Impact Evaluation of Electric and Natural Gas Efficiency United

Final Impact Evaluation Results

Michigan Community Action Agency Association

Prepared by KEMA, Inc.

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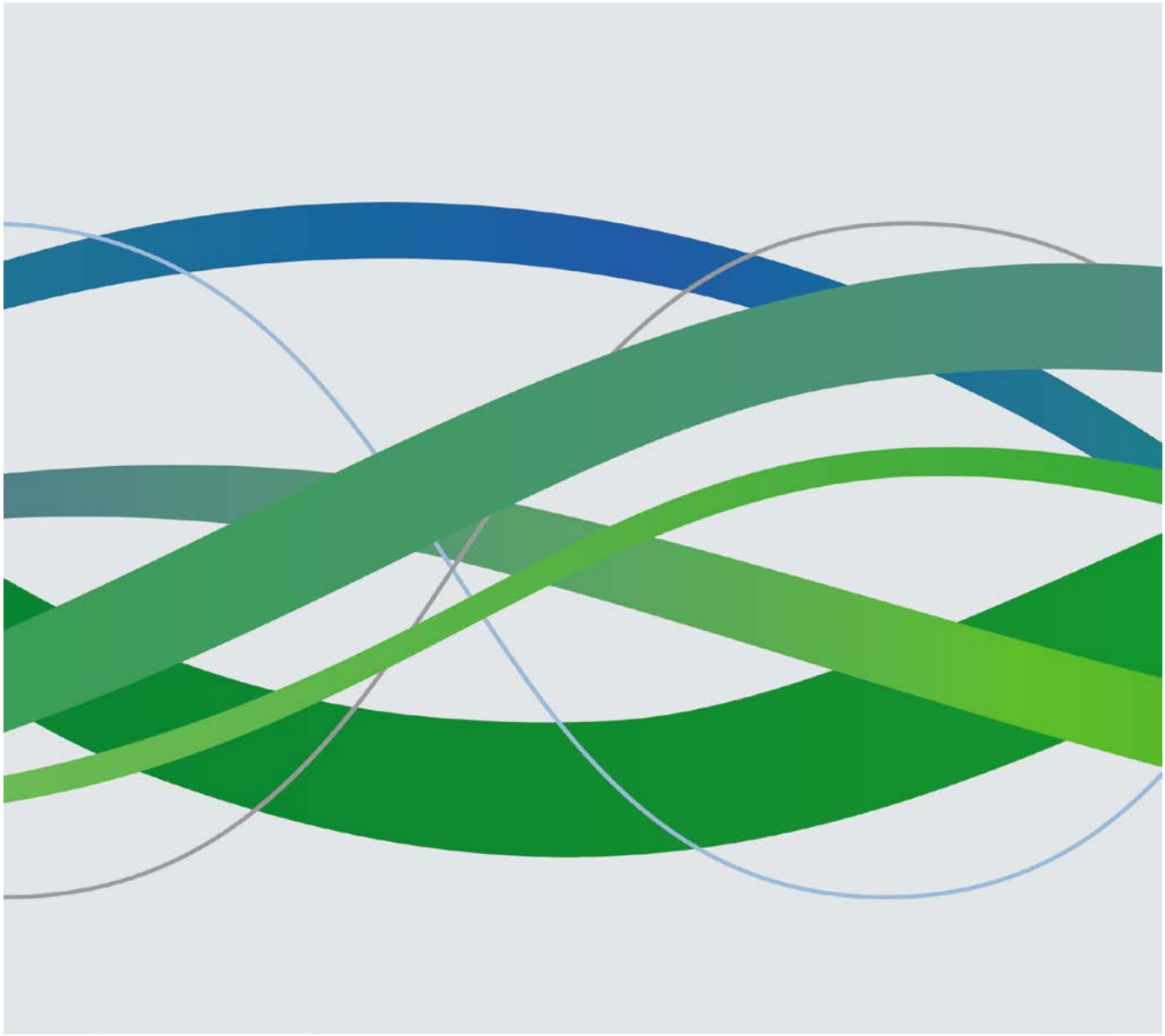


Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

List of Exhibits

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

1. Executive Summary

1.1 Introduction

This report presents the verified gross energy savings achieved by Efficiency United (EU) from the Energy Optimization Programs implemented during 2012. The savings were determined based on the impact evaluation results of the Energy Optimization Programs administered by the Michigan Community Action Agency Association (MCAAA). The impact evaluation was conducted by KEMA, Inc. from August 2012 to March 2013.

1.2 Verified Gross Savings Results

Efficiency United participated in 12 energy optimization programs implemented by CLEAResult Consulting, Inc. in 2012. Table 1 shows the annual and lifetime verified gross savings achieved for the programs that were certified as part of this evaluation. The table shows the kWh and ccf savings achieved annually for each program and the lifetime savings that will be achieved over the measure lives of the equipment installed.

Table 1. Verified Gross Savings by Program[1,2]

Program	Verified Gross kWh		Verified Gross ccf	
	Annual	Lifetime	Annual	Lifetime
ENERGY STAR	5,723,797	54,519,410	94,961	969,660
Appliance Recycling	1,285,014	5,241,667		
Residential HVAC	268,029	3,037,268	598,799	9,142,270
Low Income	1,729,528	17,629,707	462,824	4,802,547
Online Audit	2,983,338	28,959,258	35,606	366,700
Onsite Weatherization	4,056,896	39,834,727	972,653	10,595,330
Commercial and Industrial	28,199,319	332,536,985	2,299,597	24,947,500
Market Rate Multi Family	320,413	3,161,833	106,061	1,060,064
Residential Pilot	985,421	985,421	140,786	140,786
Residential Education	610,423	610,423	86,940	86,940
Commercial and Industrial Pilot	1,461,431	1,461,431	177,138	177,138
Commercial and Industrial Education	522,511	522,511	60,528	60,528
EU Overall	**48,146,120**	**488,500,640**	**5,035,891**	**52,349,463**

[1] The measure life used for the Pilot and Residential Programs is one year. The measure life is necessary to determine lifetime program savings.

[2] Savings total reflect only measure implemented through the Efficiency United programs in 2012. 2011 carryover savings and 2012 self-directed savings are not included.

2. Overview of Evaluation

2.1 Introduction

This report presents the results of DNV KEMA's evaluation of the Efficiency United (EU) programs administered by the Michigan Community Action Agency Association (MCAAA). The impact evaluation was conducted by KEMA, Inc. from August 2012 to March 2013.

2.2 Overview of Participating Utilities and Cooperatives

On October 6, 2008, Governor Jennifer Granholm signed into law the "Clean, Renewable, and Efficient Energy Act." On December 4, 2008, the Michigan Public Service Commission (MPSC) issued an order to begin implementation of the Act, requiring electric and natural gas utilities in the state to offer Energy Optimization plans to their customers after approval by the Commission. Energy optimization plans must be filed by retail rate-regulated electric utilities, retail rate-regulated rural electric cooperatives, member-regulated rural electric cooperatives, municipally-owned electric utilities, and retail rate-regulated gas utilities.

Section 91 of the Act creates an option for utilities to offer energy optimization services under the auspices of a state Energy Optimization Plan Administrator selected by the Commission. The MPSC chose the Michigan Community Action Agency Association (MCAAA) to administer the Energy Optimization Program for those utilities that have chosen not to self administer their Energy Optimization programs. MCAAA's program is called Efficiency United (EU). In 2012, eighteen utilities chose to contract with the state plan administrator; of these, 14 offer electric service only, 2 offer natural gas service only, and 2 offer both electric and gas service. Table 2 lists the participating utilities and their service options.

Table 2. Utilities Participating in Efficiency United (MCAAA)

Participating Utility or Cooperative	Electric Service	Gas Service
Alpena Power Company	X	
Baraga Electric Utility	X	
Bayfield Electric Cooperative	X	
The City of Crystal Falls	X	
Daggett Electric Department	X	
The City of Gladstone Department of Power & Light	X	
The City of Hillsdale – Board of Public Utilities	X	
Indiana Michigan Power Company	X	
L'Anse Electric Utility	X	
Michigan Gas Utilities Corporation		X
Negaunee Electric Department	X	
The City of Norway Department of Power & Light	X	
SEMCO Energy Gas Company and SEMCO Energy Gas Company - Battle Creek Division		X
City of South Haven	X	
Upper Peninsula Power Company	X	
We Energies	X	
Wisconsin Public Service Corporation	X	X
Xcel Energy	X	X

2.3 Overview of Implemented Programs

MCAAA contracted with CLEAResult Consulting to implement the energy optimization programs. CLEAResult, in turn, has contracted with JACO to implement the appliance recycling program. Not all programs are offered in all utility service territories. Table 3 shows the programs currently being implemented.

Table 3. Overview of Implemented Programs

Program Name		Notes
ENERGY STAR Products Program		Some utilities limit the measures offered through the program.
Residential Appliance Recycling Program		Not offered by all utilities; for electric customers only.
Residential Low Income Program		Implemented through previously existing assistance program.
Residential Home Performance Program	HVAC Program	Some utilities limit the measures offered through the program.
	Online Audit Program	Offered to customers of all EU utilities in 2012.
	Onsite Weatherization Program	Customers must receive gas service from participating utility
Commercial and Industrial Programs		Not offered by all utilities.
Multifamily Program		Implemented in MCAAA.
Pilot Programs		MCAAA offered 4 pilot programs in 2012.
Education Programs		One of first programs to be implemented.

2.4 Evaluation Objectives

The individual program evaluations were designed to maximize the available funding while providing a detailed study tailored to each program in the MCAAA portfolio. An impact evaluation and process evaluation were performed for each program.[3] Based on the RFP, the goals of the impact evaluation were:

- Provide independent expert evaluation of the programs to verify the incremental gross energy savings from each program as mandated by Public Act 295
- Document the effective useful life energy savings achieved and report those findings so that they can be reported to the Michigan Public Service Commission within the timeline required by the Michigan legislature
- Validate deemed savings and average measure life values for eligible energy efficiency measures in the Michigan Statewide Energy Measures Library/Database (MEMD).

As part of the impact evaluation, the RFP requests that the evaluation team verify a representative sample of program installations and verify the accuracy and consistency of program records by checking a representative sample of completed program application forms and projects.

The evaluation verified the incremental gross energy savings from each program as mandated by Public Act 295. The administrative rules for performing these evaluations are still evolving, and the current draft rules would require that net energy savings be determined in addition to the verified gross savings for future evaluations. Therefore, the evaluation was conducted in the spirit of the proposed rules, including net evaluation methods as well as gross verification for most programs in 2012. Including net effects in the study allows the evaluation team to gather the research necessary to determine the historic evolution of attributable savings for each program as it develops. This data will assist program implementers in modifying and improving the program plans going forward.

2.5 Description of Common Evaluation Tasks

DNV KEMA's impact evaluation of most of the programs in the MCAAA portfolio followed a relatively standard path. Each program received a tracking system review. Some programs also received a documentation review. Each evaluation used a participant survey for data collection, which was used in the gross savings analysis, and most of the programs received a net savings analysis, which may have

[3] The results of the process evaluation were presented in a separate report.

included an in-depth attribution analysis. Table 4 summarizes the general impact evaluation activities for each program.

Table 4. Summary of General Impact Activities

Program Name		Impact Evaluation Activity					
		Tracking Review	Paper Documentation Review	Participant Survey	Gross Savings Analysis	Net Savings Analysis	In-Depth Attribution Analysis
ENERGY STAR Products		X	X	X	X	X	X
Residential Appliance Recycling		X		X	X	X	
Residential Low Income		X		X	X		
Residential Home Performance Program	HVAC	X	X	X	X	X	X
	Online Audit	X		X	X	X	X
	Onsite Weatherization	X	X	X	X	X	X
Commercial and Industrial		X	X	X	X	X	X
Multifamily		X	X	X	X		

The following sections describe the general activities in more detail.

2.5.1 Tracking Review

DNV KEMA reviewed the CLEAResult tracking database to verify that the deemed savings values from the MEMD were applied correctly. We conducted our verification on multiple versions of the database received prior to CLEAResult's final year-end reporting. As a result, the errors found in the tracking review were corrected before the year-end savings were produced and were not included in the adjustment factors in this report. The results of our review are found in Appendix D.

2.5.2 Paper Documentation Review

DNV KEMA verified the accuracy and consistency of program records by checking a sample of completed program application forms and projects. The information entered into the tracking database was verified through a comparison with the paper documentation from most programs. The results of our review are found in Appendix E.

2.5.3 Sample Design and Data Collection Process

The primary objective of the DNV KEMA sample design for all programs was to target a relative precision of ± 10 percent at the 90 percent confidence level for the program overall, sometimes referred to

as 90/10 precision. The secondary objective was to produce technology-level results at a precision high enough to allow for reliable interpretation, though not necessarily as precise as 90/10 precision.

DNV KEMA targeted customers who made a larger contribution to the total program savings, though the sample was designed to ensure that we would complete surveys with customers with smaller contributions as well. Targeting customers with greater savings allowed us to achieve a more precise savings estimate while limiting evaluation data collection costs by limiting the number of surveys. DNV KEMA used a model based sampling approach for some designs and simple random sampling for others.

DNV KEMA collected data from customers based on a randomized order within the stratum. When a given measure was up for completion, DNV KEMA called that customer until either the survey was completed, or the customer was "killed." A customer is "killed" when they refuse to participate in the survey or terminate the survey before the responses are completed, or when the survey house fails to make contact within six attempts on different days at different times of the day.

Many customers received rebates for multiple measures, such as a CFL and a washing machine for example. Since measures are randomized within a stratum, a customer could be eligible for a survey regarding their CFL but not yet eligible for a survey regarding their washing machine. However, DNV KEMA could complete the survey regarding the CFL, and the customer could then later become eligible for a survey regarding their clothes washer. To avoid customer burden and repeated attempts at reaching the same person, DNV KEMA asked customers about all of the measures they installed regardless of where each fell within the call order. When DNV KEMA completed a survey with a customer, we asked about all measures that were installed whether or not those measures fell into the sample, to prevent the annoyance for the customer of multiple calls. For surveys conducted on measures that were not included in the sample or would not have come up in the normal call order, the results were included in the analysis but given a weight of one, meaning they represented only themselves and no other measures in the population.

DNV KEMA was unable to recruit all of the desired sample targets by strata, especially for those strata where we conducted a census. For that situation, DNV KEMA created a backup strategy that transferred a sample point from the stratum that we were unable to complete to the stratum with the largest contribution to total savings that still had sites available in the population to sample. For example, if the sample design for water heaters targeted a census, and DNV KEMA was unable to recruit one of those sites, that sample point would then be allocated to the furnace sample. In that way DNV KEMA was still able utilize the entire sample and target the optimal precision for the sample design.

2.5.4 Participant Survey

DNV KEMA collected data through participant surveys for each of the program evaluations outlined in this report. Most of the participant surveys were conducted using a computer aided telephone interview (CATI) through an outside survey house. Expert interviews were also conducted by DNV KEMA staff for the Commercial and Industrial and Multifamily programs.

The participant surveys were designed to verify equipment installation and collect equipment operating characteristics (where possible) to help verify program savings and inform MEMD savings estimates. For evaluations that included a net savings analysis, the participant survey was also used to identify what the participant would have done in the absence of the program.

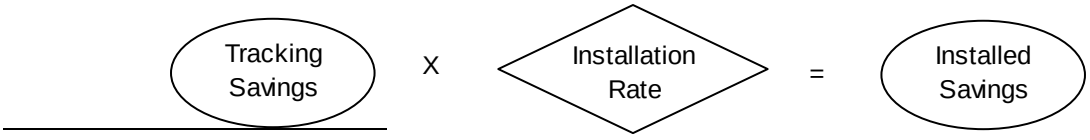
Most participant surveys also addressed program satisfaction and demographic questions. Those questions were primarily used for the process evaluation, and the results are presented in a separate report.[4]

2.5.5 Gross Savings Analysis

The installation information gathered from the participant surveys was used to determine the installed savings for the program. For most programs, the installation rate was determined by dividing the number of units installed by the number of units reported in the tracking database. For some projects, such as C&I projects, the installation rate was used as a binary variable indicating whether or not the project or something like it was installed at the customer location. If the customer said yes, the program received 100 percent installation savings for that measure, regardless of whether the number of units was consistent with the program tracking data. The program-specific methodologies outlined in the following sections identify which analysis was used for each program.

The installation rate was calculated for the each measure in the sample, and ratio estimation was used to determine the installation rate for the overall program. The overall installation rate was applied to the tracking savings to produce installed savings, as shown in Figure 1.

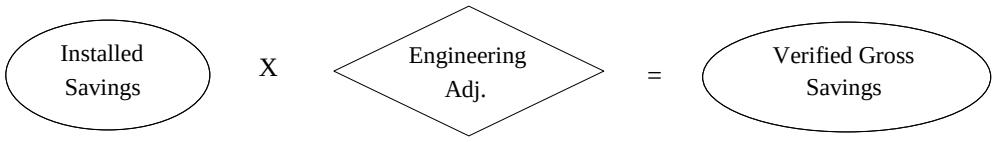
Figure 1. Installed Savings Determination



[4] DNV KEMA: *Process Evaluation of Electric and Natural Gas Energy Optimization Programs*. Prepared for Michigan Community Action Agency Association (MCAAA). March 2013.

DNV KEMA used the results of the documentation review and data from the participant surveys to determine the engineering adjustment factor. The documentation review identified inconsistencies in the transfer of data from the application to the tracking database. The participant survey data was used for C&I measures to adjust the gross savings estimates using site-specific data reported by the site contact. Once again, ratio estimation was used to determine the overall engineering adjustment factor for the entire program. The overall engineering adjustment factor was applied to the installed savings to produce verified gross savings, as shown in Figure 2.

Figure 2. Verified Gross Savings Determination



The engineering adjustment factor and the installation rate were multiplied to produce the gross savings adjustment factor. The gross savings adjustment factor is a single factor that is applied to the tracking data to produce verified gross savings, as shown in Figure 3.

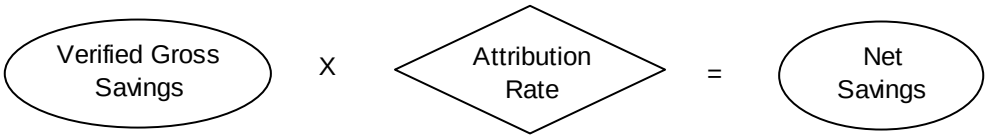
Figure 3. Overall Verified Gross Savings Determination

2.5.6 Net Savings Analysis

For projects with a net savings analysis, the data from the participant surveys was analyzed to judge the impact of the program on the participant's decision to install the energy efficiency measures. DNV KEMA analyzed the program's effect on the timing of the installation and the efficiency and quantity of the equipment installed. The program's influence on these three factors was combined to form the attribution rate for each measure. Again, the evaluation team used ratio estimation to determine the overall attribution rate and apply it to the verified gross savings for the program to calculate the

program's net savings, as shown in Figure 4. Further detail on the methodology used to determine the attribution rate can be found in Appendix G.

Figure 4. Net Savings Determination



2.5.7 Reporting Results

The adjustment factors are provided later in the report with indicators of statistical precision at the 90 percent confidence interval, sample sizes, and the percentage of program tracking savings represented by each measure group. The plus/minus (±) error (%) indicated at the 90 percent confidence interval is the absolute difference between the estimated percentage and the upper or lower confidence bound. For example, the ENERGY STAR CFL kWh installation rate estimate in Table 7 is 72 percent and the 90 percent confidence interval is ± 8 percentage points (i.e., 72 percent ± 8 percent).[5] The CFL measure group accounted for 18 percent of the overall program tracking savings. The adjustment factors are calculated using a SAS® macro provided by SAS for ratio estimation by domains.

2.5.8 In-Depth Attribution Analysis

For some programs, an in-depth attribution analysis was performed to identify where the program is having the greatest influence. The analysis reviewed the customer responses regarding the program's influence on the timing of the equipment installation and the efficiency and quantity of the equipment installed.

The purpose of in-depth attribution analysis was to indicate where the program is having a strong effect and where improvements can be made. While the net savings analysis produces overall adjustment ratios, the in-depth analysis identifies where the program is influencing the decision to install measures (i.e. timing, quantity, or efficiency) and where adjustments need to be made.

[5] The critical value for calculating the confidence interval ± for each adjustment factor is determined using Student's t-distribution and n-1 for the degrees of freedom, where n is the sample size. The critical value for the gross savings adjustment factor is determined using the degrees of freedom based on the minimum sample size for the components of the adjustment factor. The gross savings adjustment factor is a product of the installation rate and the engineering verification factor.

