us with this evaluation. Your contribution is a very important part of the process. Do you mind if we follow-up with your by phone or e-mail later, if additional questions arise? Thank you for your assistance.

Efficiency Plus Business

Delaware Department of Natural Resources and Environmental Control

Efficiency Plus for Business

Depth interviews

PROCESS Questions

Q1. How did you first hear about the Efficiency Plus for Business program? (Probe: Contractor, Website, Another Business, etc.)

Q2. When you first heard about the incentive, what stage was the project in? (Probe for as much detail as possible)

- Project was not under consideration
- Initial Planning
- Equipment had been purchased
- Equipment had been installed
- After the project was completed

Q3. How much did the rebate factor into your decision to do the project? What other factors contributed to your decision? Would you have done the same project at the same time?

Q4. Did YOU fill out the application forms for the project? If so, how would you rate the application process on a scale of 0-10 where 0 is very difficult and 10 is very easy? Why? If not who filled out the application?

Q5. Did download or use any of the program marketing materials? How useful were they in providing information about the program? Is there anything that you feel could have made them more useful?

Q6. On a scale of 1 to 10, with 1 meaning "not at all likely" and 10 meaning "very likely", how likely is it that your company would have installed equipment at the same time if the rebate program had not been available?

1 Not at all likely (to install equipment at same time)
2
3
4
5
6
7
8
9
10 Very likely (to install equipment at same time)

Please explain……

Q7. On the same scale of 1 to 10, with 1 meaning "not at all likely" and 10 meaning "very likely",

how likely would you have been to install equipment of the same efficiency level if the rebate program had not been available?

1 Not at all likely (to install same efficiency level)
2
3
4
5
6
7
8
9
10 Extremely likely (to install same efficiency level)

Please explain……

Q8. How satisfied are you with the:

- incentive amount? (why)
- The application process? (Why)
- The communication you had with the program staff? (Why)
- The type of equipment/measures that qualified for rebates? (Why)
- The Efficiency Plus Business program overall? (Why)

Q9. What would you say were the main benefits for participating in the program? Were there any drawbacks? What were they and how could they be addressed?

Q10. Would you to participate in a similar program again in the future?

1 Yes
2 No
3 (Don't Know/Not Sure)

Q11. How could the Efficiency Plus for Business Program be improved?

Delaware Department of Natural Resources and Environmental Control
Efficiency Plus for Business
Process Survey
April 11, 2012

Introduction

Hello, my name is _____ from Opinion Dynamics. I'm calling on behalf of the Delaware Department of Natural Resources and Environmental Control. Our records show that <COMPANY> purchased energy efficient <ENDUSE>, which received an incentive from Delaware's Efficiency Plus Business Program. May I please speak with <SNAME> or the person most knowledgeable about your company's participation in the Delaware Efficiency Plus Business program? We are calling to do a follow-up study about your firm's participation in this program and our records list you as the contact name for his project. [IF NOT, ASK TO BE TRANSFERRED TO MOST KNOWLEDGABLE PERSON OR RECORD NAME & NUMBER.]

(IF NEEDED: This survey should take about 10 minutes .)

Great. I'd like to ask you a few general questions about your participation in the Efficiency Plus Business program.

PROGRAM MARKETING

PM1. How did you hear about the Efficiency Plus for Business program? [MULTIPLE RESPONSE]
1. (Program Website)
2. (DSIRE Website)
3. (Contractor/Trade Ally)
4. (Email)
5. (Friend/colleague/word of mouth)
00. (Other, specify)
98. (Don't know)
99. (Refused)

PM2. Did you fill out the application forms for the project?
1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK PM3 IF PM2=1 ELSE SKIP TO PM6]

PM3. Did the application forms clearly explain the program requirements and how to participate?
1. (Yes)
2. (No)
3. (Somewhat)
8. (Don't know)
9. (Refused)

PM4. How would you rate the application process? Please use a scale of 1 to 10 where 1 is "very difficult" and 10 is "very easy". [SCALE 1-10; 98=Don't know, 99=Refused]

[ASK PM5 IF PM4<4]

PM5. Why did you rate it that way?
- 1. (Difficult to understand)
- 2. (Long process)
- 3. (Documentation requirements for ARRA/Stimulus funds)
- 00. (Other, specify)
- 98. (Don't know)
- 99. (Refused)

[ASK PM6 IF PM2=2]