2.6 Overview of Report

The following sections have program-specific evaluation results and methodology. Sections 3 through 10 present program-level results for the following programs:

- Residential and Small Business ENERGY STAR Products
- Residential Appliance Recycling
- Residential HVAC
- Residential Low Income
- Residential Online Audit
- Residential Onsite Weatherization
- Commercial and Industrial
- Multifamily

Section 11 reports the conclusions and recommendations for each program and the portfolio overall. Sections 12 and 13 and appendices A through E report on savings for the following program components:

- Pilot Programs
- Education Programs
- Evidence of Spillover – Audit Programs
- Geographical Comparison – UP / LP
- Measure Life
- Tracking Review
- Documentation Review
- Sample Design and Disposition

Appendix G presents the attribution analysis methodology used for many of the programs.

A separate volume provides the survey instruments used for the participant surveys.

3. Residential and Small Business ENERGY STAR Products Program

This section reports on the methodology and overall results of DNV KEMA's evaluation of the Residential ENERGY STAR Program.

- Section 3.1 provides a description of the program.
- Section 3.2 gives an overview of the evaluation approach.
- Section 3.3 presents the verified gross savings results and the overall adjustment factors.
- Section 3.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.
- Section 3.5 offers a comparison of 2011 and 2012 program results.

3.1 Program Description

The Residential and Small Business ENERGY STAR Products (ESP) Program was launched in November 2009 in all utility service territories. Incentives are provided to customers through mail-in rebates for ENERGY STAR products such as CFLs, clothes washers, smart strips, faucet aerators, low-flow showerheads, and hot water pipe insulation. During 2012, the ESP Program began providing upstream rebates to suppliers or manufacturers of CFLs. The ESP Program is the second largest electric program in the MCAAA portfolio. Not all measures are offered in all utility service territories as shown in Table 5.

Table 5. Measures Offered by Utility through ESP Program

Utility	Measure								
	CFL	Ceiling Fan	Clothes Washer	Clothes Dryer	Faucet Aerator	Low Flow Showerhead	Pipe Wrap	Dishwasher	LED Night Light
Alpena Power Company	X		X	X	X	X		X	X
Baraga Electric Utility	X				X	X			X
Bayfield Electric Cooperative	X				X				
The City of Crystal Falls	X				X	X			X
Daggett Electric Department	X				X	X			
The City of Gladstone Department of Power and Light	X	X	X	X	X	X		X	
City of Hillsdale Board of Public Utilities	X	X	X	X	X	X		X	X
Indiana Michigan Power Company	X	X	X	X	X	X		X	X
L'Anse Electric Utility	X				X	X			
Michigan Gas Utilities Corporation			X		X	X	X	X	
Negaunee Electric Utility	X				X	X			X
City of Norway Department of Power and Light	X		X	X	X	X		X	X
SEMCO Energy Gas Company			X		X	X	X	X	
City of South Haven	X	X	X	X		X		X	X
Upper Peninsula Power Company	X	X	X	X	X	X		X	X
We Energies	X	X	X	X	X	X		X	X
Wisconsin Public Service Corporation	X	X	X	X	X	X	X	X	X
Xcel Energy	X	X	X	X	X	X	X	X	X

Table 6 shows the accomplishments for the ENERGY STAR Products Program based on the program implementer tracking data. The table shows the tracking savings, number of measures rebated, and incentives paid for the evaluation period and the entire 2012 program period. The majority of ESP projects were paid in the last quarter of the year and could not be included in the evaluation sample frame.

Table 6. Overview of ESP Program Accomplishments per Program Tracking

Metric	Evaluation Period Jan to Aug 2012	Program Period Jan to Dec 2012
Tracking kWh Savings	292,334	9,121,534
Tracking ccf Savings	10,623	158,414
# Measures	983	8,882
Incentives	$19,201	$405,342

3.2 General Approach

The impact evaluation of the ESP Program had the following objectives for the 2012 program:

- Reliably estimate the program's gross annual kWh and gas savings (ccf) over the effective useful life of the installations
- Provide an estimate of program attribution.

To meet these objectives, the impact evaluation included the following tasks:

- Verify proper tracking assignments (Appendix D)
- Verify proper documentation with a sample of participating applications (Appendix E)
- Conduct CATI surveys with a sample of participants
- Conduct verified gross savings analysis
- Conduct net savings analysis
- Complete in-depth attribution analysis to assist with program planning.

Section 2.5 describes the steps used to complete these tasks in greater detail.

3.3 Verified Gross Savings Results

3.3.1 Installation Rate

DNV KEMA calculated the installation rate for the ENERGY STAR Program. For non-kit measures, we defined the installation rate as the number of units installed divided by the number of units in the tracking database. For kit measures, we gathered installation rate information at the technology level. We defined the installation rate as the number of units installed divided by the number of units in the tracking database description of the kit, as we had with non-kit measures. Table 7 shows the results. In the table, the technologies that were sold in kits are distinguished from the same technologies purchased outside of kits.

The table shows that installation rates differ greatly between measure types, with lower rates generally seen among kit measures.

- For non-kit measures, the installation rates were generally greater than 70 percent. The exception to this was LED Night Lights, with an installation rate of 69 percent. For kit measures, the installation rates were much lower, in the 45 to 70 percent range.

- On the electric side, non-kit CFLs had an installation rate of 72 percent compared to 59 percent for kits.
- The only technology that had a comparable installation between kit and non-kit measures was LED Night Lights, with 69 percent for non-kits and 71 percent for kits. This was also the only technology where the kit installation rate was higher than the non-kit installation rate.
- Smart strips had an installation rate of 86 percent for non-kit measures. No kits that included smart strips were in the database in time for the evaluation this year.
- Measures that were exclusively non-kit (clothes dryers, washing machines and dishwasher) all had a 100 percent installation rate.

Table 7. Installation Rate, ENERGY STAR

	kWh						ccf					
			90% Confidence Interval			%			90% Confidence Interval			%
Measure Group	n	Installation Rate	+/-	Lower Bound	Upper Bound	Program Savings	n	Installation Rate	+/-	Lower Bound	Upper Bound	Program Savings
CFL	38	72%	8%	64%	80%	18%	0	-	-	-	-	0%
Clothes Dryer	5	100%	<0.1%	100%	100%	1%	0	-	-	-	-	0%
Faucet Aerator	1	100%	<0.1%	100%	100%	1%	2	87%	90%	0%	100%	1%
LED Night Light	14	69%	17%	51%	86%	2%	0	-	-	-	-	0%
Pipe Wrap	0	-	-	-	-	0%	2	100%	<0.1%	100%	100%	0%
Showerhead	11	89%	20%	69%	100%	11%	12	82%	14%	67%	96%	21%
Smart Strip	30	86%	8%	78%	95%	2%	0	-	-	-	-	0%
Washing Machine	18	100%	<0.1%	100%	100%	5%	24	100%	<0.1%	100%	100%	18%
Dishwasher	0	-	-	-	-	0%	9	100%	<0.1%	100%	100%	4%
Kit - CFL	22	59%	15%	45%	74%	20%	0	-	-	-	-	0%
Kit - Faucet Aerator	12	48%	26%	22%	74%	10%	19	53%	18%	35%	71%	16%
Kit - LED Night Light	22	71%	15%	56%	86%	3%	0	-	-	-	-	0%
Kit - Pipe Wrap	12	46%	26%	21%	72%	12%	19	58%	18%	39%	76%	16%
Kit - Showerhead	12	50%	26%	24%	75%	16%	19	61%	19%	43%	80%	25%
Energy Star Overall	**197**	**66%**	**10%**	**56%**	**76%**	**100%**	**106**	**73%**	**7%**	**66%**	**80%**	**100%**

3.3.2 Verified Gross Savings

The installation rate was combined with the results of the documentation review to produce the gross savings adjustment factor (GSA), which is a single adjustment that can be applied to the tracking savings

to determine verified gross savings.[6] Table 8 shows the gross savings adjustment factors for ENERGY STAR Products.

DNV KEMA's review found a number of issues with individual measures. These include washing machines with savings calculated assuming an incorrect dryer type, and measures which were not shown on the application. On the gas side, these findings resulted in slightly lower gross savings adjustment than installation rates for dishwashers, showerheads and washing machines and a slightly higher gross savings adjustment than installation rate for faucet aerators. Overall, the electric gross savings adjustment is equal to the installation rate, while the gas gross savings adjustment is 3 percent lower (70 percent GSA as opposed to a 73 percent installation rate).

Table 8. Gross Savings Adjustment Factor, ENERGY STAR

	kWh						ccf					
		Gross Savings	90% Confidence Interval			%		Gross Savings	90% Confidence Interval			%
Measure Group	min n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings	min n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings
CFL	36	72%	8%	64%	79%	18%	0	-	-	-	-	0%
Clothes Dryer	5	100%	<0.1%	100%	100%	1%	0	-	-	-	-	0%
Faucet Aerator	1	100%	<0.1%	100%	100%	1%	2	88%	91%	-2%	179%	1%
LED Night Light	11	69%	18%	51%	86%	2%	0	-	-	-	-	0%
Pipe Wrap	0	-	-	-	-	0%	2	100%	<0.1%	100%	100%	0%
Showerhead	10	89%	21%	68%	109%	11%	11	78%	14%	64%	92%	21%
Smart Strip	28	86%	9%	78%	95%	2%	0	-	-	-	-	0%
Washing Machine	18	100%	<0.1%	100%	100%	5%	24	94%	<0.1%	94%	94%	18%
Dishwasher	0	-	-	-	-	0%	9	96%	<0.1%	96%	96%	4%
Kit - CFL	20	59%	15%	44%	73%	20%	0	-	-	-	-	0%
Kit - Faucet Aerator	8	48%	28%	20%	76%	10%	11	53%	19%	35%	72%	16%
Kit - LED Night Light	17	71%	15%	56%	86%	3%	0	-	-	-	-	0%
Kit - Pipe Wrap	7	46%	29%	18%	75%	12%	12	58%	19%	39%	77%	16%
Kit - Showerhead	8	50%	27%	22%	77%	16%	11	58%	18%	40%	77%	25%
Energy Star Overall	**169**	**66%**	**10%**	**56%**	**76%**	**100%**	**82**	**70%**	**7%**	**64%**	**77%**	**100%**

The gross savings adjustment factor was applied by measure group to the total savings reported for the ENERGY STAR Products Program in 2012 to produce the verified gross savings for the program. Table 9 shows the tracking gross savings (an annual number), the gross savings adjustment factor determined from the evaluation, the verified gross annual savings, and the verified gross lifetime savings.[7] The verified gross annual savings is the tracking gross savings multiplied by the gross savings adjustment

[6] The gross savings adjustments reported in Table 8 (and throughout this report) are the LCNS gross savings adjustments used to produce the verified gross lifetime savings, which may differ slightly from the Y1NS gross adjustment factors used to produced the annual verified gross savings.

[7] The overall gross savings adjustment factors reported in Table 9 differ from Table 8 because they represent the proportion of verified savings to tracked savings in the final population. The mix of measures in the final population differed from the mix of measures in the sample frame used to develop the gross savings adjustments.

factor. The verified gross lifetime savings is the verified gross annual savings with the measure life applied.[8]

Table 9. Verified Gross Savings, ENERGY STAR

Measure Group	kWh				ccf			
	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
CFL	112,008	72%	80,122	721,102				
Clothes Dryer	9,792	100%	9,792	137,088	63	100%	63	881
Faucet Aerator	17,264	100%	17,264	172,640	1,369	88%	1,209	12,094
Ceiling Fan	780	72%	558	8,369				
LED Night Light	18,304	69%	12,563	201,006				
Pipe Wrap					78	100%	78	858
Refrigerator	1,980	100%	1,980	27,720				
Showerhead	187,516	89%	166,598	1,665,979	10,233	78%	7,954	79,538
Smart Strip	46,803	86%	40,395	201,973				
Washing Machine	29,897	100%	29,897	328,867	3,674	94%	3,453	37,985
Dishwasher	3,600	96%	3,456	38,016	1,194	96%	1,146	12,608
Kit - CFL	1,681,524	59%	986,335	8,877,013				
Kit - Faucet Aerator	550,788	48%	264,684	2,646,842	28,441	53%	15,206	152,065
Kit - LED Night Light	308,132	71%	218,936	3,502,974				
Kit - Pipe Wrap	507,654	46%	234,790	3,052,270	26,099	58%	15,125	166,378
Kit - Showerhead	1,668,478	50%	831,922	8,319,217	87,264	58%	50,725	507,254
Kit - Smart Strip	241,087	86%	208,075	1,040,374				
Kit - LED Holiday Lights	43,343	69%	29,749	297,485				
Dehumidifier	336	100%	336	3,360				
Upstream CFL	3,692,247	70%	2,586,346	23,277,115				
ENERGY STAR Overall	**9,121,534**	**63%**	**5,723,797**	**54,519,410**	**158,414**	**60%**	**94,961**	**969,660**

3.4 Attribution Results

The EU program was not required to report net or attributable savings for the 2012 program year. However, discussions within the State of Michigan suggest that net savings may be required in future program years. DNV KEMA conducted a net savings analysis to provide the program with the information they will need for planning and implementation when moving toward net savings reporting.

[8] DNV KEMA's study did not complete any surveys addressing ceiling fans, refrigerators, kit - smart strips, LED holiday lights, dehumidifiers or upstream CFLs. To estimate verified gross savings, DNV KEMA applied the GSA for clothes dryers to estimate verified gross savings for refrigerators and dehumidifiers, applied the CFL GSA to ceiling fans, the smart strip GSA to kit - smart strips, and the LED night light GSA to LED holiday lights. For upstream CFLs, DNV KEMA combined the installation rate found for CFLs and the upstream CFL documentation review adjustment factor.

3.4.1 Attribution Adjustment Factors

DNV KEMA calculated the attribution adjustment factor for each measure group in the ENERGY STAR Program. The attribution adjustment factor is applied to the verified gross savings to produce net savings. It reflects the influence the program had on the timing, efficiency level, and scope of the energy efficiency measure installed.[9] Table 10 shows the results.

As with the installation rate, this table highlights the differences between kit and non-kit technologies. For the most part, kit and non-kit versions of the same technology had similar attribution. There were no statistically significant differences between kit and non-kit versions of the same technology.

- Attribution rates for non-appliance measures with ccf savings were much higher than measures with kWh savings. For these measures, attribution ranged from 62 percent for kit pipe wrap to 90 percent for kit faucet aerators.
- Among non-appliance measures with kWh savings, attribution ranged from 23 percent for kit showerheads to 60 percent for non-kit smart strips.
- Non-kit CFLs, which account for 18 percent of kWh program savings, had an attribution of 38 percent. Kit CFLs had an attribution rate of 37 percent, accounting for 20 percent of kWh program savings.
- Attribution was generally low for appliance measures. Washing machines had an attribution of 21 percent for kWh savings and 17 percent for ccf savings. Dishwashers had an attribution of 11 percent for ccf savings. Clothes dryers had a somewhat higher attribution rate of 36 percent for kWh savings.

There is more discussion about attribution results in Appendix G and the following section.

[9] Appendix G discusses the methodology used in the attribution analysis.

Table 10. Attribution Adjustment Factor, ENERGY STAR

	kWh						ccf					
		Attribution	90% Confidence Interval			%		Attribution	90% Confidence Interval			%
Measure Group	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings
CFL	34	38%	13%	25%	51%	18%	0	-	-	-	-	0%
Clothes Dryer	5	36%	36%	0%	72%	1%	0	-	-	-	-	0%
Faucet Aerator	1	*	*	*	*	1%	1	*	*	*	*	1%
LED Night Light	9	39%	29%	11%	68%	2%	0	-	-	-	-	0%
Pipe Wrap	0	-	-	-	-	0%	2	*	*	*	*	0%
Showerhead	10	32%	39%	0%	71%	11%	11	72%	27%	45%	99%	21%
Smart Strip	28	60%	14%	46%	74%	2%	0	-	-	-	-	0%
Washing Machine	18	21%	10%	11%	32%	5%	24	17%	11%	7%	28%	18%
Dishwasher	0	-	-	-	-	0%	9	11%	16%	0%	26%	4%
Kit - CFL	11	37%	14%	22%	51%	20%	0	-	-	-	-	0%
Kit - Faucet Aerator	5	32%	45%	0%	77%	10%	5	90%	21%	69%	110%	16%
Kit - LED Night Light	8	42%	32%	10%	74%	3%	0	-	-	-	-	0%
Kit - Pipe Wrap	4	*	*	*	*	12%	7	62%	36%	26%	98%	16%
Kit - Showerhead	5	23%	34%	0%	57%	16%	5	78%	33%	45%	112%	25%
Energy Star Overall	**138**	**36%**	**10%**	**26%**	**47%**	**100%**	**64**	**55%**	**14%**	**41%**	**69%**	**100%**

*To preserve respondent confidentiality, attribution results are not displayed for measure groups with less than five completed surveys.

3.4.2 Analysis of Survey Responses

DNV KEMA reviewed the responses to the attribution question sequence used in the ENERGY STAR survey to identify where the program was having an effect and where improvements could be made. We investigated the program's effect on timing, efficiency, and quantity, the three components of attribution. Appendix G has greater detail on the attribution analysis methodology and the methods used to combine the three components into a single attribution value. (Table 11)

Table 11. Attribution Question Sequence

Number	Question
Timing	
DAT1	Without EU, how likely is it that you would have installed the same type of equipment at this time?
DAT1a	Without EU, how different would the timing have been?
DAT1b	Approximately how many months later?
Efficiency	
DAT2	Without EU, how likely is it that you would have installed the same level of efficiency?
DAT2a	Without EU, how likely is it that you would have installed the same, greater, or lesser efficiency?
DAT2b	Without EU, what efficiency would you have installed?
Quantity	
DAT3	Without EU, how different would the quantity/size have been?
DAT3a	By what percentage did you change the quantity/size because of EU?

3.4.2.1 Timing

Respondents are asked a sequence of questions that address the timing of the equipment installation. First, respondents are asked how likely it is that they would have installed the same type of equipment at the same time without the program (DAT1). Then respondents are asked how different the timing would have been (DAT1a).

- A response of "Same Time" means that the customer would have installed the measure(s) at the same time regardless of program involvement.

- A response of "Later" indicates that they would have waited to install the measure(s) if the program had not been present. This measure is called "accelerated." Respondents who answered "Later" are asked a follow-up question (DAT1b) about how much later they would have installed the equipment without the program.

Table 12 shows the responses to the DAT1a and DAT1b questions for ENERGY STAR. The table shows the unweighted number of responses in each category and the associated percentage of overall program energy savings represented by those responses. The number of responses does not reflect any survey weight or relative savings but the percentage of energy savings does.

The table outlines the skip pattern and attribution assignment for DAT1a and DAT1b. If a respondent indicates that they would have installed the equipment at the same time or earlier, the acceleration period is zero months and there is no timing effect. If the respondent indicates that they never would have installed the equipment without the program, then the program is credited with influencing the entire project and receives 100 percent attribution. The same effect is applied if the respondent indicates it would have been greater than four years before they would have installed the equipment without the program. If the response to DAT1a is Later and the response to DAT1b is a number less than 48, then the acceleration period is equal to that number of months.

Table 12. Determining Acceleration Period, ENERGY STAR

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	65	31%	29%	0
Earlier	N/A	10	14%	1%	0
Later	Months < 48	34	28%	16%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	7	2%	8%	Average of DAT1b
Never	N/A	32	13%	39%	100%
Not Applicable	N/A	7	11%	7%	Not Asked
Don't Know/Refused	N/A	2	1%	0%	Average of DAT1a

The table shows that sixty-five of the respondents would have installed the equipment at the same time regardless of program involvement, representing 31 percent of kWh and 29 percent of gas savings (ccf). Thirty-two customers gave the program full attribution credit, representing 13 percent of kWh savings and 39 percent of gas savings (ccf). Forty-one respondents representing 30 percent of kWh savings and 24 percent of gas savings (ccf) said they would have installed the equipment within the next four years or said they would have installed it later, but did not know when, both of which result in an accelerated measure. Seven measures were not asked the timing questions, either because they received 100 percent attribution based on their response to DAT0, or they went through the CFL attribution sequence.

3.4.2.2 Efficiency

Respondents are asked a sequence of questions that address the efficiency of the equipment installation. First, respondents are asked how likely it is that they would have installed the same, lesser, or greater efficiency without the program (DAT2a). Then respondents are asked how different the efficiency would have been (DAT2b).

- A response of “Same” means that the customer would have installed the same level of efficiency regardless of program involvement.
- A response of “Lower” indicates that they would have installed a less efficient piece of equipment if the program had not been there. Respondents who answered “Lower” are asked a follow-up question (DAT2b) about what equipment efficiency they would have installed without the program.

Table 13 shows the responses to the DAT2a question for each measure category. The table includes a response of Not Applicable, which represents measures that do not have variable efficiency themselves,

but are added to the existing equipment or systems to make the overall operation more efficient. Programmable thermostats fall into the Not Applicable category.

The table outlines the skip pattern and attribution assignment for DAT2a and DAT2b. If a respondent indicates that they would have installed the equipment of the same or higher efficiency, the efficiency attribution is zero. If the respondent indicates that they would have installed a lower efficiency then the efficiency attribution is some number between 30 and 100 percent, depending on the answer to DAT2b.

Table 13. Determining Efficiency Attribution, ENERGY STAR

DAT2a. Without EU, would you have installed the same, higher, or lower efficiency?					
DAT2b. Without EU, what efficiency would you have installed?					
DAT2a Response	DAT2b Response	Responses	Percent kWh	Percent ccf	Efficiency Attribution
Same	N/A/Skipped	96	7%	23%	0%
Lower	Standard Efficiency	7	2%	3%	100%
	Slightly > Standard	3	1%	1%	70%
	Between Standard and High	0	0%	0%	50%
	Slightly < High	2	1%	0%	30%
	Don't Know/Refused	0	0%	0%	Average of DAT2b
	N/A	19	13%	7%	100%
Higher	N/A/Skipped	0	56%	36%	0%
Not Applicable	N/A	18	18%	18%	Not Asked
Don't Know/Refused	N/A	12	2%	12%	Average of DAT2a

The table shows that the majority of respondents would have installed the same efficiency level without the program, with 96 measures representing 7 percent of program kWh savings and 23 percent of program gas savings (ccf). Seven measures received 100 percent attribution because the respondents indicated they would have installed the same efficiency without the program. . Twenty-four measures received between 30 and 100 percent attribution by answering lower to DAT2a and something other than standard efficiency for DAT2b. Eighteen measures were not asked either efficiency question, either because they received 100 percent attribution based on their response to DAT0, they were went through the CFL attribution sequence, or because the measure they installed did not have a less efficient alternative, such as pipe wrap.

3.4.2.3 Quantity

Respondents are asked a sequence of questions that address the quantity of equipment installed. First, respondents are asked how likely it is that they would have installed the same quantity of equipment without the program (DAT3). Then respondents are asked how much they changed the quantity (DAT3a).

- A response of "Same amount" means that the customer would have installed the same or greater size or quantity regardless of program involvement.
- A response of "Less" indicates that the customer would have installed fewer units if the program had not been there. Respondents who answered "Less" are asked a follow-up question (DAT3a) about the quantity of equipment they would have installed without the program.
- A response of "More" indicates that the customer would have installed more units, or larger units if the program had not been there. Respondents who answered "More" are asked a follow-up question (DAT3a) about the quantity of equipment they would have installed without the program.

Table 14 shows the responses to the DAT3 question for each measure group. The table includes a response of Not Applicable, which represents measures where varying quantity or size does not make sense in the context of the measure.

The table outlines the skip pattern and attribution assignment for DAT3 and DAT3a. If a respondent indicates that they would have installed the same or greater quantity or size, the quantity attribution is zero. If the respondent indicates that they would have installed less quantity/size, then the quantity attribution is some value between 0 and 100 percent. If the respondent indicates that they would not have installed any equipment without the program then the quantity attribution is 100 percent.

Table 14. Determining Quantity Attribution, ENERGY STAR

DAT3. Without EU, how different would the quantity/size have been?					
DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	21	26%	8%	0%
Less	Value < 100%	16	19%	8%	Value < 50%
	Value >= 100%	0	0%	0%	Value > 50%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
More	Value < 100%	6	6%	3%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	1	1%	0%	Average of DAT3a
None	N/A	16	9%	21%	100%
Not Applicable	N/A	96	40%	59%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT3

The table shows that twenty-one respondents representing 26 percent of kWh savings and 8 percent of gas savings (ccf) would have installed equipment of the same size or quantity without the program. Seven respondents representing 7 percent of kWh savings and 3 percent of gas savings (ccf) would have installed equipment of a greater size or quantity than without the program. Sixteen respondents representing 9 percent of kWh savings and 21 percent of gas savings (ccf) would not have installed any equipment, resulting in 100 percent quantity attribution. Sixteen respondents representing 19 percent of kWh savings and 8 percent of gas savings (ccf) would have installed a smaller size or quantity of equipment without the program, resulting in an attribution of between 0 and 100 percent.

Ninety-six measures were not asked either quantity question. This was because they either received 100 percent attribution based on their response to DAT0, they went through the CFL attribution sequence, or because they only installed one of a measure where the question asks about quantity rather than size.

3.4.2.4 Overall Attribution

DNV KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 15 shows the three effects together; 'Yes' indicates some (not necessarily full) attribution while 'No' indicates responses that did not receive any attribution.

The table shows that twenty-nine responses representing 14 percent of kWh savings and 15 percent of gas savings (ccf) received all three types of attribution (or full attribution based on the overall likelihood question). Seventy-four responses representing 31 percent of kWh savings and 25 percent of gas savings (ccf) did not receive any timing, efficiency, or quantity attribution.

Table 15. Simplistic Representation of Overall Attribution, ENERGY STAR

Attribution			Responses	Percent kWh	Percent ccf
Timing	Efficiency	Quantity			
Yes	Yes	Yes	29	14%	15%
Yes	No	Yes	7	5%	4%
Yes	No	No	26	16%	12%
Yes	Yes	No	2	1%	0%
No	Yes	Yes	15	5%	12%
No	Yes	No	24	18%	3%
No	No	Yes	25	10%	28%
No	No	No	74	31%	25%

3.5 Comparison of 2011 and 2012 Program Results

DNV KEMA compared the results of the 2011 program evaluation to the results of the 2012 program evaluation.

3.5.1 Overall Comparison

Table 16 shows the tracking savings, number of measures, and total incentives paid for the 2011 and 2012 program periods. The final column shows the difference between the two, with a negative value representing a decrease from 2011 and a positive value representing an increase.

The table shows a significant increase in savings for the ENERGY STAR Program from 2011 to 2012. Tracking kWh savings and incentives increased by 131 and 139 percent, respectively, while natural gas savings, increased by 61 percent. The number of measures purchased through the program increased by six percent.

One reason for the difference is that the 2012 program included the new upstream CFL program, which requires very little from a customer in order to participate. Upstream CFLs made up 40 percent of program kWh in 2012, almost as much electric savings as were in the 2011 program as a whole.

Table 16. Comparison of 2011 and 2012 ENERGY STAR Program Results

Metric	Program Period Jan to Dec 2011	Program Period Jan to Dec 2012	2011 to 2012 Change
Tracking kWh Savings	3,956,593	9,121,534	131%
Tracking ccf Savings	98,516	158,414	61%
Total # Measures	8,374	8,882	6%
Total Incentive	$169,497	$405,342	139%

3.5.2 Adjustment Factors

Table 17 shows the 2011 and 2012 installation rate, gross savings adjustment factor, and attribution adjustment factor for kWh and ccf. No ratios showed a statistically significant difference from the 2011 to 2012 program periods at the 90 percent confidence interval.

Table 17. Comparison of 2011 and 2012 ENERGY STAR Adjustment Factors

Adjustment Factor	kWh		ccf	
	2011	2012	2011	2012
Installation Rate	75%	66%	67%	73%
Gross Savings Adjustment Factor	75%	66%	67%	70%
Attribution Adjustment Factor	46%	37%	38%	55%

4. Residential Appliance Recycling Program

This section reports on the methodology and overall results of DNV KEMA's evaluation of the Residential Appliance Recycling Program.

- Section 4.1 provides a description of the program.
- Section 4.2 gives an overview of the evaluation approach.
- Section 4.3 presents the verified gross savings results and the overall adjustment factors.
- Section 4.4 shows the attribution analysis results.
- Section 4.5 offers a comparison of 2011 and 2012 Program results.

4.1 Program Description

The Residential Appliance Recycling (AR) Program was launched in March 2010. Incentives are provided to the customer for removing and recycling refrigerators or freezers in working condition and within a given size range. The goal is to produce cost-effective long-term annual energy savings by removing operable, inefficient appliances from the utility grid in an environmentally safe manner. Participation is limited to all electric utilities except Bayfield Electric Cooperative and Daggett Electric Department. The AR program is the fourth largest residential electric program in the MCAAA portfolio. Not all measures are offered in all utility service territories as shown in Table 18.

Table 18. Measures Offered by Utility through Appliance Recycling Program

Utility	Measure	
	Refrigerator	Freezer
Alpena Power Company	X	X
Baraga Electric Utility		
Bayfield Electric Cooperative		
The City of Crystal Falls	X	X
Daggett Electric Department		
The City of Gladstone Department of Power and Light	X	X
City of Hillsdale Board of Public Utilities	X	X
Indiana Michigan Power Company	X	X
L'Anse Electric Utility	X	X
Michigan Gas Utilities Corporation	X	X
Negaunee Electric Utility	X	X
City of Norway Department of Power and Light	X	X
SEMCO Energy Gas Company	X	X
City of South Haven	X	X
Upper Peninsula Power Company	X	X
We Energies	X	X
Wisconsin Public Service Corporation	X	X
Xcel Energy	X	X

The Appliance Recycling Program has contracted with JACO, Inc. to provide turnkey refrigerator recycling services. JACO is responsible for marketing the program, qualifying product eligibility over the phone and through their website, arranging appointments for refrigerator and freezer pick-up, transporting units to a recycling facility, and arranging for the de-manufacture and recycling of units. JACO is responsible for keeping records of all refrigerators collected and recycled as part of this program and provides this data to the program in electronic form, which will allow tracking of energy savings. JACO is also responsible for processing rebate forms and issuing incentives to program participants.

Table 19 shows the accomplishments for the AR program based on the program implementer tracking data. The table shows the tracking savings, number of measures rebated, number of participants, and incentives paid for the evaluation period and the final 2012 program period. The table shows data for the program as a whole and by equipment type.

Table 19. Overview of AR Program Accomplishments per Program Tracking

Metric	Evaluation Period Jan to Aug 2012	2011 Program Period Jan to Dec 2012
Tracking kWh Savings	1,171,445	1,888,634
Refrigerator kWh	906,224	1,407,824
Freezer kWh	265,221	480,810
Total # Measures	713	1,152
# Refrigerators Recycled	542	842
# Freezers Recycled	171	310
Total Incentive paid to Implementer	$105,015.00	$173,695.00
Refrigerator	$79,785.00	$126,490.00
Freezer	$25,230.00	$47,205.00

4.2 General Approach

The impact evaluation of the AR program had the following objectives for the 2012 program:

- Reliably estimate the program's gross annual kWh and gas savings (ccf) over the effective useful life of the installations
- Provide an estimate of program attribution.

To meet these objectives, the impact evaluation included the following tasks:

- Verify proper tracking assignments (Appendix D)
- Verify proper documentation with a sample of participating applications (Appendix E)
- Conduct CATI surveys with a sample of participants
- Conduct verified gross savings analysis
- Implement participant action-based approach to evaluate energy impacts of the program.

Section 2.5 describes the steps used to complete these tasks in greater detail.

4.2.1 Net and Gross Savings in an Appliance Recycling Framework

Appliance recycling programs are different from most other programs in that the measure is the removal of a working unit rather than the installation of an efficient unit in place of an inefficient unit. Moreover, the program goal is defined as removal of units not just from participating homes but from the grid. Free-riders in an AR framework are participants whose units would not have provided a load on the electrical grid in the absence of the program. This occurs when the participant's actions would have resulted in the destruction of the unit or if they would have stored the unit unplugged from the grid. All other participants, including those who transfer units to the second hand market, are not considered free-riders.

4.2.1.1 Gross Savings

Gross savings from an appliance recycling program include all net savings and all savings associated with free-riders. As a result, gross savings represents the total potential savings, while net savings is the savings from only those participants whose units would have contributed to ongoing load on the electrical grid in the absence of the program.

Michigan utilizes a deemed energy savings process, where the baseline energy consumption for energy efficient equipment has been agreed upon in advance of the program. However, there exists the possibility that assumptions underlying the deemed energy consumption might not hold true for the current program, in which case an adjustment to gross savings might be recommended.

4.2.1.2 Non-participant Survey

In addition to the participant survey, 649 non-participants were surveyed about actions they had taken in the past three years with respect to acquiring and discarding refrigerators and freezers. These non-participants were recruited from two groups. The first group was taken from the other residential participant surveys fielded as part of this evaluation, such as the ENERGY STAR Products survey and the HVAC survey. This group provided 409 respondents. The second group was from a general population survey of Michigan residential customers. There were 240 respondents from the general population survey who reported acquiring/discarding a refrigerator or freezer in the past three years. Responses from this population were used to help characterize the used refrigerator market and determine typical disposal patterns in the absence of the recycling program.

4.3 Verified Gross Savings Results

4.3.1 Removal Rate

When a unit is removed, the program confirms that it was installed and operational in accordance with program assumptions. DNV KEMA found that only one participant reported that a unit was not removed by the program. This resulted in an effective removal rate of 100 percent. Table 20 shows the results of the survey data analysis.

Table 20. Removal Rate, Appliance Recycling

Measure Group	kWh					
			90% Confidence Interval			%
	n	Removal Rate	+/-	Lower Bound	Upper Bound	Program Savings
Refrigerators	230	100%	<0.1%	99%	100%	75%
Freezers	75	100%	<0.1%	100%	100%	25%
Overall Appliance Recycling	**305**	**100%**	**1%**	**99%**	**100%**	**100%**

4.3.2 Engineering Adjustment Factor

The engineering adjustment factor incorporates the changes to the per-unit energy savings made by the evaluation team. For the Appliance Recycling Program, the evaluation team adjusted the equipment operation assumption to account for partial usage as reported by the participant responses.

The MEMD annual energy consumption (Unit Energy Consumption – UEC) for refrigerator recycling is 1,672 kWh/yr and for freezer recycling is 1,551 kWh/yr. These numbers were determined by taking the average of five recent appliance recycling program evaluations.

The baseline assumption for equipment usage is that the recycled equipment is in operation 24 hours per day, 365 days per year (24/365). DNV KEMA surveyed program participants about the typical usage patterns of their units and believe that an assumption of 24/365 operation is overstating the savings from appliance recycling. Based on survey data, we found that, although all main units reported a 24/365 usage profile, the larger percentage of secondary units recycled had reduced operating hours, resulting in a mean operational rate of 84 percent for refrigerators and 21 percent for freezers. When averaged across all equipment types (refrigerators and freezers both), the units recycled by the program operated for 69 percent of the year rather than the 24/365 operation assumed in the MEMD. The operation levels is discussed later in this report in comparison to 2011 program results in Section 4.5.2

Main refrigerators typically have 24/365 operation, but with secondary refrigerators and freezers an assumption of 24/365 operation is not realistic as shown in the data above. While main refrigerators are used on a 24/365 schedule, appliance recycling evaluations typically find that some percentage of secondary refrigerators and freezers are only used sporadically, either on a seasonal basis, or as overflow refrigerated storage for special events like parties. This part use factor can vary by region and program. For this evaluation, survey responses indicate that usage was significantly below 24/365 operation for secondary and freezer units. DNV KEMA used an adjusted equipment usage that reflects the more limited usage of secondary units when determining the engineering adjustment factor. On average, the refrigerators and freezers recycled by the program operated for approximately 69 percent of the year, which is reflected in Table 21.

Table 21. Engineering Adjustment Factor, Appliance Recycling

	kWh					
		Engineering	90% Confidence Interval			%
Measure Group	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings
Refrigerators	230	84%	3%	81%	88%	75%
Freezers	75	21%	5%	16%	26%	25%
Overall Appliance Recycling	**305**	**69%**	**4%**	**65%**	**73%**	**100%**

4.3.3 Verified Gross Savings

The engineering adjustment factor and removal rate were combined into the gross savings adjustment factor, which is a single adjustment that can be applied to the tracking savings to determine verified gross savings. Table 22 shows the gross savings adjustment factor for Appliance Recycling. As the removal rate was 100 percent, the gross savings adjustment reflects the engineering adjustment.

Table 22. Gross Savings Adjustment Factor, Appliance Recycling

Measure Group	kWh					
	min n	Gross Savings Adjustment Factor	90% Confidence Interval			% Program Savings
			+/-	Lower Bound	Upper Bound	
Refrigerators	230	84%	3%	81%	88%	75%
Freezers	75	21%	5%	16%	26%	25%
Overall Appliance Recycling	**305**	**69%**	**4%**	**65%**	**73%**	**100%**

The gross savings adjustment factor was applied by measure group to the total savings reported for the Appliance Recycling Program in 2012 to produce the verified gross savings for the program. Table 23 shows the tracking gross savings (an annual number); the gross saving adjustment factor determined from the evaluation; the verified gross annual savings; and the verified gross lifetime savings.[10] The verified gross annual savings is the tracking gross savings multiplied by the gross savings adjustment factor. The verified gross lifetime savings is the verified gross annual savings with the measure life applied.

Table 23. Verified Gross Savings, Appliance Recycling

Measure Group	kWh			
	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
Refrigerators	1,407,824	84%	1,183,403	4,733,612
Freezers	480,810	21%	101,611	508,055
Appliance Recycling Overall	**1,888,634**	**68%**	**1,285,014**	**5,241,667**

[10] The overall gross savings adjustment factors reported in Table 23 differ from Table 22 because they represent the proportion of verified savings to tracked savings in the final population. The mix of measures in the final population differed from the mix of measures in the sample frame used to develop the gross savings adjustments.

4.4 Attribution Results

The EU programs were not required to report net or attributable savings for the 2012 program year. However, discussions within the state of Michigan suggest that net savings may be required in future program years. DNV KEMA collected data to allow for attribution (net-to-gross) analysis to give program managers an idea of the kind of attribution they could expect in future program years. The following sections outline the attribution methodology for the Appliance Recycling Program and the attribution results for the 2012 program year.

4.4.1 Appliance Recycling Net Savings Methodology

For an appliance recycling program, the baseline is the energy that would have been pulled from the grid if the unit had not been destroyed or stored unused. The program-attributable energy savings, or the reduction in energy use resulting from program intervention, depends on the probable load on the grid had the destroyed unit not been removed by the program.

Net savings are generated under two scenarios: if the unit would have remained in use or if the unit would have been transferred to the second-hand market and remained on the grid. In both of these cases, the program gets full attribution credit for the unit to the extent that it was plugged in and operational.

The disposition of the unit, what would have happened to the recycled unit in the absence of the program, is essential to the determination of net savings. To determine this, our sample of program participants was asked a series of questions about what they would have done with their refrigerator or freezer in the absence of the program.

The first stage question determines whether the unit would have been disposed of or not without the program. Units that would have been kept generate both gross and net savings to the extent that they were in use. This is the direct path by which units can generate gross and net savings.

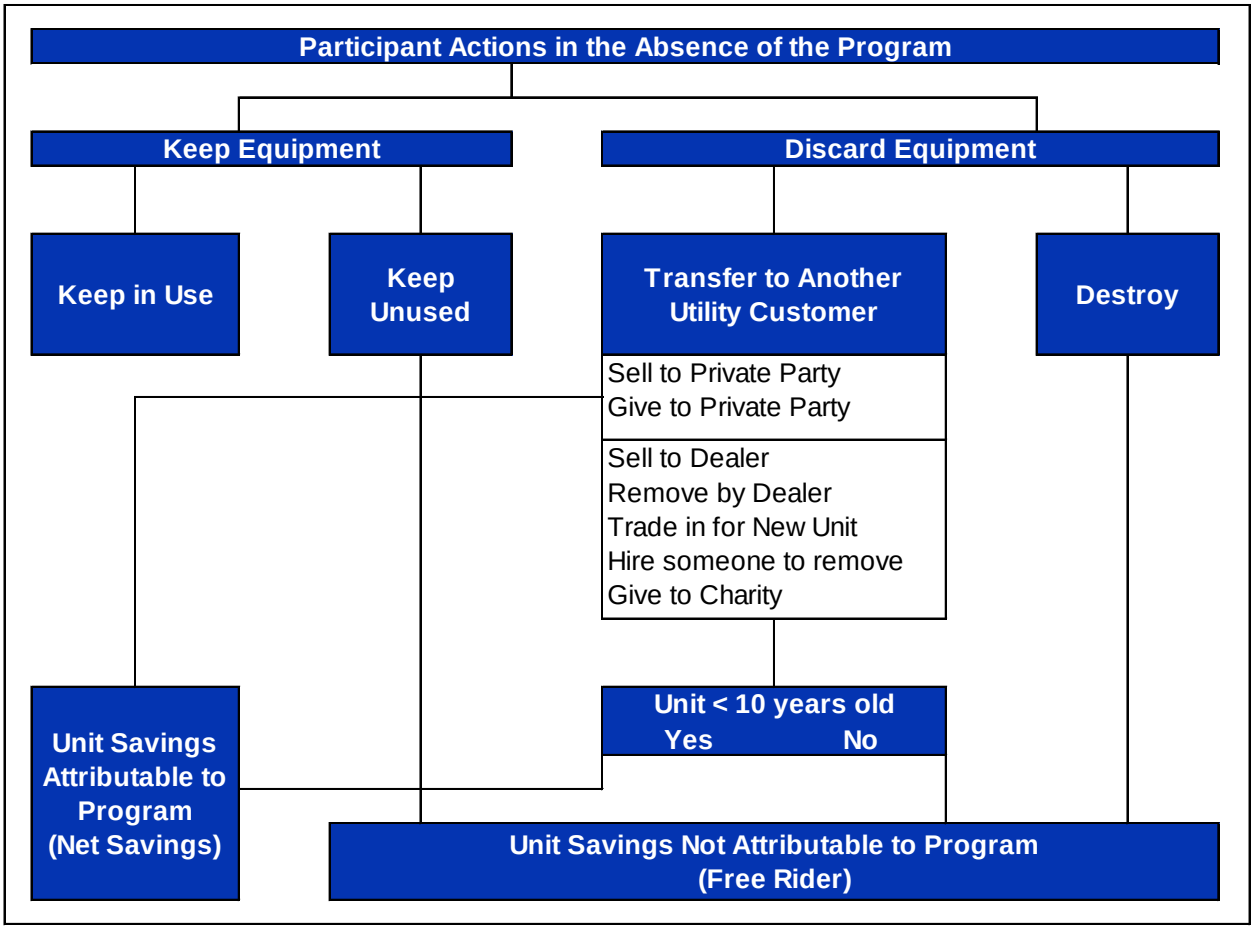
Units that would have been disposed may or may not generate gross and/or net savings. A second stage question determines how the disposer would have disposed of the unit in the absence of the program. At this stage units would either be destroyed or transferred to the second hand market.