PM6. Who filled out the application forms for the project?
- 1. (Someone else at the facility)
- 2. (Someone else at the company)
- 3. (Contractor)
- 4. (Supplier/Distributor/Vendor)
- 5. (Engineer)
- 6. (Consultant)
- 00. (Other, specify)
- 98. (Don't know)
- 99. (Refused)

PM7. Do you recall receiving any of the program marketing materials?
- 1. (Yes)
- 2. (No)
- 8. (Don't know)
- 9. (Refused)

[ASK PM8 IF PM7=1 ELSE SKIP TO PM10]

PM8. How useful were the program's marketing materials in providing information about the program? Please use a scale of 1 to 10 where 1 is "not at all useful" and 10 is "very useful". [SCALE 0-10; 98=Don't know, 99=Refused]

[ASK PM9 IF PM8<4]

PM9. What would have made the materials more useful to you? [MULTIPLE RESPONSE, UP TO 3]
- 1. (More detailed information)
- 2. (Where to get additional information)
- 00. (Other, specify)
- 98. (Don't know)
- 99. (Refused)

PM10. In general, what is the best way of reaching companies like yours to provide information about energy efficiency opportunities like the Efficiency Plus Business program? [MULTIPLE RESPONSE, UP TO 3]
- 1. (Bill inserts)
- 2. (Flyers/ads/mailings)
- 3. (e-mail)
- 4. (Telephone)
- 5. (Trade allies/contractors)
- 00. (Other, specify)
- 98. (Don't know)
- 99. (Refused)

Free Ridership

FR1 Which of the following best describes the status of the project when you first heard about the incentive?:

1. The project was not under consideration
2. The project was in the initial planning stage
3. The equipment had already been purchased
4. The equipment had already been installed
5. The entire project had already been completed

00. (Other, specify)
98. (Don't know)
99. (Refused)

FR2. On a scale of 1 to 10 with 1 being "not at all important" and 10 being "very important", how important was the rebate in your decision to complete the project? [SCALE 0-10; 98=Don't know, 99=Refused]

FR3. What other factors contributed to your decision? [Open Ended, 96 (none/no other factors), 98, 99]

FR4. Would you have installed the equipment at the same time if the rebate program was not available?

1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK FR5 IF FR4=2 ELSE SKIP TO FR6]

FR5. Can you please explain how the rebate program influenced the timing of this project? [Open End]

FR6. Would you have installed the same level of efficiency for this equipment if the rebate program was not available?

1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK FR7 IF FR6=2 ELSE SKIP TO S1]

FR7. Can you please explain how the rebate program influenced the level of efficiency for this equipment [Open End]

Satisfaction

S1. On a scale of 1 to 10, where 1 is "very dissatisfied" and 10 is "very satisfied", how would you rate your satisfaction with… [SCALE 0-10; 96=not applicable, 98=Don't know, 99=Refused]

a. the incentive amount
b. the communication you had with the Efficiency Plus Business program staff
c. the measures offered by the program (If needed: this is the equipment that is eligible for an incentive under the program)
d. the Efficiency Plus Business program overall

[ASK S2 IF S1a<4]

S2 You indicated some dissatisfaction with the incentive amount, why did you rate it this way? [MULTIPLE RESPONSE; UP TO 3]
1. (Better rebates in other states)
2. (Too small)
3. (Equipment didn't qualify)
00. (Other, specify)
98. (Don't know)
99. (Refused)

[ASK S3 IF S1b<4]
S3. You indicated some dissatisfaction with the communication you had with the Efficiency Plus Business staff, why did you rate it this way?
1. (Provided inconsistent information)
2. (Didn't understand the question)
3. (Hard to reach the right person/person with the answer)
00. (Other, specify)
98. (Don't know)
99. (Refused)

[ASK S4 IF S1c<4]
S4. You indicated some dissatisfaction with the measures offered by the Efficiency Plus Business program, why did you rate it this way? [OPEN END; 98=Don't know, 99=Refused]

[ASK S5 IF S1d<4]
S5. You indicated some dissatisfaction with the Efficiency Plus Business Program overall, why did you rate it this way?
1. (Not as easy as other states)
2. (No clear guidance)
00. (Other, specify)
98. (Don't know)
99. (Refused)

BENEFITS AND BARRIERS

B1. What do you see as the main benefits to participating in the Efficiency Plus Business program? [MULTIPLE RESPONSE, UP TO 3]
1. (Energy Savings/Saving money)
2. (Good for the Environment)
3. (Lower Maintenance Costs)
4. (Better Quality/New Equipment)
5. (Rebate/Incentive)
9. (Able to make improvements sooner)
00 .(Other, Specify)
98. (Don't know)
99. (Refused)