Units that would have been hauled to a dump or recycling center were considered to be units that would have been destroyed. Units that would have been given or sold to private parties were considered to be units that would have been transferred to the secondary market.

The final group of units consists of units that, through one method or another, would have ended up in the hands of a used appliance dealer. Previous disposal studies of the used refrigerator market in California have shown that units less than 10 years old were typically resold on the secondary market, while units

older than 10 years of age were generally deemed to be not saleable and recycled by the dealers.[11] The figure below shows the logical process through which determination of unit disposition was deemed appropriate for each unit recycled.

Figure 5. Model for Determining Unit Disposition



Unfortunately, this participant disposition is necessarily hypothetical, since all participant units were recycled by the program. While participants may reasonably expect to take one course of action, when faced with the reality of moving a heavy and cumbersome piece of equipment, there exists the possibility that they might ultimately choose another route for disposal. Historically, appliance recycling program evaluations have dealt with this issue by combining the participant response with the responses from a survey of non-participants. To accomplish this, DNV KEMA surveyed a group of non-participants who

[11] ADM Associates, 2008. "Evaluation Study of the 2004-05 Statewide Residential Appliance Recycling Program: 2004-2005 Programs #1114, #1157, #1232 and #1348" April, 2008

had disposed of a refrigerator or freezer in the past three years and asked them how they disposed of their unit. Figure 6 and Figure 7 show the differences in disposal methods for the two groups for refrigerators and freezers.

Figure 6. Comparison of Refrigerator Discard Choices

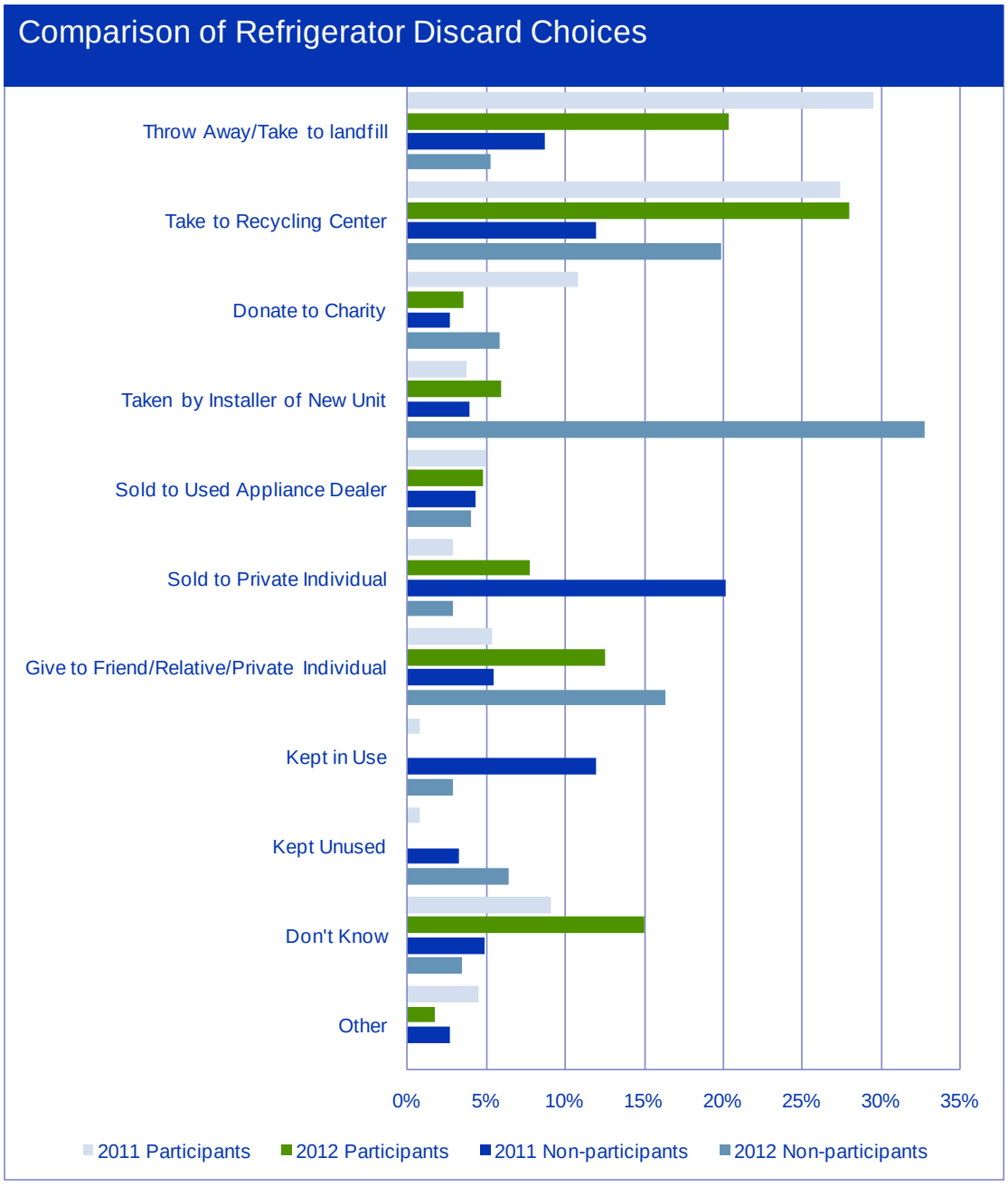
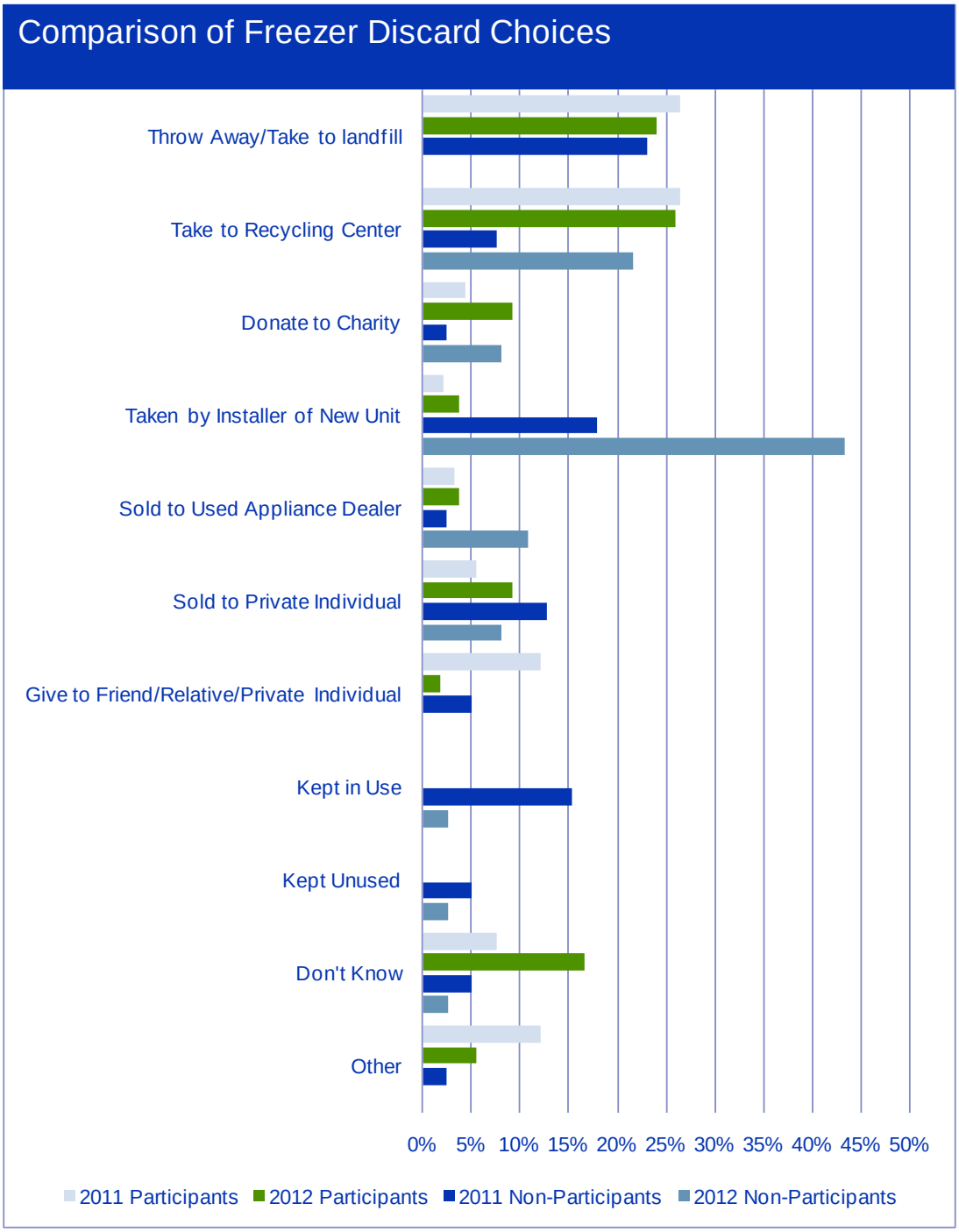


Figure 7. Comparison of Freezer Discard Choices



DNV KEMA found fairly noticeable differences in the disposal patterns between participants and non-participants, with non-participants more likely to give the unit away in some fashion, either to an individual party or to have it removed by the installer of their equipment when purchasing a new unit, while participants were more likely to either dispose of the unit to the landfill or recycling center or just keep the unit. Each respondent in both participant and non-participant groups were given an attribution score according to our disposition logic.

Net savings are calculated as a function of the equipment energy consumption; the gross savings adjustment factor discussed in Section 4.3.2 above; the attribution rate, which incorporates free ridership; and acceleration, the savings credited to the program for early removal of units. Table 24 shows these various factors based on participant responses.

Table 24. Attribution Parameters

Equipment	Mean Attribution	Aggregate Mean Attribution	Acceleration Rate (Annual %)	Energy from Acceleration Period (kWh)
Refrigerators				
Particpants	39%	35%	13%	193
Non-Participants	29%			
Freezers				
Particpants	40%	32%	18%	50
Non-Participants	17%			

4.4.2 Attribution Adjustment Factors

DNV KEMA calculated the attribution adjustment factor for each measure group in the Appliance Recycling Program. The attribution adjustment factor is applied to the verified gross savings to produce net savings. Table 25 shows the results.

Program attribution was statistically consistent across refrigerators and freezers, with freezers showing a slightly lower result. Refrigerators made up a larger portion of program delivery at approximately 75 percent and therefore dominated the overall attribution result, which was 47 percent.

Table 25. Attribution Adjustment Factor, Appliance Recycling

Measure Group	kWh					
	n	Attribution Adjustment Factor	90% Confidence Interval			% Program Savings
			+/-	Lower Bound	Upper Bound	
Refrigerators	230	46%	2%	44%	49%	75%
Freezers	75	51%	4%	47%	55%	25%
Overall Appliance Recycling	**305**	**47%**	**2%**	**45%**	**49%**	**100%**

4.5 Comparison of 2011 and 2012 Program Results

4.5.1 Overall Comparison

Comparing results from last program cycle to this cycle provides some insight into program trends. As shown in Table 26, there was a significant increase in program activity during the 2012 program cycle. The addition to EU of eight new utilities that had not had appliance recycling programs previously may account for some of the increase in activity.

Table 26. Comparison of 2011 and 2012 Appliance Recycling Program Results

Metric	2011 Program Period Jan to Dec 2011	2012 Program Period Jan to Dec 2012	2011 - 2012 Change
Tracking kWh Savings	1,408,198	1,888,634	34%
Refrigerator kWh	1,070,080	1,407,824	32%
Freezer kWh	338,118	480,810	42%
Total # Measures	858	1,152	34%
# Refrigerators Recycled	640	842	32%
# Freezers Recycled	218	310	42%
Total Incentive paid to Implementer	$128,700.00	$173,695.00	35%
Refrigerator	$96,000.00	$126,490.00	32%
Freezer	$32,700.00	$47,205.00	44%

4.5.2 Equipment Usage and Gross Savings Adjustment

The evaluation found that there was a change in the usage reported for refrigerators and freezers between 2011 and 2012. In the last program cycle, both refrigerators and freezers reported being plugged in and operational approximately 80 and 70 percent of the time respectively. In this program cycle, refrigerators were operational 84 percent of the time which was driven by an increase in usage for secondary units. In contrast, usage for freezers plummeted from 2011 levels from approximately 8.5 months during the year when recycled units were plugged in and operational to approximately 2.5 months of the year for 2012 program units. One theory is that the reduction in usage by freezers could be driven by the current economic climate, as participants are moved to decrease the operational hours of freezers to reduce energy bills as a cost-cutting measure, and then ultimately moving them to recycle the unit. This theory is inconsistent however with the increased usage of secondary refrigerators in comparison to 2011.

As discussed in Section 4.3.2, the adjustment for usage was the only modification included in the gross savings adjustment. Highlighted cells show a statistically significant difference from the 2011 to 2012 program periods at the 90 percent confidence interval. Refrigerators, freezers and the program overall all showed a statistically significant increase in gross savings adjustment. (Table 27)

Table 27. Gross Savings Adjustment by Equipment Type

Measure Group	Gross Savings Adj.	
	2011	2012
Refrigerators	80%	84%
Freezers	70%	21%
Overall Appliance Recycling	**77%**	**69%**

4.5.3 Program Attribution

The evaluation team found that program attribution increased between the 2011 and 2012 program years. Factors driving the reduction in attribution were the reduction in the number of units that participants would have taken to the landfill for destruction, and an increase in the proportion of units that would have been transferred to friends or relatives A unit that would have gone to the landfill is determined to be a complete free-rider, and gets no attribution credit for the program. Conversely, units transferred through private channels are very likely to remain in use, and therefore receive 100 percent attribution credit for the program. This shift increased the average attribution for units leaving the home. (Table 28) Highlighted cells show a statistically significant difference from the 2011 to 2012 program periods at the 90 percent confidence interval. Refrigerators, freezers and the program overall all showed a statistically significant increase in attribution.

Table 28. Change in Attribution from 2011 to 2012

Measure Group	Attribution	
	2011	2012
Refrigerators	43%	46%
Freezers	40%	51%
Overall Appliance Recycling	**42%**	**47%**

5. Residential HVAC Program

This section reports on the methodology and overall results of DNV KEMA's evaluation of the 2012 Residential HVAC Program.

- Section 5.1 provides a description of the program.
- Section 5.2 gives an overview of the evaluation approach.
- Section 5.3 presents the verified gross savings results and the overall adjustment factors.
- Section 5.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.
- Section 5.5 offers a comparison of 2011 and 2012 Program results.

5.1 Program Description

The Residential HVAC Program, one of the Home Performance Programs, was launched in November 2009. Incentives are provided to customers through mail-in rebates for installing high efficiency heating, cooling, and water heating equipment in residential buildings. The HVAC Program is the second largest residential natural gas program and the smallest residential electric program in the MCAAA portfolio. The program is offered in all utility service territories except Baraga Electric Utility, Bayfield Electric Cooperative, the City of Crystal Falls and Daggett Electric Department. Not all measures are offered in all utility service territories as shown in Table 29.

Table 29. Measures Offered by Utility through HVAC Program

Utility	Measure							
	ECM Drive	Electric Water Heater	Gas Water Heater	Programmable Thermostat	Furnace; Furnace Tune-Up	Central Air Conditioner	Boiler	Heat Pump
Alpena Power Company	X					X		
Baraga Electric Utility								
Bayfield Electric Cooperative								
The City of Crystal Falls								
Daggett Electric Department								
The City of Gladstone Department of Power and Light	X							
City of Hillsdale Board of Public Utilities	X					X		
Indiana Michigan Power Company	X	X				X		X
L'Anse Electric Utility								
Michigan Gas Utilities Corporation			X	X	X		X	
Negaunee Electric Utility	X							
City of Norway Department of Power and Light	X	X						
SEMCO Energy Gas Company			X	X	X		X	
City of South Haven	X	X						X
Upper Peninsula Power Company	X							X
We Energies	X					X		X
Wisconsin Public Service Corporation	X	X	X	X	X	X	X	
Xcel Energy	X	X	X	X	X	X	X	

Table 30 shows the accomplishments for the HVAC Program based on the program implementer tracking data. The table shows the tracking savings, number of measures rebated, and incentives paid for the evaluation period and the entire 2012 program period.

Table 30. Overview of HVAC Program Accomplishments per Program Tracking

Metric	Evaluation Period Jan to Aug 2012	Program Period Jan to Dec 2012
Tracking kWh Savings	117,936	256,986
Tracking ccf Savings	222,895	599,794
# Measures	1,478	4,949
Incentives	$197,959	$676,785

5.2 General Approach

The impact evaluation of the HVAC Program had the following objectives for the 2012 program:

- Reliably estimate the program's gross annual kWh and gas savings (ccf) over the effective useful life of the installations
- Provide an estimate of program attribution.

To meet these objectives, the impact evaluation included the following tasks:

- Verify proper tracking assignments (Appendix D)
- Verify proper documentation with a sample of participating applications (Appendix E)
- Conduct CATI surveys with a sample of participants
- Conduct verified gross savings analysis
- Conduct net savings analysis
- Complete in-depth attribution analysis to assist with program planning.

Section 2.5 describes the steps used to complete these tasks in greater detail.

5.3 Verified Gross Savings Results

5.3.1 Installation Rate

DNV KEMA calculated the installation rate for each measure group in the HVAC Program. We defined the installation rate as the number of units installed divided by the number of units in the tracking database for each measure. Table 31 shows the results.

The table shows that all but one measure group had 100 percent installation rate for both electric and gas. The only exception is thermostats, which had an installation rate of 99 percent for natural gas. One customer indicated that they had not installed the thermostat because they already had a working thermostat.

Table 31. Installation Rate, HVAC

Measure Group	kWh n	kWh Installation Rate	kWh 90% Confidence Interval +/-	kWh Lower Bound	kWh Upper Bound	kWh % Program Savings	ccf n	ccf Installation Rate	ccf 90% Confidence Interval +/-	ccf Lower Bound	ccf Upper Bound	ccf % Program Savings
Boiler	0	-	-	-	-	0%	3	100%	<0.1%	100%	100%	5%
CAC	13	100%	<0.1%	100%	100%	18%	0	-	-	-	-	0%
ECM	36	100%	<0.1%	100%	100%	59%	0	-	-	-	-	0%
Furnace	0	-	-	-	-	0%	159	100%	<0.1%	100%	100%	85%
Furnace Tune-up	0	-	-	-	-	0%	12	100%	<0.1%	100%	100%	1%
Thermostat	0	-	-	-	-	0%	85	99%	2%	97%	100%	9%
Water Heaters	0	-	-	-	-	0%	6	100%	<0.1%	100%	100%	0%
Heat Pump	6	100%	<0.1%	100%	100%	23%	0	-	-	-	-	0%
HVAC Overall	**55**	**100%**	**<0.1%**	**100%**	**100%**	**100%**	**265**	**100%**	**0%**	**100%**	**100%**	**100%**

5.3.2 Verified Gross Savings

DNV KEMA combined the installation rate and the effects of the documentation review (Appendix E) to produce the gross savings adjustment factor, which is a single adjustment factor that can be applied to the tracking savings to produce verified gross savings.[12] Table 32 shows the gross savings adjustment factor for HVAC.

DNV KEMA's documentation review found a number of items with various calculation issues. These include a ground source heat pump categorized as an air conditioner, A/C units with the SEER entered incorrectly, and measures which were found on the application but not in the database. These findings resulted in a difference between the gross savings adjustment factor and the installation rate for the CAC and ECM measure groups, both of which have gross savings adjustment factors greater than the installation rate.

Table 32. Gross Savings Adjustment Factor, HVAC

Measure Group	kWh min n	kWh Gross Savings Adjustment Factor	kWh 90% Confidence Interval +/-	kWh Lower Bound	kWh Upper Bound	kWh % Program Savings	ccf n	ccf Gross Savings Adjustment Factor	ccf 90% Confidence Interval +/-	ccf Lower Bound	ccf Upper Bound	ccf % Program Savings
Boiler	0	-	-	-	-	0%	3	100%	<0.1%	100%	100%	5%
CAC	13	110%	<0.1%	110%	110%	18%	0	-	-	-	-	0%
ECM	36	104%	<0.1%	104%	104%	59%	0	-	-	-	-	0%
Furnace	0	-	-	-	-	0%	159	100%	<0.1%	100%	100%	85%
Furnace Tune-up	0	-	-	-	-	0%	12	100%	<0.1%	100%	100%	1%
Thermostat	0	-	-	-	-	0%	84	99%	2%	97%	101%	9%
Water Heaters	0	-	-	-	-	0%	6	100%	<0.1%	100%	100%	0%
Heat Pump	6	100%	<0.1%	100%	100%	23%	0	-	-	-	-	0%
HVAC Overall	**55**	**104%**	**0%**	**104%**	**104%**	**100%**	**264**	**100%**	**0%**	**100%**	**100%**	**100%**

[12] The gross savings adjustments reported in the table (and throughout this report) are the LCNS gross savings adjustments used to produce the verified gross lifetime savings, which may differ slightly from the Y1NS gross adjustment factors used to produced the annual verified gross savings.

The gross savings adjustment factor was applied by measure group to the total savings reported for the HVAC Program in 2012 to produce the verified gross savings for the program.[13] Table 33 shows the tracking gross savings (an annual number); the gross saving adjustment factor determined from the evaluation; the verified gross annual savings; and the verified gross lifetime savings. The verified gross annual savings is the tracking gross savings multiplied by the gross savings adjustment factor. The verified gross lifetime savings is the verified gross annual savings with the measure life applied.

Table 33. Verified Gross Savings, HVAC

Measure Group	kWh				ccf			
	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
Boiler					19,158	100%	19,158	383,159
CAC	34,805	110%	38,285	574,275				
ECM	189,070	104%	196,633	1,966,328				
Furnace					360,947	100%	360,947	7,218,945
Furnace Tune-up					144,948	100%	144,948	724,740
Thermostat					73,577	99%	72,583	798,411
Water Heaters					1,163	100%	1,163	17,014
Heat Pump	33,111	100%	33,111	496,665				
HVAC Overall	**256,986**	**104%**	**268,029**	**3,037,268**	**599,794**	**100%**	**598,799**	**9,142,270**

5.4 Attribution Results

The EU programs were not required to report net or attributable savings for the 2012 program year. However, discussions within the State of Michigan suggest that net savings may be required in future program years. DNV KEMA conducted a net savings analysis to provide the program with the information they will need for planning and implementation when moving toward net savings reporting.

5.4.1 Attribution Adjustment Factors

DNV KEMA calculated the attribution adjustment factor for each measure group in HVAC. The attribution adjustment factor is applied to the verified gross savings to produce net savings. It reflects the influence the program had on the timing, efficiency level, and scope of the energy efficiency measure installed.[14] Table 34 shows the results.

[13] The overall gross savings adjustment factors reported in Table 33 differ (slightly) from Table 32 because they represent the proportion of verified savings to tracked savings in the final population. The mix of measures in the final population differed from the mix of measures in the sample frame used to develop the gross savings adjustments.

[14] Appendix G discusses the methodology used in the attribution analysis.

Attribution results were below 20 percent for all measure groups except ECMs (28%) and CACs (26%). Both measures are, however, a large portion of overall program kWh savings. On the electric side, ECMs (28% attribution, 59% of program savings), CACs (26%, 18%), and heat pumps (18%, 23%) combined to account for all savings. For natural gas, furnaces and thermostats account for 94 percent of program savings with attribution rates of 11 percent.

Table 34. Attribution Adjustment Factor, HVAC

	kWh						ccf					
		Attribution	90% Confidence Interval			%		Attribution	90% Confidence Interval			%
Measure Group	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings
Boiler	0	-	-	-	-	0%	3	*	*	*	*	5%
CAC	13	26%	15%	12%	41%	18%	0	-	-	-	-	0%
ECM	36	28%	10%	19%	38%	59%	0	-	-	-	-	0%
Furnace	0	-	-	-	-	0%	159	11%	3%	8%	14%	85%
Furnace Tune-up	0	-	-	-	-	0%	12	13%	13%	0%	26%	1%
Thermostat	0	-	-	-	-	0%	84	11%	5%	6%	16%	9%
Water Heaters	0	-	-	-	-	0%	6	3%	6%	0%	9%	0%
Heat Pump	6	18%	22%	0%	40%	23%	0	-	-	-	-	0%
HVAC Overall	**55**	**26%**	**7%**	**18%**	**33%**	**100%**	**264**	**10%**	**3%**	**8%**	**13%**	**100%**

*To protect respondent confidentiality, attribution results for boilers (3 respondents) are not reported.

5.4.2 Analysis of Survey Responses

DNV KEMA reviewed the responses to the attribution question sequence used in the HVAC survey to identify where the program was having an effect and where improvements could be made. We investigated the program's effect on timing, efficiency, and quantity, the three components of attribution. Appendix G has greater detail on the attribution analysis methodology and the methods used to combine the three components into a single attribution value.

Table 35. Attribution Question Sequence

Number	Question
Timing	
DAT1	Without EU, how likely is it that you would have installed the same type of equipment at this time?
DAT1a	Without EU, how different would the timing have been?
DAT1b	Approximately how many months later?
Efficiency	
DAT2	Without EU, how likely is it that you would have installed the same level of efficiency?
DAT2a	Without EU, how likely is it that you would have installed the same, greater, or lesser efficiency?
DAT2b	Without EU, what efficiency would you have installed?
Quantity	
DAT3	Without EU, how different would the quantity/size have been?
DAT3a	By what percentage did you change the quantity/size because of EU?

5.4.2.1 Timing

Respondents are asked a sequence of questions that address the timing of the equipment installation. First, respondents are asked how likely it is that they would have installed the same type of equipment at the same time without the program (DAT1). Then respondents are asked how different the timing would have been (DAT1a).

- A response of "Same Time" means that the customer would have installed the measure(s) at the same time regardless of program involvement.
- A response of "Later" indicates that they would have waited to install the measure(s) if the program had not been present. This measure is called "accelerated." Respondents who answered "Later" are asked a follow-up question (DAT1b) about how much later they would have installed the equipment without the program.

Table 36 shows the responses to the DAT1a and DAT1b questions for HVAC. The table shows the unweighted number of responses in each category and the associated percentage of overall program energy savings represented by those responses. The number of responses does not reflect any survey weight or relative savings but the percentage of energy savings does.

The table outlines the skip pattern and attribution assignment for DAT1a and DAT1b. If a respondent indicates that they would have installed the equipment at the same time or earlier, the acceleration period is zero months and there is no timing effect. If the respondent indicates that they would never have installed the equipment without the program, then the program is credited with influencing the entire project and receives 100 percent attribution. The same effect is applied if the respondent indicates it would have been greater than four years before they would have installed the equipment without the program. If the response to DAT1a is Later and the response to DAT1b is a number less than 48, then the acceleration period is equal to that number of months.

Table 36. Determining Acceleration Period, HVAC

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	264	83%	82%	0
Earlier	N/A	3	0%	3%	0
Later	Months < 48	30	9%	10%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	12	4%	3%	Average of DAT1b
Never	N/A	8	4%	1%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	2	0%	0%	Average of DAT1a

The table shows that the majority of the respondents would have installed the equipment at the same time regardless of program involvement, representing 83 percent of kWh and 82 percent of gas savings (ccf). Eight respondents give the program full attribution credit, representing 4 percent of kWh savings and 1 percent of gas savings (ccf). Forty-four respondents representing 13 percent of kWh savings and gas savings (ccf) said they would have installed the equipment within the next four years, or answered one of the two questions "Don't Know," all of which result in an accelerated measure.

Table 37 shows the DAT1a and DAT1b responses for furnaces, which is by far the largest measure group in the HVAC Program. Eighty-six percent of ccf savings were represented by Same Time responses, which do not receive attribution. One respondent answered Never, which receives full attribution.

Table 37. Determining Acceleration Period, Furnace

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	135	0%	86%	0
Earlier	N/A	1	0%	1%	0
Later	Months < 48	16	0%	9%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	5	0%	3%	Average of DAT1b
Never	N/A	1	0%	0%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	1	0%	0%	Average of DAT1a

5.4.2.2 Efficiency

Respondents are asked a sequence of questions that address the efficiency of the equipment installation. First, respondents are asked how likely it is that they would have installed the same, lesser, or greater

efficiency without the program (DAT2a). Then respondents are asked how different the efficiency would have been (DAT2b).

- A response of "Same" means that the customer would have installed the same level of efficiency regardless of program involvement.
- A response of "Lower" indicates that they would have installed a less efficient piece of equipment if the program had not been there. Respondents who answered "Lower" are asked a follow-up question (DAT2b) about what equipment efficiency they would have installed without the program.

Table 38 shows the responses to the DAT2a question for each measure category. The table includes a response of Not Applicable, which represents measures that do not have variable efficiency themselves, but are added to the existing equipment or systems to make the overall operation more efficient. Programmable thermostats fall into the Not Applicable category.

The table outlines the skip pattern and attribution assignment for DAT2a and DAT2b. If a respondent indicates that they would have installed the equipment of the same or higher efficiency, the efficiency attribution is zero. If the respondent indicates that they would have installed a lower efficiency then the efficiency attribution is some number between 30 and 100 percent, depending on the answer to DAT2b.

Table 38. Determining Efficiency Attribution, HVAC

DAT2a. Without EU, would you have installed the same, higher, or lower efficiency?					
DAT2b. Without EU, what efficiency would you have installed?					
DAT2a Response	DAT2b Response	Responses	Percent kWh	Percent ccf	Efficiency Attribution
Same	N/A/Skipped	155	61%	57%	0%
Lower	Standard Efficiency	11	10%	2%	100%
	Slightly > Standard	10	6%	3%	70%
	Between Standard and High	6	1%	2%	50%
	Slightly < High	12	8%	4%	30%
	Don't Know/Refused	1	0%	1%	Average of DAT2b
	N/A	0	0%	0%	100%
Higher	N/A/Skipped	17	6%	9%	0%
Not Applicable	N/A	96	0%	19%	Not Asked
Don't Know/Refused	N/A	11	8%	4%	Average of DAT2a

The table shows that the majority of respondents would have installed the same efficiency level without the program, with 155 respondents representing 61 percent of program kWh savings and 57 percent of program gas savings (ccf). Fifty-one respondents representing 33 percent of program kWh savings and 16 percent of program gas savings (ccf) will receive some form of efficiency attribution by answering "Lower" or "Don't know/Refused" to DAT2a. Ten percent of kWh and two percent of gas savings (ccf) will receive 100 percent efficiency attribution. All of the programmable thermostat measures are "Not

Applicable." Therefore, the efficiency attribution component does not contribute to the overall attribution for thermostats.

Table 39 shows the DAT2a and DAT2b responses for furnaces. Furnaces represent the majority of the responses in Table 38 that received attribution, but overall less than 25 percent of respondents that could have received efficiency credit did.

Table 39. Determining Efficiency Attribution, Furnaces

DAT2a. Without EU, would you have installed the same, higher, or lower efficiency?					
DAT2b. Without EU, what efficiency would you have installed?					
DAT2a Response	DAT2b Response	Responses	Percent kWh	Percent ccf	Efficiency Attribution
Same	N/A/Skipped	114	0%	70%	0%
Lower	Standard Efficiency	6	0%	3%	100%
	Slightly > Standard	6	0%	4%	70%
	Between Standard and High	5	0%	3%	50%
	Slightly < High	7	0%	5%	30%
	Don't Know/Refused	1	0%	1%	Average of DAT2b
	N/A	0	0%	0%	100%
Higher	N/A/Skipped	13	0%	9%	0%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	7	0%	5%	Average of DAT2a

5.4.2.3 Quantity

Respondents are asked a sequence of questions that address the quantity of the equipment installed. First, respondents are asked how likely it is that they would have installed the same quantity or capacity of equipment without the program (DAT3). Then respondents are asked how much they changed the quantity or capacity (DAT3a).

- A response of "Same amount" means that the customer would have installed the same size or quantity regardless of program involvement.
- A response of "Less" indicates that the customer would have installed fewer units or a smaller capacity if the program had not been there. Respondents who answered "Less" are asked a follow-up question (DAT3a) about the quantity or capacity of equipment they would have installed without the program.
- A response of "More" indicates that the customer would have installed more units or capacity if the program had not been there. In these cases, the evaluation team assumes that the respondent would have installed a less efficient system without the program assistance because it would have been oversized. Respondents who answered "More" are asked the same follow-up question

(DAT3a) about the quantity or capacity of equipment they would have installed without the program.

Table 40 shows the responses to the DAT3 question for each measure group. The table includes a response of Not Applicable, which represents measures where varying quantity or size does not make sense in the context of the measure.

The table outlines the skip pattern and attribution assignment for DAT3 and DAT3a. If a respondent indicates that they would have installed the same quantity or size, the quantity attribution is zero. If the respondent indicates that they would have installed more or less quantity/size, then the quantity attribution is some value between 0 and 100 percent. If the respondent indicates that they would not have installed any equipment without the program then the quantity attribution is 100 percent.

Table 40. Determining Quantity Attribution

DAT3. Without EU, how different would the quantity/size have been?					
DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	287	90%	91%	0%
Less	Value < 100%	4	1%	1%	Value < 50%
	Value >= 100%	0	0%	0%	Value > 50%
	Don't Know/Refused	5	1%	1%	Average of DAT3a
More	Value < 100%	0	0%	0%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	1	0%	0%	Average of DAT3a
None	N/A	11	6%	2%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	11	2%	4%	Average of DAT3

The table shows that 287 respondents representing 90 percent of kWh savings and 91 percent of gas savings (ccf) would have installed equipment of the same size or quantity without the program. Eleven respondents representing 6 percent of kWh savings and 2 percent of gas savings (ccf) would not have installed any equipment, resulting in 100 percent quantity attribution.

5.4.2.4 Overall Attribution

DNV KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 41 shows the three effects together with “Yes” indicating some (not necessarily full) attribution while “No” indicates responses that did not receive any attribution.

Table 41. Simplistic Representation of Overall Attribution, HVAC

Attribution			Responses	Percent kWh	Percent ccf
Timing	Efficiency	Quantity			
Yes	Yes	Yes	8	0%	2%
Yes	No	Yes	0	0%	0%
Yes	No	No	26	8%	8%
Yes	Yes	No	10	5%	3%
No	Yes	Yes	12	12%	3%
No	Yes	No	27	16%	9%
No	No	Yes	87	0%	18%
No	No	No	149	58%	57%

The table shows that 8 responses representing 0 percent of kWh savings and 2 percent of gas savings (ccf) received all three types of attribution. In total, 149 responses representing 58 percent of kWh savings and 57 percent of gas savings (ccf) did not receive any timing, efficiency, or quantity attribution. In other words, the program had no influence over 50 percent of the savings reported by the program.

5.5 Comparison of 2011 and 2012 Program Results

DNV KEMA compared the results of the 2011 program evaluation to the results of the 2012 program evaluation.

5.5.1 Overall Comparison

Table 42 shows the tracking savings, number of measures, and total incentives paid for the 2011 and 2012 program periods. The final column shows the difference between the two, with a negative value representing a decrease from 2011 and a positive value representing an increase.

The table shows a slight decrease in program savings (1 percent for kWh and 8 percent for ccf) from the 2011 program period to the 2012 program period. The number of measures and incentives paid increased by 33 percent and 19 percent.

Table 42. Comparison of 2011 and 2012 HVAC Program Results

Metric	Program Period Jan to Dec 2011	Program Period Jan to Dec 2012	2011 to 2012 Change
Tracking kWh Savings	259,548	256,986	-1%
Tracking ccf Savings	648,661	599,794	-8%
Total # Measures	3,722	4,949	33%
Total Incentive	$568,400	$676,785	19%

5.5.2 Adjustment Factors

Table 43 shows the 2011 and 2012 installation rate, gross savings adjustment factor, and attribution adjustment factor for kWh and ccf. Highlighted cells show a statistically significant difference from the 2011 to 2012 program periods at the 90 percent confidence interval.

Table 43. Comparison of 2011 and 2012 HVAC Adjustment Factors

Adjustment Factor	kWh		ccf	
	2011	2012	2011	2012
Installation Rate	95%	100%	100%	100%
Gross Savings Adjustment Factor	95%	96%	100%	100%
Attribution Adjustment Factor	13%	26%	13%	10%

The table shows a statistically significant increase in attribution factor for kWh from 2011 to 2012. The table also shows consistent gross savings adjustment factors, with a statistically significant, but not meaningful difference for ccf.

6. Residential Low Income Program

This section reports on the methodology and overall results of DNV KEMA's evaluation of the Residential Low Income Program.

- Section 6.1 provides a description of the program.
- Section 6.2 gives an overview of the evaluation approach.
- Section 6.3 presents the verified gross savings results and the overall adjustment factors.
- Section 6.4 offers a comparison of 2011 and 2012 Program results.

6.1 Program Description

The Residential Low Income (LI) Program is implemented through a pre-existing and ongoing assistance program that aids income-qualified customers in obtaining weatherization products and services and high efficiency appliances. The program provides funding to weatherization providers through non-profit Community Action Agencies (CAAs) to expand their low income services of installing energy efficient equipment and improving insulation levels. Electric measures include refrigerators, ECMs, and CFLs. Natural gas measures include air sealing, insulation, thermostats, boilers, furnaces, and tune-ups. Low flow showerheads, pipe wrap, and faucet aerators may also be installed. The MCAAA portion of the program began implementation in November 2009. CLEAResult began implementing a separate non-weatherization direct install portion of the program in 2012. The program is available in all utility service territories. The LI program is the fourth largest natural gas program in the MCAAA portfolio.

Table 44 shows the accomplishments for the LI program based on the program implementer tracking data. The table shows the tracking savings, number of measures rebated, and incentives paid for the evaluation period and the entire 2012 program period.

Table 44. Overview of LI Program Accomplishments per Program Tracking

Metric	Evaluation Period Jan to Aug 2012	Program Period Jan to Dec 2012
Tracking kWh Savings	588,821	1,806,171
Tracking ccf Savings	189,654	471,924
# Measures	5,968	13,160
Incentives	$372,594	$823,868

6.2 General Approach

The impact evaluation of the 2012 LI program had one objective: reliably estimate the program's gross annual kWh and gas savings (ccf) over the effective useful life of the installations.

To meet this objective, the impact evaluation included the following tasks:

- Verify proper tracking savings assignments (Appendix D)
- Conduct CATI surveys with a sample of participants
- Complete verified gross savings analysis.

There was no net savings analysis for this program. Section 2.5 describes the steps used to complete these tasks in greater detail.

6.3 Verified Gross Savings Results

6.3.1 Installation Rate

DNV KEMA calculated the installation rate for each measure group in the Low Income Program. We defined the installation rate for CFLs, refrigerators, showerheads, and faucet aerators as the number of units installed divided by the number of units in the tracking database. For all other measures, we verified the savings multiplier, which was included in the tracking database. For wall, ceiling, and floor insulation, the multiplier is the square footage of insulation installed. For rim joist insulation, air sealing, and programmable thermostats, it is the square feet of conditioned space. For pipe wrap, it is feet of pipe wrap installed. For furnaces, boilers and furnace tune-ups, it is the capacity of the furnace or boiler. Table 45 shows the results.

The installation rate for all measure groups except pipe wrap was greater than 90 percent:

- The installation rate for pipe wrap was 82 percent for kWh savings and 85 percent for ccf savings. In each of the nine cases where customers indicated pipe wrap was not installed, customers stated that pipe wrap was either not offered or not installed by the contractor. All of the sites where pipe wrap was not installed were part of the non-weatherization direct install portion program, which is not implemented by the CAA's.