B2. What do you see as the drawbacks to participating in the program? [MULTIPLE RESPONSE, UP TO 3]
1. (Paperwork too burdensome)
2. (Incentives not high enough/not worth the effort)
3. (Program is too complicated)
4. (Cost of equipment)
00. (Other, specify)
96. (No drawbacks)
98. (Don't know)
99. (Refused)

FEEDBACK AND RECOMMENDATIONS

R1 Would you participate in a similar incentive program again in the future?
1. Yes
2. No
3. Maybe
8. (Don't know)
9. (Refused)

R2 How could the Efficiency Plus Business Program be improved? [MULTIPLE RESPONSE, UP TO 4]
1. (Higher incentives)
2. (More measures)
3. (Greater publicity)
4. (Better Communication/Improve Program Information)
8. (Simplify application process)
11. (Quicker processing times)
00. (Other, specify)
96. (No recommendations)
98. (Don't know)
99. (Refused)

R3. Do you have any other comments you would like to make regarding your participation in the Efficiency Plus Business program?
1. Yes
2. No
3. Maybe
8. (Don't know)
9. (Refused)

[If R3=Yes ask R4, if else skip to closing statement]
R4. Could you please elaborate? [Open ended]

CLOSING STATEMENT:
On behalf of the Delaware Department of Natural Resources and Environmental Control, thank you for your time today.

I. EFFICIENCY PLUS FOR BUSINESS EVALUATED PROJECT DETAIL

Delaware Department of Natural Resources and Environmental Control
Efficiency Plus for Business
Evaluated Project Detail

Rebate Number	Stratum	Equipment Type	Ex Ante kWh	Ex Post kWh	Ex Ante kW	Ex Post kW	Ex Ante Gas (kbtu)	Ex Post Gas (kBTu)
PM8208	1	Lighting	3,408	8,170	0.6	0.9	-	
CM9621	1	Refrigeration Motors	4,688	3,997		0.1	-	
CM9473	1	Lighting	5,469	3,871		0.6	-	
PM8481	1	Lighting	47,035	17,660	8.7	4.0	-	
PM5292	2	Boiler					341,445	353,680
PM9229	2	Lighting	71,211	227,911	16.2	71.6	-	
PM9474	2	Lighting	84,999	262,244	16.3	43.2	-	
PM9619	2	Lighting	89,013	272,439	20.3	75.1	-	
PM9620	2	Lighting	71,211	217,951	16.2	60.1	-	
PM9167	2	VFD	70,821	132,361	6.1	14.1	-	
PM8568	2	Lighting	74,300	116,238	13.8	17.6	-	
CM9156	2	Lighting	233,896	289,772	87.0	106.7	-	

PM9150	2	Lighting	69,596	80,921	12.9	14.5	-	
CM8371	2	Lighting	104,214	118,439	21.0	26.1	-	
CM9607	2	Induction Lighting	148,862	159,222	15.9	18.2	-	
PM9220	2	Lighting	217,433	211,627	39.2	43.2	-	
PM9381	2	Lighting	140,266	58,166	26.0	-	-	
PM8368	2	Lighting	104,082	34,040	13.0	7.8	-	
CM9513	3	New Construction	93,554	416,930	53.0	53.8	1,698,000	3,046,495
PM8103	3	Lighting & controls	712,680	940,863	127.9	78.4	-	
CM9485	3	Lighting	296,525	365,093	72.0	95.7	-	
PM8510	3	VFD	291,751	339,255	23.2	50.4	-	
CM5028	3	CRAC	708,049	751,756	111.0	100.0	-	
PM9608	3	Lighting	430,132	368,492	22.9	26.4	-	
PM9581	3	Motors & Drives	447,724	340,665	61.8	38.9	-	
PM8509	3	VFD on HVAC equipment	409,034	281,095	36.6	35.6	-	
CM9462	3	Lighting	542,942	262,268	124.0	68.6	-	
CM8479	3	Roofing (HVAC savings)	304,390	143,212	-	24.9	1,197,600	-

CM9615	3	Lighting	478,173	192,281	54.0	38.4	-	
PM9511	3	HVAC	56,584	9,340	0.8	3.8	2,639,700	127,085
PM9232	3	Lighting	398,453	59,915	41.9	1.4	-	
CM5024	3	CRAC	312,646	287,440	-		-	
PM9574	3	VFD on chiller equipment	320,493	153,174	93.2	65.5	-	