- Faucet aerators had an installation rate of 95 percent for kWh savings and 98 percent for ccf savings. Several customers indicated that the at least one of the aerators tracked for their home was never installed because the aerators did not fit their faucets.

- The installation rate for showerheads was 95 percent for kWh savings and 99 percent for ccf savings. Three customers did not have all of the showerheads currently installed; each indicated they had received showerheads, but chose not to install at least one of them.

- The installation rate for CFLs was 96 percent. This installation rate was due to 11 customers that had not installed all of their bulbs or had removed bulbs that were installed. The customers

indicated several reasons for this, most often citing a desire to wait for their other bulbs to burn out before installing the new CFLs.

- The installation rate for furnace tune-ups was 98 percent. One customer indicated that the home where the furnace was tuned-up receives gas service through a non-participating utility. All other measure types had a 100 percent installation rate.

Table 45. Installation Rate, Low Income

	kWh						ccf					
			90% Confidence Interval			%			90% Confidence Interval			%
Measure Group	n	Installation Rate	+/-	Lower Bound	Upper Bound	Program Savings	n	Installation Rate	+/-	Lower Bound	Upper Bound	Program Savings
CFL	90	96%	3%	93%	99%	45%	0	-	-	-	-	0%
Air Sealing	0	-	-	-	-	0%	8	100%	<0.1%	100%	100%	2%
Boiler	0	-	-	-	-	0%	1	100%	<0.1%	100%	100%	2%
Faucet Aerator	27	95%	5%	90%	100%	6%	240	98%	1%	97%	99%	15%
Furnace	0	-	-	-	-	0%	12	100%	<0.1%	100%	100%	8%
Furnace Tune-up	0	-	-	-	-	0%	46	98%	3%	95%	100%	5%
Insulation	0	-	-	-	-	0%	35	100%	<0.1%	100%	100%	5%
Pipe Wrap	12	82%	15%	67%	97%	1%	54	85%	20%	66%	100%	5%
Thermostat	0	-	-	-	-	0%	155	100%	1%	99%	100%	34%
Refrigerator	19	100%	<0.1%	100%	100%	38%	0	-	-	-	-	0%
Showerhead	16	95%	5%	90%	100%	10%	102	99%	2%	97%	100%	25%
Low Income Overall	**164**	**98%**	**1%**	**97%**	**99%**	**100%**	**653**	**99%**	**1%**	**98%**	**100%**	**100%**

6.3.2 Verified Gross Savings

DNV KEMA did not conduct a documentation review for the Low Income Program and the tracking review was completed in time for the program to update the database for reporting; therefore, the gross savings adjustment factor is equal to the installation rate. Table 46 shows the gross savings adjustment factor for the Low Income Program.[15]

[15] The gross savings adjustments reported in the table (and throughout this report) are the LCNS gross savings adjustments used to produce the verified gross lifetime savings, which may differ slightly from the Y1NS gross adjustment factors used to produces the annual verified gross savings.

Table 46. Gross Savings Adjustment Factor, Low Income

	kWh						ccf					
			90% Confidence Interval						90% Confidence Interval			
Measure Group	min n	Gross Savings Adjustment Factor	+/-	Lower Bound	Upper Bound	% Program Savings	min n	Gross Savings Adjustment Factor	+/-	Lower Bound	Upper Bound	% Program Savings
CFL	89	96%	3%	93%	99%	45%	0	-	-	-	-	0%
Air Sealing	0	-	-	-	-	0%	8	100%	<0.1%	100%	100%	2%
Boiler	0	-	-	-	-	0%	1	100%	<0.1%	100%	100%	2%
Faucet Aerator	27	95%	5%	90%	100%	6%	233	98%	1%	97%	99%	15%
Furnace	0	-	-	-	-	0%	12	100%	<0.1%	100%	100%	8%
Furnace Tune-up	0	-	-	-	-	0%	45	98%	3%	95%	101%	5%
Insulation	0	-	-	-	-	0%	35	100%	<0.1%	100%	100%	5%
Pipe Wrap	10	82%	15%	67%	98%	1%	47	85%	20%	66%	105%	5%
Thermostat	0	-	-	-	-	0%	153	100%	1%	99%	100%	34%
Refrigerator	19	100%	<0.1%	100%	100%	38%	0	-	-	-	-	0%
Showerhead	15	95%	6%	90%	101%	10%	102	99%	2%	97%	100%	25%
Low Income Overall	**160**	**98%**	**1%**	**97%**	**99%**	**100%**	**636**	**99%**	**1%**	**98%**	**100%**	**100%**

The gross savings adjustment factor was applied to the total savings reported for the Low Income Program to produce the verified gross savings for the program. Table 47 shows the tracking gross savings (an annual number), the LCNS gross savings adjustment factor determined from the evaluation, the verified gross annual savings, and the verified gross lifetime savings.[16] The verified gross annual savings is the tracking gross savings multiplied by the gross savings adjustment factor. The verified gross lifetime savings is the verified gross annual savings with the measure life applied.

Table 47. Verified Gross Savings, Low Income

	kWh				ccf			
Measure Group	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
CFL	916,851	96%	883,560	7,952,040				
Air Sealing					6,568	100%	6,568	72,250
Boiler					4,030	100%	4,030	80,604
Faucet Aerator	198,204	95%	187,991	1,879,910	77,401	98%	76,163	761,633
Furnace					12,754	100%	12,754	255,076
Furnace Tune-up					54,210	98%	53,069	265,345
Insulation					9,294	100%	9,294	185,884
Pipe Wrap	92,412	82%	75,997	987,957	28,829	85%	24,646	271,109
Thermostat					148,400	100%	147,659	1,624,245
Refrigerator	247,500	100%	247,500	3,465,000				
Showerhead	351,204	95%	334,480	3,344,800	130,437	99%	128,640	1,286,401
Low Income Overall	**1,806,171**	**96%**	**1,729,528**	**17,629,707**	**471,924**	**98%**	**462,824**	**4,802,547**

[16] The overall gross savings adjustment factors reported in Table 47 differ from Table 46 because they represent the proportion of verified savings to tracked savings in the final population. The mix of measures in the final population differed from the mix of measures in the sample frame used to develop the gross savings adjustments.

6.4 Comparison of 2011 and 2012 Program Results

DNV KEMA compared the results of the 2011 program evaluation to the results of the 2012 program evaluation.

6.4.1 Overall Comparison

Table 48 shows the tracking savings, number of measures, and total incentives paid for the 2011 and 2012 program periods. The final column shows the difference between the two, with a negative value representing a decrease from 2011 and a positive value representing an increase.

The EU Low Income Program shows an increase in all four metrics: kWh savings, ccf savings, number of measures, and incentives. The number of measures shows the greatest increase, with nearly three times as many measures installed in 2012 as were installed in 2011. Natural gas savings doubled, while electric savings increased by 12 percent.

Table 48. Comparison of 2011 and 2012 Low Income Program Results

Metric	Program Period Jan to Dec 2011	Program Period Jan to Dec 2012	2011 to 2012 Change
Tracking kWh Savings	1,617,652	1,806,171	12%
Tracking ccf Savings	156,519	471,924	202%
Total # Measures	3,343	13,160	294%
Total Incentive	$715,595	$823,868	15%

6.4.2 Adjustment Factors

Table 49 shows the 2011 and 2012 installation rate and gross savings adjustment factor for kWh and ccf. Highlighted cells show a statistically significant difference from the 2011 to 2012 program periods at the 90 percent confidence interval.

The table shows a statistically significant decrease in gross savings adjustment factor for natural gas from 2011 to 2012. Though statistically significant, the difference in adjustment factors for the two years is not meaningful: they are within one percent of each other and both round to 99 percent.

Table 49. Comparison of 2011 and 2012 Low Income Adjustment Factors

Adjustment Factor	kWh		ccf	
	2011	2012	2011	2012
Installation Rate	97%	98%	99%	99%
Gross Savings Adjustment Factor	97%	98%	99%	99%

7. Residential Online Audit Program

This section reports on the methodology and overall results of DNV KEMA's evaluation of the Residential Online Audit Program.

- Section 7.1 provides a description of the program.
- Section 7.2 gives an overview of the evaluation approach.
- Section 7.3 presents the verified gross savings results and the overall adjustment factors.
- Section 7.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.
- Section 7.5 offers a comparison of 2011 and 2012 Program results.

7.1 Program Description

The Residential Online Audit (OA) Program was launched in March 2010, at which time the program offered a free online self-auditing tool for residential buildings of four units or less. Participants who completed the full audit received an energy kit containing some combination of CFLs, low-flow showerheads, faucet aerators, LED night lights, pipe wrap, and door weatherization kits. The program is offered in all utility service territories except Bayfield Electric Cooperative and Daggett Electric Department. The OA program is a growing part of the MCAAA portfolio: in 2012 it was the second largest residential electric program.

Table 50 shows the accomplishments for the OA program based on the program implementer tracking data. The table shows the tracking savings, number of measures rebated, number of participants, and incentives paid for the evaluation period and the entire 2012 program period.

Table 50. Overview of OA Program Accomplishments per Program Tracking

Metric	Evaluation Period Jan to Aug 2012	Program Period Jan to Dec 2012
Tracking kWh Savings	659,945	4,751,030
Tracking ccf Savings	44,897	62,915
# Measures	1,878	5,146
Incentives	$36,643	$252,067

7.2 General Approach

The impact evaluation of the OA program had the following objectives for the 2012 program:

- Reliably estimate the program's gross annual kWh and gas savings (ccf) over the effective useful life of the installations
- Provide an estimate of program attribution.

To meet these objectives, the impact evaluation included the following tasks:

- Verify proper tracking assignments (Appendix D)
- Verify proper documentation with a sample of participating applications (Appendix E)
- Conduct CATI surveys with a sample of participants
- Conduct verified gross savings analysis
- Conduct net savings analysis
- Complete in-depth attribution analysis to assist with program planning.

Section 2.5 describes the steps used to complete these tasks in greater detail.

7.3 Verified Gross Savings Results

7.3.1 Installation Rate

DNV KEMA calculated the installation rate for the Online Audit Program at the technology level. We defined the installation rate as the number of units installed divided by the number of units in the tracking database kit definition for each technology: CFLs, low flow showerheads, faucet aerators, LED night lights, pipe wrap, and door weather-stripping. Table 51 shows the results.

On the electric side, CFLs and LED night lights had the highest installation rates at 77 percent and 72 percent and accounted for 40 percent of the savings. The overall electric installation rate was 59 percent. On the natural gas side, showerheads had the highest installation rate at 60 percent and accounted for 41 percent of savings. The overall installation rate for natural gas measures was 56 percent.

The installation rate for the Online Audit Program is low relative to other programs in the portfolio. In general, this type of program would be expected to have a lower installation rate, as many homeowners receive the kit and only install portions of it, or place the equipment in storage for when their current equipment fails. There were also some respondents who reported they had not received the energy kit. This number however fell from 13 percent of respondents in 2011 to 3 percent of respondents in 2012.

Table 51. Installation Rate, Online Audit

Measure Group	kWh n	kWh Installation Rate	kWh 90% Confidence Interval +/-	kWh Lower Bound	kWh Upper Bound	kWh % Program Savings	ccf n	ccf Installation Rate	ccf 90% Confidence Interval +/-	ccf Lower Bound	ccf Upper Bound	ccf % Program Savings
Kit - CFL	194	77%	5%	73%	82%	32%	0	-	-	-	-	0%
Kit - Door Strip	0	-	-	-	-	0%	131	47%	6%	41%	53%	8%
Kit - Faucet Aerator	100	48%	6%	42%	54%	24%	132	54%	6%	49%	60%	26%
Kit - LED Night Light	94	72%	9%	63%	80%	8%	0	-	-	-	-	0%
Kit - Pipe Wrap	0	-	-	-	-	0%	132	55%	7%	49%	62%	26%
Kit - Showerhead	100	48%	8%	41%	56%	37%	131	60%	7%	54%	67%	41%
Online Audit Overall	**488**	**59%**	**4%**	**55%**	**63%**	**100%**	**526**	**56%**	**5%**	**52%**	**61%**	**100%**

7.3.2 Verified Gross Savings

The Online Audit Program does not have a paper application; therefore, we did not do a documentation review for this program. As a result, the gross savings adjustment factor is equal to the installation rate. Table 52 shows the gross savings adjustment factor for Online Audit.[17]

Table 52. Gross Savings Adjustment Factor, Online Audit

Measure Group	kWh min n	kWh Gross Savings Adjustment Factor	kWh 90% Confidence Interval +/-	kWh Lower Bound	kWh Upper Bound	kWh % Program Savings	ccf n	ccf Gross Savings Adjustment Factor	ccf 90% Confidence Interval +/-	ccf Lower Bound	ccf Upper Bound	ccf % Program Savings
Kit - CFL	177	77%	5%	73%	82%	32%	0	-	-	-	-	0%
Kit - Door Strip	0	-	-	-	-	0%	70	47%	6%	41%	54%	8%
Kit - Faucet Aerator	62	48%	6%	42%	55%	24%	90	54%	6%	49%	60%	26%
Kit - LED Night Light	79	72%	9%	63%	80%	8%	0	-	-	-	-	0%
Kit - Pipe Wrap	0	-	-	-	-	0%	74	55%	7%	49%	62%	26%
Kit - Showerhead	48	48%	8%	41%	56%	37%	78	60%	7%	54%	67%	41%
Online Audit Overall	**366**	**59%**	**4%**	**55%**	**63%**	**100%**	**312**	**56%**	**5%**	**52%**	**61%**	**100%**

The gross savings adjustment factor was applied to the total savings reported for the Online Audit Program in 2012 to produce the verified gross savings for the program. Table 53 shows the tracking gross savings (an annual number); the gross saving adjustment factor determined from the evaluation; the verified gross annual savings; and the verified gross lifetime savings.[18] The verified gross annual savings is the tracking gross savings multiplied by the gross savings adjustment factor. The verified gross lifetime savings is the verified gross annual savings with the measure life applied.

[17] The gross savings adjustments reported in Table 52 (and throughout this report) are the LCNS gross savings adjustments used to produce the verified gross lifetime savings, which may differ slightly from the Y1NS gross adjustment factors used to produced the annual verified gross savings.

[18] The overall gross savings adjustment factors reported in Table 53 differ from Table 52 because they represent the proportion of verified savings to tracked savings in the final population. The mix of measures in the final population differed from the mix of measures in the sample frame used to develop the gross savings adjustments.

Table 53. Verified Gross Savings, Online Audit[19]

Measure Group	kWh				ccf			
	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
Kit - CFL	1,547,286	77%	1,197,119	10,774,070				
Kit - Door Strip					4,780	47%	2,255	24,809
Kit - Faucet Aerator	967,282	48%	466,535	4,665,354	16,686	54%	9,074	90,740
Kit - LED Night Light	275,088	72%	197,158	3,154,525				
Kit - Pipe Wrap	470,322	55%	259,875	3,378,375	15,179	55%	8,387	92,257
Kit - Showerhead	1,111,110	48%	534,735	5,347,354	26,271	60%	15,889	158,894
Kit - Smart Strip	379,942	86%	327,916	1,639,580				
Online Audit Overall	**4,751,030**	**63%**	**2,983,338**	**28,959,258**	**62,915**	**57%**	**35,606**	**366,700**

7.4 Attribution Results

The EU programs were not required to report net or attributable savings for the 2012 program year. However, discussions within the State of Michigan suggest that net savings may be required in future program years. DNV KEMA conducted a net savings analysis to provide the program with the information they will need for planning and implementation when moving toward net savings reporting.

7.4.1 Attribution Adjustment Factors

DNV KEMA calculated the attribution adjustment factor for the Online Audit Program. The attribution adjustment factor is applied to the verified gross savings to produce net savings. It reflects the influence the program had on the timing, efficiency level, and scope of the energy efficiency measure installed.[20] Table 54 shows the results.

LED Night Lights had the lowest electric attribution rate at 39 percent. On the gas side, door strips showed the lowest rate at 24 percent. Faucet aerators showed relatively high attribution for both natural gas and electric, with attribution rates above 50 percent. Overall, the electric attribution adjustment factor was 48 percent and gas was 42 percent.

There is more discussion about attribution results in Appendix G and the following section.

[19] DNV KEMA's study did not complete any surveys addressing Online Audit kit - smart strips. DNV KEMA applied the GSA for ENERGY STAR smart strips to Online Audit kit - smart strips.

[20] Appendix G discusses the methodology used in the attribution analysis.

Table 54. Attribution Adjustment Factor, Online Audit

Measure Group	kWh n	kWh Attribution Adjustment Factor	kWh 90% Confidence Interval +/-	kWh Lower Bound	kWh Upper Bound	kWh % Program Savings	ccf n	ccf Attribution Adjustment Factor	ccf 90% Confidence Interval +/-	ccf Lower Bound	ccf Upper Bound	ccf % Program Savings
Kit - CFL	164	42%	7%	35%	48%	32%	0	-	-	-	-	0%
Kit - Door Strip	0	-	-	-	-	0%	60	24%	9%	16%	33%	8%
Kit - Faucet Aerator	58	68%	9%	59%	78%	24%	80	59%	9%	50%	68%	26%
Kit - LED Night Light	66	39%	11%	28%	51%	8%	0	-	-	-	-	0%
Kit - Pipe Wrap	0	-	-	-	-	0%	63	33%	9%	24%	42%	26%
Kit - Showerhead	44	47%	11%	37%	58%	37%	69	39%	9%	30%	48%	41%
Online Audit Overall	**332**	**48%**	**6%**	**43%**	**54%**	**100%**	**272**	**42%**	**6%**	**36%**	**48%**	**100%**

7.4.2 Analysis of Survey Responses

DNV KEMA reviewed the responses to the questions in the Online Audit survey that were used to determine program attribution. We reviewed the results to identify where the program was having an effect and where improvements could be made. We investigated the program's effect on timing, efficiency, and quantity, the three components of attribution. Appendix G has greater detail on the attribution analysis methodology.

For the Online Audit Program, the respondents were asked questions at the technology level (CFLs, faucet aerators, showerheads), not the measure level like other programs. The measure level response for this program would be the entire energy kit. DNV KEMA wanted to get information at a disaggregated level to judge the relative attribution of each technology in the kit, not the kit overall.

7.4.2.1 Overall Likelihood

For the energy kits, DNV KEMA added an introductory question that asked, for each technology in the kit, how likely the respondent was to purchase it on its own (DAT0). If respondents said No, they would not have purchased it, DNV KEMA skipped them through the rest of the attribution sequence and assigned them an attribution rate of 100 percent for that technology.

Table 55 shows the results for the Online Audit Program. One hundred and eleven of the respondents, representing 17 percent of kWh and 20 percent of ccf, said they would not have purchased the technology and received full attribution credit. Respondents representing 66 percent of kWh and 51 percent of ccf savings said they would or were likely to have purchased it, while those representing 17 percent of kWh and 28 percent of ccf savings said they were not likely.

Table 55. Likelihood of Purchase, Online Audit

DAT0. Without EU, what would you say the likelihood of installing was?			
Response	Responses	Percent kWh	Percent ccf
Yes	230	47%	30%
Probably yes	122	19%	21%
Probably not	135	17%	28%
No	111	17%	20%
Not Applicable	0	0%	0%
Don't Know/Refused	6	0%	2%

7.4.2.2 Timing

Respondents are asked a sequence of questions that address the timing of the equipment installation. First, respondents are asked how likely it is that they would have installed the same type of equipment at the same time without the program (DAT1). Then respondents are asked how different the timing would have been (DAT1a).

- A response of "Same Time" means that the customer would have installed the measure(s) at the same time regardless of program involvement.
- A response of "Later" indicates that they would have waited to install the measure(s) if the program had not been present. This measure is called "accelerated." Respondents who answered "Later" are asked a follow-up question (DAT1b) about how much later they would have installed the equipment without the program.

Table 56 shows the responses to the DAT1a and DAT1b questions for the Online Audit Program. The table shows the unweighted number of responses in each category and the associated percentage of overall program energy savings represented by those responses. The number of responses does not reflect any survey weight or relative savings but the percentage of energy savings does. The table shows a response of "Not Applicable", which applies to any measure that did not have this question asked for it. This applies to measures that used an alternative attribution methodology (CFLs) and those who answered DAT0 as "would not have bought" the technology outside the kit.

The table outlines the skip pattern and attribution assignment for DAT1a and DAT1b. If a respondent indicates that they would have installed the equipment at the same time or earlier, the acceleration period is zero months and there is no timing effect. If the respondent indicates that they would have never installed the equipment without the program, then the program is credited with influencing the entire project and receives a 100 percent attribution. The same effect is applied if the respondent indicates it would have been greater than four years before they would have installed the equipment without the

program. If the response to DAT1a is "Later" and the response to DAT1b is a number less than 48, then the acceleration period is equal to that number of months.

Table 56. Determining Acceleration Period, Online Audit

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	38	3%	11%	0
Earlier	N/A	47	6%	9%	0
Later	Months < 48	174	20%	42%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	13	3%	2%	Average of DAT1b
Never	N/A	63	6%	14%	100%
Not Applicable	N/A	252	61%	17%	Not Asked
Don't Know/Refused	N/A	17	1%	5%	Average of DAT1a

The table shows that the majority of the respondents who were asked the timing questions would have installed the equipment later without the program, representing 23 percent of total kWh and 44 percent of total gas savings (ccf). Only 85 responses representing 9 percent of kWh and 20 percent of ccf would have installed the equipment earlier or at the same time, received no timing attribution. Respondents representing 6 percent of kWh and 14 percent of ccf would never have purchased the equipment without the program.

7.4.2.3 Efficiency

Respondents are asked a sequence of questions that address the efficiency of the equipment installation. First, respondents are asked how likely it is that they would have installed the same, lesser, or greater efficiency without the program (DAT2a). Then respondents are asked how different the efficiency would have been (DAT2b).

- A response of "Same" means that the customer would have installed the same level of efficiency regardless of program involvement.
- A response of "Lower" indicates that they would have installed a less efficient piece of equipment if the program had not been there. Respondents who answered "Lower" are asked a follow-up question (DAT2b) about what equipment efficiency they would have installed without the program.

Table 57 shows the responses to the DAT2a question. The table includes a response of Not Applicable, which represents measures that do not have variable efficiency themselves, but are added to the existing equipment or systems to make the overall operation more efficient. Pipe wrap and door strips are an

example of such a measure. Measures that used an alternative attribution methodology (CFLs) or answered "would not have installed" to DAT0 are also Not Applicable.

None of the Online Audit measures that were asked the attribution sequence has more than one less efficient alternative, so the efficiency attribution was based solely off of DAT2a, in a binary fashion: 100 percent efficiency attribution if the respondent indicates that they would have installed a lower efficiency, zero efficiency attribution if not.

The table shows that, for applicable measures, 51 respondents representing 9 percent of kWh and 10 percent of ccf would have installed equipment of a lower efficiency.

Table 57. Determining Efficiency Attribution, Online Audit

DAT2a. Without EU, would you have installed the same, higher, or lower efficiency?			
Response	Responses	Percent kWh	Percent ccf
Same	148	23%	40%
Lower	51	9%	10%
Higher	0	0%	0%
Not Applicable	369	62%	44%
Don't Know/Refused	36	6%	5%

7.4.2.4 Quantity

Respondents are asked a sequence of questions that address the quantity of the equipment installed. First, respondents are asked how likely it is that they would have installed the same quantity of equipment without the program (DAT3). Then respondents are asked how much they changed the quantity (DAT3a).

- A response of "Same amount" means that the customer would have installed the same or greater size or quantity regardless of program involvement.
- A response of "Less" indicates that the customer would have installed fewer units if the program had not been there. Respondents who answered "Less" are asked a follow-up question (DAT3a) about the quantity of equipment they would have installed without the program.
- A response of "More" indicates that the customer would have installed more units, or larger units if the program had not been there. Respondents who answered "More" are asked a follow-up question (DAT3a) about the quantity of equipment they would have installed without the program.

Table 58 shows the responses to the DAT3 question for each measure group. The table includes a response of Not Applicable, which represents measures where varying quantity or size does not make

sense in the context of the measure or where the customer only received a single unit. Measures that used an alternative attribution methodology (CFLs) or answered "would not have installed" to DAT0 are also Not Applicable.

The table outlines the skip pattern and attribution assignment for DAT3 and DAT3a. If a respondent indicates that they would have installed the same or greater quantity or size, the quantity attribution is zero. If the respondent indicates that they would have installed less quantity/size, then the quantity attribution is some value between 0 and 100 percent. If the respondent indicates that they would not have installed any equipment without the program, then the quantity attribution is 100 percent.

Table 58. Determining Quantity Attribution, Online Audit

DAT3. Without EU, how different would the quantity/size have been?					
DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	99	8%	15%	0%
Less	Value < 100%	47	5%	9%	Value < 50%
	Value >= 100%	0	0%	0%	Value > 50%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
More	Value < 100%	46	1%	11%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	2	0%	1%	Average of DAT3a
None	N/A	52	4%	8%	100%
Not Applicable	N/A	353	81%	54%	Not Asked
Don't Know/Refused	N/A	5	0%	2%	Average of DAT3

The table shows that only 104 respondents representing 9 percent of kWh savings and 18 percent of ccf savings received quantity attribution: 47 respondents who would have installed less, 52 who would have installed none, and 5 who answered "don't know." DNV KEMA reviewed the technology level data and found that 46 of those responses were for faucet aerators, 19 for LED night lights, 17 for door strips, and 17 for pipe wraps.

7.4.2.5 Overall Attribution

DNV KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 59 shows the three effects together with "Yes" indicating some (not necessarily full) attribution while "No" indicates responses that did not receive any attribution.

The table shows that 220 respondents representing 34 percent of kWh and 40 percent of ccf received all three kinds of attribution (or full attribution based on the overall likelihood question). Ninety-three respondents representing 22 percent of kWh savings and 15 percent of natural gas savings did not receive

any attribution. The Timing attribution was the most represented, with 366 respondents representing 55 percent of kWh savings and 69 percent of ccf savings.

Table 59. Simplistic Representation of Overall Attribution, Online Audit

Attribution			Responses	Percent kWh	Percent ccf
Timing	Efficiency	Quantity			
Yes	Yes	Yes	220	34%	40%
Yes	No	Yes	24	2%	6%
Yes	No	No	114	18%	22%
Yes	Yes	No	8	1%	1%
No	Yes	Yes	21	2%	1%
No	Yes	No	71	18%	5%
No	No	Yes	53	2%	10%
No	No	No	93	22%	15%

7.5 Comparison of 2011 and 2012 Program Results

DNV KEMA compared the results of the 2011 program evaluation to the results of the 2012 program evaluation.

7.5.1 Overall Comparison

Table 60 shows the tracking savings, number of measures, and total incentives paid for the 2011 and 2012 program periods. The final column shows the difference between the two, with positive values representing increase.

The dominant change from 2011 to 2012 is a large increase in kWh savings, with 3.2 times more kWh saved in 2012 than in 2011. The program also experienced a relatively small increase in ccf savings (5 percent) and an 85 percent increase in the number of measures. Much of the increase in savings came from rebates recorded in the last quarter of the year.

Table 60. Comparison of 2011 and 2012 Online Audit Program Results

Metric	Program Period Jan to Dec 2011	Program Period Jan to Dec 2012	2011 to 2012 Change
Tracking kWh Savings	1,116,661	4,751,030	325%
Tracking ccf Savings	59,721	62,915	5%
Total # Measures	2,788	5,146	85%
Total Incentive	$52,309	$252,067	382%

7.5.2 Adjustment Factors

Table 61 shows the 2011 and 2012 installation rate, gross savings adjustment factor, and attribution adjustment factor for kWh and ccf. Between the two years, the installation rate and gross savings

adjustment factor for kWh were statistically significant at the 90 percent confidence interval. None of the factors for natural gas were statistically significant.

Table 61. Comparison of 2011 and 2012 Online Audit Adjustment Factors

Adjustment Factor	kWh		ccf	
	2011	2012	2011	2012
Installation Rate	50%	59%	60%	56%
Gross Savings Adjustment Factor	50%	59%	60%	56%
Attribution Adjustment Factor	46%	48%	49%	42%

8. Onsite Weatherization

This section reports on the methodology and overall results of DNV KEMA's evaluation of the Residential Onsite Weatherization Program.

- Section 8.1 provides a description of the program.
- Section 8.2 gives an overview of the evaluation approach.
- Section 8.3 presents the verified gross savings results and the overall adjustment factors.
- Section 8.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.
- Section 8.5 offers a comparison of 2011 and 2012 Program results.

8.1 Program Description

The Residential Onsite Weatherization (AW) Program, which is part of the Home Performance program, was launched in late 2010. The program offers a free in-person audit for residential natural gas customers with gas heat in buildings of four units or less. The participants may also have received direct install measures, including CFLs, faucet aerators, low flow showerheads, pipe wrap, and programmable thermostats if the home is a customer of a participating electric utility or the water heater uses natural gas. Savings from weatherization measures that were incentivized through the program were reported as part of the AW program, though an audit is not required to receive incentives for these measures. The AW Program was the largest residential natural gas program and third largest electric program in the 2012 MCAAA portfolio. Not all measures were offered in all utility service territories as shown in Table 62.

Table 62. Measures Offered by Utility through Onsite Weatherization Program

Utility	Measure							
	CFL	Faucet Aerator	Low Flow Showerhead	Pipe Wrap	Programmable Thermostat	Insulation	Window Replacement	Air Sealing
Alpena Power Company	X	X	X	X				
Baraga Electric Utility	X	X	X	X				
Bayfield Electric Cooperative								
The City of Crystal Falls	X	X	X	X				
Daggett Electric Department	X	X	X	X				
The City of Gladstone Department of Power and Light	X	X	X	X				
City of Hillsdale Board of Public Utilities	X	X	X	X				
Indiana Michigan Power Company	X	X	X	X				
L'Anse Electric Utility	X	X	X	X				
Michigan Gas Utilities Corporation		X	X	X	X	X	X	X
Negaunee Electric Utility	X	X	X	X				
City of Norway Department of Power and Light	X	X	X	X				
SEMCO Energy Gas Company		X	X	X	X	X	X	X
City of South Haven	X	X	X	X				
Upper Peninsula Power Company	X	X	X	X				
We Energies	X	X	X	X				
Wisconsin Public Service Corporation	X	X	X	X	X	X	X	X
Xcel Energy	X	X	X	X	X	X	X	X

Table 63 shows the accomplishments for the AW program based on the program implementer tracking data. The table shows the tracking savings, number of measures rebated, number of participants, and incentives paid for the evaluation period and the entire 2012 program period.

Table 63. Overview of AW Program Accomplishments per Program Tracking

Metric	Evaluation Period Jan to Aug 2012	Program Period Jan to Dec 2012
Tracking kWh Savings	1,790,752	4,466,831
Tracking ccf Savings	308,843	1,042,257
# Measures	15,133	49,006
Incentives	$334,790	$1,138,791

8.2 General Approach

The impact evaluation of the AW Program had the following objectives for the 2012 program:

- Reliably estimate the program's gross annual kWh and gas savings (ccf) over the effective useful life of the installations
- Provide an estimate of program attribution.

To meet these objectives, the impact evaluation included the following tasks:

- Verify proper tracking assignments (Appendix D)
- Verify proper documentation with a sample of participating applications (Appendix E)
- Conduct CATI surveys with a sample of participants
- Conduct verified gross savings analysis
- Conduct net savings analysis
- Complete in-depth attribution analysis to assist with program planning.

Section 2.5 describes the steps used to complete these tasks in greater detail.

8.3 Verified Gross Savings Results

8.3.1 Installation Rate

DNV KEMA calculated the installation rate for each measure group in the Onsite Weatherization Program. For all measures except insulation, we defined the installation rate as the number of units installed divided by the number of units in the tracking database. For insulation measures, we asked respondents to verify the multiplier used to determine savings, which was either the square footage of insulation installed or the conditioned square footage of the house. Table 64 shows the results.

The table shows that the all measure groups had installation rates greater than 80 percent for both electric and gas. For ratios less than 100 percent, many of the respondents reported removing the equipment after it was installed. For CFLs, several respondents reported that the contractors only installed a few bulbs and left the remaining for customers without installing them. Customers also removed the bulbs that burnt out or emitted less light. For faucet aerators and showerheads, the most common reason for removal was malfunctioning equipment; for example, leakage, plugging up, and breakage of constituent parts. Some customers mentioned that they replaced those provided through the program with more efficient ones and others reported that they did not like the flow. For thermostats, 10 respondents removed them: a majority reported removing it due to difficulties using it, while others reported that the thermostat stopped working.

Table 64. Installation Rate, Onsite Weatherization

Measure Group	kWh n	kWh Installation Rate	kWh 90% Confidence Interval +/-	kWh Lower Bound	kWh Upper Bound	kWh % Program Savings	ccf n	ccf Installation Rate	ccf 90% Confidence Interval +/-	ccf Lower Bound	ccf Upper Bound	ccf % Program Savings
CFL	133	89%	6%	83%	96%	45%	0	-	-	-	-	0%
Faucet Aerator	111	83%	7%	76%	91%	15%	128	85%	8%	77%	93%	13%
Insulation	0	-	-	-	-	0%	16	100%	<0.1%	100%	100%	4%
Pipe Wrap	58	95%	7%	88%	100%	13%	84	93%	8%	86%	100%	10%
Thermostat	0	-	-	-	-	0%	136	96%	3%	93%	99%	48%
Showerhead	81	96%	4%	93%	100%	27%	92	91%	8%	83%	100%	22%
Window Replacement	0	-	-	-	-	0%	2	100%	<0.1%	100%	100%	3%
Onsite Weatherization Overall	**383**	**91%**	**3%**	**87%**	**94%**	**100%**	**458**	**94%**	**3%**	**91%**	**96%**	**100%**

8.3.2 Verified Gross Savings

DNV KEMA combined the installation rate and the effects of the documentation review (Appendix E) to produce the gross savings adjustment factor, which is a single adjustment factor that can be applied to the tracking savings to produce verified gross savings.[21] Table 65 shows the gross savings adjustment factor for Onsite Weatherization.[22]

DNV KEMA's documentation review found a number of items with various calculation issues. These include measures on the application but not in the database and measures in the database but not on the application. For Insulation measures, the large adjustment results from relatively large homes with conditioned basements which did not receive savings for the basement. While we only found a few projects with this issue, the relatively small number of projects reviewed (12) caused this to become a large adjustment. The overall effect of the documentation review is negligible, but the adjustments do result in a large change for insulation measures and small changes for pipe wrap, thermostat, showerhead and window replacement natural gas savings.

[21] DNV KEMA completed the tracking review in time for the program to update the database for reporting, so it did not affect the gross adjustment factor this year.

[22] The gross savings adjustments reported in Table 65 (and throughout this report) are the LCNS gross savings adjustments used to produce the verified gross lifetime savings, which may differ slightly from the Y1NS gross adjustment factors used to produced the annual verified gross savings.

Table 65. Gross Savings Adjustment Factor, Onsite Weatherization

	kWh						ccf					
			90% Confidence Interval						90% Confidence Interval			
Measure Group	min n	Gross Savings Adjustment Factor	+/-	Lower Bound	Upper Bound	% Program Savings	min n	Gross Savings Adjustment Factor	+/-	Lower Bound	Upper Bound	% Program Savings
CFL	130	89%	6%	83%	96%	45%	0	-	-	-	-	0%
Faucet Aerator	108	83%	7%	76%	91%	15%	121	85%	8%	77%	93%	13%
Insulation	0	-	-	-	-	0%	16	119%	<0.1%	119%	119%	4%
Pipe Wrap	57	95%	7%	88%	102%	13%	82	94%	8%	87%	102%	10%
Thermostat	0	-	-	-	-	0%	126	95%	3%	92%	98%	48%
Showerhead	76	96%	4%	93%	100%	27%	87	92%	9%	84%	101%	22%
Window Replacement	0	-	-	-	-	0%	2	101%	<0.1%	101%	101%	3%
Onsite Weatherization Overall	**371**	**91%**	**3%**	**87%**	**94%**	**100%**	**434**	**94%**	**3%**	**91%**	**97%**	**100%**

The gross savings adjustment factor was applied to the total savings reported for the Onsite Weatherization Program in 2012 to produce the verified gross savings for the program. Table 66 shows the tracking gross savings (an annual number), the gross savings adjustment factor determined from the evaluation, the verified gross annual savings, and the verified gross lifetime savings.[23] The verified gross annual savings is the tracking gross savings multiplied by the gross savings adjustment factor. The verified gross lifetime savings is the verified gross annual savings with the measure life applied.[24]

Table 66. Verified Gross Savings, Onsite Weatherization

	kWh				ccf			
Measure Group	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
CFL	2,090,695	89%	1,860,958	16,748,618				
Air Sealing					2,926	133%	3,892	42,810
Faucet Aerator	694,378	83%	579,333	5,793,329	156,545	85%	133,501	1,335,014
Insulation					17,066	119%	20,309	406,178
Pipe Wrap	395,046	95%	375,576	4,882,490	91,759	94%	86,413	950,544
Thermostat					485,930	95%	462,024	5,082,260
Showerhead	1,286,712	96%	1,241,029	12,410,291	276,804	92%	255,175	2,551,750
Window Replacement					11,226	101%	11,339	226,773
Onsite Weatherization Overall	**4,466,831**	**91%**	**4,056,896**	**39,834,727**	**1,042,257**	**93%**	**972,653**	**10,595,330**

8.4 Attribution Results

The EU programs were not required to report net or attributable savings for the 2012 program year. However, discussions within the State of Michigan suggest that net savings may be required in future

[23] The overall gross savings adjustment factors reported in Table 66 differ from Table 65 because they represent the proportion of verified savings to tracked savings in the final population. The mix of measures in the final population differed from the mix of measures in the sample frame used to develop the gross savings adjustments.

[24] DNV KEMA's study did not complete any surveys addressing air sealing, but did complete documentation reviews on a sample of projects. To estimate verified gross savings, DNV KEMA combined the installation rate found for the most similar program and measure group available (the corresponding air sealing ratio from the Low Income program) and the documentation review adjustment factor for AW air sealing.

program years. DNV KEMA conducted a net savings analysis to provide the program with the information they will need for planning and implementation when moving toward net savings reporting.

8.4.1 Attribution Adjustment Factors

DNV KEMA calculated the attribution adjustment factor for each measure group in Onsite Weatherization. The attribution adjustment factor is applied to the verified gross savings to produce net savings. It reflects the influence the program had on the timing, efficiency level, and scope of the energy efficiency measure installed.[25] Table 67 shows the results.

The Onsite Weatherization Program had a relatively high attribution rate, which is expected for a program that is largely based on direct-install savings. The lowest attribution came from the thermostat measure group. Overall, the program showed a 59 percent attribution for electric measures and 65 percent for natural gas measures. The lower attribution for electric measures is driven primarily by the low attribution for CFLs.

Table 67. Attribution Adjustment Factor, Onsite Weatherization

	kWh						ccf					
		Attribution	90% Confidence			%		Attribution	90% Confidence			%
Measure Group	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings
CFL	130	49%	10%	39%	59%	45%	0	-	-	-	-	0%
Faucet Aerator	104	78%	9%	69%	88%	15%	118	85%	9%	76%	94%	13%
Insulation	0	-	-	-	-	0%	13	37%	40%	0%	77%	4%
Pipe Wrap	49	64%	25%	39%	89%	13%	67	73%	14%	60%	87%	10%
Thermostat	0	-	-	-	-	0%	126	59%	10%	49%	69%	48%
Showerhead	75	60%	22%	39%	82%	27%	87	73%	18%	56%	91%	22%
Window Replacement	0	-	-	-	-	0%	2	*	*	*	*	3%
Onsite Weatherization Overall	358	59%	8%	50%	67%	100%	413	65%	7%	58%	72%	100%

*Attribution adjustment factor not reported for Window Replacement measures to preserve respondent confidentiality

8.4.2 Analysis of Survey Responses

DNV KEMA reviewed the responses to the attribution question sequence used in the Onsite Weatherization survey to identify where the program was having an effect and where improvements could be made. We investigated the program's effect on timing, efficiency, and quantity, the three components of attribution. Appendix G has greater detail on the attribution analysis methodology and the methods used to combine the three components into a single attribution value.

[25] Appendix G discusses the methodology used in the attribution analysis.

Table 68. Attribution Question Sequence

Number	Question
Timing	
DAT1	Without EU, how likely is it that you would have installed the same type of equipment at this time?
DAT1a	Without EU, how different would the timing have been?
DAT1b	Approximately how many months later?
Efficiency	
DAT2	Without EU, how likely is it that you would have installed the same level of efficiency?
DAT2a	Without EU, how likely is it that you would have installed the same, greater, or lesser efficiency?
DAT2b	Without EU, what efficiency would you have installed?
Quantity	
DAT3	Without EU, how different would the quantity/size have been?
DAT3a	By what percentage did you change the quantity/size because of EU?

8.4.2.1 Overall Likelihood

For non-CFL measures directly installed as part of the Onsite Weatherization program, DNV KEMA added an introductory question that asked, for the measures installed, how likely the respondent was to purchase it on their own (DAT0). If respondents said No, they would not have purchased it, DNV KEMA skipped them through the rest of the attribution sequence and assigned them an attribution rate of 100 percent for that technology. These technologies are faucet aerators, pipe wrap, showerheads, and thermostats. The reason for skipping through the rest of the attribution sequence is to reduce response burden for the respondents.

Table 69 shows the results for the Onsite Weatherization Program. Three hundred thirty six of the respondents, representing 29 percent of kWh and 47 percent of ccf, said they would not have purchased the technology and received full attribution credit. Respondents representing 15 percent of kWh and 28 percent of ccf savings said they would or were likely to have purchased it, while those representing 7 percent of kWh and 22 percent of ccf savings said they were not likely.

Table 69. Likelihood of Purchase, Onsite Weatherization

DAT0. Without EU, what would you say the likelihood of installing was?			
Response	Responses	Percent kWh	Percent ccf
Yes	83	10%	16%
Probably yes	94	5%	12%
Probably not	111	7%	22%
No	336	29%	47%
Not Applicable	130	49%	0%
Don't Know/Refused	12	1%	3%

8.4.2.2 Timing

Respondents are asked a sequence of questions that address the timing of the equipment installation. First, respondents are asked how likely it is that they would have installed the same type of equipment at the same time without the program (DAT1). Then respondents are asked how different the timing would have been (DAT1a).

- A response of "Same Time" means that the customer would have installed the measure(s) at the same time regardless of program involvement.
- A response of "Later" indicates that they would have waited to install the measure(s) if the program had not been present. This measure is called "accelerated." Respondents who answered "Later" are asked a follow-up question (DAT1b) about how much later they would have installed the equipment without the program.

Table 70 shows the responses to the DAT1a and DAT1b questions for Onsite Weatherization. The table shows the unweighted number of responses in each category and the associated percentage of overall program energy savings represented by those responses. The number of responses does not reflect any survey weight or relative savings but the percentage of energy savings does.

The table outlines the skip pattern and attribution assignment for DAT1a and DAT1b. If a respondent indicates that they would have installed the equipment at the same time or earlier, the acceleration period is zero months and there is no timing effect. If the respondent indicates that they would never have installed the equipment without the program, then the program is credited with influencing the entire project and receives 100 percent attribution. The same effect is applied if the respondent indicates that it would have been greater than four years before they would have installed the equipment without the program. If the response to DAT1a is Later and the response to DAT1b is a number less than 48, then the acceleration period is equal to that number of months.

Table 70. Determining Acceleration Period, Onsite Weatherization

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	21	6%	8%	0
Earlier	N/A	27	3%	3%	0
Later	Months < 48	127	5%	16%	Months / 48
	Months >= 48	2	0%	1%	100%
	Don't Know/Refused	51	6%	5%	Average of DAT1b
Never	N/A	58	2%	17%	100%
Not Applicable	N/A	466	77%	47%	Not Asked
Don't Know/Refused	N/A	14	0%	2%	Average of DAT1a

The table shows that 21 of the respondents would have installed the equipment at the same time regardless of program involvement, representing 6 percent of kWh and 8 percent of gas savings (ccf). Fifty-eight respondents give the program full attribution credit, representing 2 percent of kWh savings and 17 percent of gas savings (ccf). One-hundred-ninety-four respondents representing 11 percent of kWh savings and 24 percent of gas savings (ccf) said they would have installed the equipment within the next four years, or answered one of the two questions "Don't Know" all of which result in an accelerated measure.

8.4.2.3 Efficiency

Respondents are asked a sequence of questions that address the efficiency of the equipment installation. First, respondents are asked how likely it is that they would have installed the same, lesser, or greater efficiency without the program (DAT2a). Then respondents are asked how different the efficiency would have been (DAT2b).

- A response of "Same" means that the customer would have installed the same level of efficiency regardless of program involvement.
- A response of "Lower" indicates that they would have installed a less efficient piece of equipment if the program had not been there. Respondents who answered "Lower" are asked a follow-up question (DAT2b) about what equipment efficiency they would have installed without the program.

Table 71 shows the responses to the DAT2a question for each measure category. The table includes a response of Not Applicable, which represents measures that do not have variable efficiency themselves, but are added to the existing equipment or systems to make the overall operation more efficient. Programmable thermostats and pipe wraps fall into the Not Applicable category. For, showerheads and faucet aerators, DAT2a would be Not Applicable if the responded answered "No" to the introductory question that asked, how likely the respondent was to purchase it on their own (DAT0).

The table outlines the skip pattern and attribution assignment for DAT2a and DAT2b. If a respondent indicates that they would have installed the equipment of the same or higher efficiency, the efficiency attribution is zero. If the respondent indicates that they would have installed a lower efficiency then the efficiency attribution is some number between 30 and 100 percent, depending on the answer to DAT2b.

Table 71. Determining Efficiency Attribution, Onsite Weatherization

DAT2a. Without EU, would you have installed the same, higher, or lower efficiency?					
DAT2b. Without EU, what efficiency would you have installed?					
DAT2a Response	DAT2b Response	Responses	Percent kWh	Percent ccf	Efficiency Attribution
Same	N/A/Skipped	114	0%	2%	0%
Lower	Standard Efficiency	0	0%	0%	100%
	Slightly > Standard	0	0%	0%	70%
	Between Standard and High	0	0%	0%	50%
	Slightly < High	1	0%	0%	30%
	Don't Know/Refused	0	0%	0%	Average of DAT2b
	N/A	35	2%	4%	100%
Higher	N/A/Skipped	0	13%	12%	0%
Not Applicable	N/A	591	83%	80%	Not Asked
Don't Know/Refused	N/A	27	2%	2%	Average of DAT2a

The table shows that the majority of respondents would have installed the same efficiency level without the program, with 114 respondents representing zero percent of program kWh savings and two percent of program gas savings (ccf). Two percent of kWh savings and 4 percent of gas savings (ccf) will receive 100 percent efficiency attribution. These are faucet aerators and showerheads for which respondents indicated that they would have installed lower efficiency ones without the program (dat2a).

8.4.2.4 Quantity

Respondents are asked a sequence of questions that address the quantity of the equipment installed. First, respondents are asked how likely it is that they would have installed the same quantity of equipment without the program (DAT3). Then respondents are asked how much they changed the quantity (DAT3a).

- A response of "Same amount" means that the customer would have installed the same or greater size or quantity regardless of program involvement.
- A response of "Less" indicates that the customer would have installed fewer units if the program had not been there. Respondents who answered "Less" are asked a follow-up question (DAT3a) about the quantity of equipment they would have installed without the program.
- A response of "More" indicates that the customer would have installed more units or capacity if the program had not been there. In these cases, the evaluation team assumes that the respondent would have installed a less efficient system without the program assistance because it would have been oversized. Respondents who answered "More" are asked the same follow-up question (DAT3a) about the quantity or capacity of equipment they would have installed without the program.

Table 72 shows the responses to the DAT3 question for each measure group. The table includes a response of Not Applicable, which represents measures where varying quantity or size does not make sense in the context of the measure. Measures that are not applicable include CFLs, which have a different attribution question sequence and measures where only one unit was installed.

The table outlines the skip pattern and attribution assignment for DAT3 and DAT3a. If a respondent indicates that they would have installed the same, the quantity attribution is zero. If the respondent indicates that they would have installed less quantity/size or greater quantity or size, then the quantity attribution is some value between 0 and 100 percent. If the respondent indicates that they would not have installed any equipment without the program then the quantity attribution is 100 percent.

Table 72. Determining Quantity Attribution, Onsite Weatherization

DAT3. Without EU, how different would the quantity/size have been?					
DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	73	10%	9%	0%
Less	Value < 100%	12	0%	1%	Value < 50%
	Value >= 100%	1	0%	0%	Value > 50%
	Don't Know/Refused	1	0%	0%	Average of DAT3a
More	Value < 100%	18	2%	1%	Value < 100%
	Value >= 100%	1	0%	0%	Value = 100%
	Don't Know/Refused	4	1%	0%	Average of DAT3a
None	N/A	29	1%	5%	100%
Not Applicable	N/A	616	85%	82%	Not Asked
Don't Know/Refused	N/A	16	0%	1%	Average of DAT3

The table shows that 73 respondents representing 10 percent of kWh savings and 9 percent of gas savings (ccf) would have installed equipment of the same size or quantity without the program. Eighty-two respondents representing 4 percent of kWh savings and 8 percent of gas savings (ccf) received some quantity attribution.

8.4.2.5 Overall Attribution

DNV KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 73 shows the three effects together with "Yes" indicating some (not necessarily full) attribution while "No" indicates responses that did not receive any attribution.

The table shows that 426 responses representing 49 percent of kWh savings and 62 percent of gas savings (ccf) received all three types of attribution (or full attribution based on the overall likelihood question). In total, only 63 measures representing 14 percent of kWh savings and 12 percent of gas savings (ccf) did

not receive any timing, efficiency, or quantity attribution. In other words, the program had at least some influence over more than 85 percent of the savings reported by the program.

Table 73. Simplistic Representation of Overall Attribution, Onsite Weatherization

Attribution			Responses	Percent kWh	Percent ccf
Timing	Efficiency	Quantity			
Yes	Yes	Yes	426	49%	62%
Yes	No	Yes	82	10%	5%
Yes	No	No	49	3%	1%
Yes	Yes	No	22	3%	1%
No	Yes	Yes	24	1%	5%
No	Yes	No	60	18%	1%
No	No	Yes	45	3%	13%
No	No	No	63	14%	12%

8.5 Comparison of 2011 and 2012 Program Results

2012 was the second year of the Onsite Weatherization Program. DNV KEMA compared the results of the 2011 program evaluation to the results of the 2012 program evaluation.

8.5.1 Overall Comparison

Table 93 shows the tracking savings, number of measures, and total incentives paid for each program period. The final column shows the difference between the two, with a negative value representing a decrease from 2011 and a positive value representing an increase.

The table shows a significant increase in savings, number of measures, and incentives paid from 2011 to 2012. This is likely because, in 2012, the Onsite Weatherization Program completed its second full year of implementation and has become or is becoming fully ramped up.

Table 74. Comparison of 2011 and 2012 Onsite Weatherization Program Results

Metric	Program Period Jan to Dec 2011	Program Period Jan to Dec 2012	2011 to 2012 Change
Tracking kWh Savings	2,047,900	4,466,831	118%
Tracking ccf Savings	250,468	1,042,257	316%
Total # Measures	12,364	49,006	296%
Total Incentive	$120,248	$1,138,791	847%

8.5.2 Adjustment Factors

Table 94 shows the 2011 and 2012 installation rate, gross savings adjustment factor, and attribution adjustment factor. Highlighted cells show a statistically significant difference from the 2011 to 2012 program periods at the 90 percent confidence interval.

Most of the numbers are similar, and the differences are not statistically significant. However, the 2012 attribution factor for kWh is 19 percent less than 2011 and the difference is statistically significant. The difference is likely because CFLs, pipe wrap, and showerheads together make up more than 80 percent of kWh savings in both years but each had lower attribution in 2012 than 2011.

Table 75. Comparison of 2011 and 2012 Onsite Weatherization Adjustment Factors

Adjustment Factor	kWh		ccf	
	2011	2012	2011	2012
Installation Rate	89%	91%	91%	94%
Gross Savings Adjustment Factor	87%	91%	90%	94%
Attribution Adjustment Factor	78%	59%	63%	65%

9. Commercial and Industrial Program

This section reports on the methodology and overall results of DNV KEMA's evaluation of the Commercial and Industrial Program.

- Section 9.1 provides a description of the program.
- Section 8.29.2 gives an overview of the evaluation approach.
- Section 9.3 presents the verified gross savings results and the overall adjustment factors.
- Section 9.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.
- Section 9.5 offers a comparison of 2011 and 2012 Program results.

9.1 Program Description

The Commercial and Industrial (C&I) Program encompasses many components under a single umbrella, including a prescriptive rebate program, a custom rebate program, and a direct install program. The 2012 C&I Program saw participation in the direct install, prescriptive and custom programs.

The C&I prescriptive program provides prescriptive incentives to commercial and industrial customers for the installation of energy-efficiency equipment for numerous applications. Measures include but are not limited to lighting, motors and drives, controls, heating ventilation and air conditioning (HVAC), refrigeration, food service equipment, and boiler and steam systems. The prescriptive measures offered in the C&I Program include:

- CFL bulbs
- T8 lamps and fixtures
- HVAC equipment
- Motors/fans/pumps/drives
- Water heaters
- Refrigeration
- Lighting controls
- Thermostat controls
- Boiler and Furnace tune-ups
- LED Exit Signs
- Direct install measures, including Faucet Aerators, Showerheads and CFLs

The C&I custom program provides custom incentives to commercial and industrial customers for the installation of innovative and unique energy efficient equipment and controls. Having a custom program allows efficiency measures and systems to be installed for situations specific to that customer's

application or process. Incentives are offered on a per kWh and/or ccf energy savings basis based on pre-approved engineering estimates. This program targets energy saving equipment or processes as well as applications with so much variability in operating characteristics that standardized savings cannot be assumed across the customer base. This program also includes those technologies that are new to the market and have not yet established baseline savings.

The program was implemented throughout 2012 for Efficiency United utilities. The C&I programs are implemented by CLEAResult, who took over the running of the C&I programs for the first time in 2012. The program is offered in all service territories except Bayfield Electric Cooperative. The C&I Program is the largest program in the MCAAA portfolio.

Table 76 shows the accomplishments for the C&I program based on the program implementer tracking data. The table shows the tracking savings, number of measures rebated, and incentives paid for the evaluation period and the entire 2012 program period. In 2012, the majority of savings occurred in the last 4 months of the year and could not be included in the evaluation sample.

Table 76. Overview of C&I Program Accomplishments per Program Tracking

Metric	Evaluation Period Jan to Aug 2012	Program Period Jan to Dec 2012
Tracking kWh Savings	5,948,594	27,298,944
Tracking ccf Savings	295,128	4,376,367
# Measures	467	1,355
Incentives	$363,251.70	$2,617,636.67

9.2 General Approach

9.2.1 Evaluation Objectives

The impact evaluation of the C&I Program had the following objectives for the 2012 program:

- Reliably estimate the program's gross annual MWh and gas savings (ccf) over the effective useful life of the custom retrofits and installations; and
- Provide an estimate of program attribution.

The evaluation addressed prescriptive, custom and direct install measures. For the evaluation, sites with only direct install or prescriptive measures were addressed through CATI surveys. Site with at least one custom measure were included in the engineering sample. The goal was to conduct approximately 40 on-site visits. DNV KEMA attempted an on-site visit to all customers in the custom group. All of the customers in the evaluation timeframe were included in the sample frame.

Table 2 shows the number of customers and measures included in the engineering sample frame, as well as the number completed.

Table 77. Engineering Sample and Disposition

Sample	Customers	Custom Measures	Prescriptive Measures	Total Measures
Completed	27	40	42	82
Dead	8	8	7	15
Total	**35**	**48**	**49**	**97**

The following tasks apply to these customer groups:

- Engineering sample customers, with custom measures, as well as prescriptive measures that occur at the same sites
  - On-site verification with a sample of completed installations;
  - Expert interviews with a sample of participants; and
  - Engineering reviews of a sample of completed measures.
- Customers with prescriptive and/or direct install measures only:
  - Verify paper documentation and tracking with a sample of participating applications;
  - Verified gross savings analysis; and
  - Net savings analysis and overall program realization rate.

9.2.2 Overview of Approach

The steps used to complete the tracking and documentation verification are provided in greater detail in appendix D and E, respectively. The following sections provide detail on the rest of the evaluation tasks.

9.2.2.1 On-site Verification

DNV KEMA performed on-site inspections of prescriptive and custom measures. All customers who implemented at least one custom measure were included in the on-site sample frame. A total of 82 measures for 35 customers at 41 locations received site visits.

Prior to arriving at the site, the tracking data, application file, and survey results were reviewed to provide the auditor with a background understanding of the project. A data collection strategy prior to entering the field was identified to maximize on-site efficiency and foster more directed questioning of the site contact. While at the site, the inspection and verification activities included the following components:

- Verification that the incented equipment was installed;
- Collection of nameplate data when applicable;
- Confirmation that the incented equipment operated as designed;
- Discussion of operating schedules and control set points with the site contact;

- Discussion of occupancy and load schedules that affect the incented equipment;
- Discussion of any issues that may prevent the installed equipment from operating as designed;
- Discussion of any discrepancies between program documentation and what was found on site;
- Collection of all available model data on the replaced equipment when possible.

The data collected during the on-site visits was used to determine the program installation rate and to verify the estimated savings tracked by the program.

9.2.2.2 Survey Data Collection

Two types of surveys were conducted to collect data to inform the impact evaluation. The customers who implemented only prescriptive and direct install measures received a CATI survey and those who implemented custom measures received an expert interview delivered by a DNV KEMA engineer.

9.2.2.2.1 CATI Survey Data Collection

A CATI survey was conducted for a sample of prescriptive and direct install program participants. DNV KEMA attempted a census of the customers with only prescriptive and direct install measures. For customers with more than 8 measures, the survey was performed by a DNV KEMA engineer.

The survey verified equipment installation, requested information about equipment operation, and asked the participant to identify what actions they would have taken in the absence of the program.

9.2.2.2.2 Expert Interview Data Collection

Customers who implemented at least one custom measure were contacted for an expert interview and a site visit. We attempted to complete a survey with all of the customers in these categories; a total of 27 customers agreed to a site visit and 26 customers agreed to complete the survey. As noted in Table 77, we were not able to contact or arrange a survey for 8 custom participants, despite at least six attempts to contact the customer. The survey verified equipment installation, requested information about equipment operation, and asked the participant to identify what actions they would have taken in the absence of the program. The expert interviews allowed collection of nuanced decision-making information that is often a part of larger custom project installations. The expert interviews also formed the basis of the engineering review, discussed in the next section.

9.2.2.3 Engineering Review

All custom participants that completed an expert interview received an on-site visit and an engineering review analysis. During the engineering review, a DNV KEMA engineer used information from the program documentation, site contact, and secondary sources to determine whether the tracking estimate of savings was reasonable. If the tracking estimate was not reasonable, the engineer determined the verified gross savings for that measure. Adjustments were made for a number of reasons, including changes to equipment operation, differences in measure installation, and changes in production or facility operating

hours. In some instances tracking savings methodology, assumptions, and/or inputs were unclear, and therefore the source of discrepancies between tracking and VGI savings could not be identified.

For prescriptive measures, the engineering review determined if the prescriptive savings were properly calculated according to the program. Savings estimates also included operating characteristics, particularly hours of operation. For example, site-specific lighting schedules can be quite different than expected from the prescriptive approach. A manufacturing facility may operate their lights 24 hours a day, for five to seven days a week, resulting in more savings than estimated in deemed savings.

9.2.2.4 Verified Gross Savings Analysis

The installation information gathered from the CATI survey and expert interviews was used to determine the installation rate for the program. Unlike with most other programs, DNV KEMA used a "binary" installation rate for the C&I Program. This method asks customers whether the energy efficiency project was installed. Those that answer yes receive a 100 percent installation rate. Those that answer no receive a 0 percent installation rate. If DNV KEMA found that the quantity of equipment installed differed from the tracking information, then that adjustment was handled as part of the engineering review, not as part of the installation rate. The "binary" method allows for a consistent installation rate method across two types of projects: those with easily determined quantities (i.e. lighting) and also those with an indeterminate measure of size/quantity (variable frequency drives). Once the installation rate was determined for the sample, ratio estimation was applied to determine the installation rate for the overall program. That value was applied to the population to determine the installed savings for the entire program.

DNV KEMA aggregated the verified savings (produced from the engineering review) for each customer and determined measure-level adjustment factors. Ratio estimation was applied to determine the gross savings adjustment factor for the overall program (based on our sample) and apply that value to the population to determine the verified gross savings for the entire program.

9.2.2.5 Net Savings Analysis

The data collected from the CATI survey and expert interviews was used to judge the impact of the program on the participant's decision to install high efficiency measures. DNV KEMA combined the program's effect on the timing of the installation and the efficiency and quantity of the equipment installed to form the attribution rate for each customer.

9.3 Verified Gross Savings Results

9.3.1 Prescriptive Project Review

DNV KEMA completed engineering evaluations for 9 customers for a total of 50 measures in the prescriptive program.

The application paperwork did not specify a calculation approach. For most measures, the MEMD database provided the calculation approach. Where the MEMD was unclear, the calculation method was not available to the evaluation engineer. A number of inconsistencies were found between the expected measure approach and the tracking savings.

DNV KEMA contacted customers regarding the measures that were installed at the site. For each measure, the engineer verified that the measure was installed. In some cases it was not possible to observe all the components of the measures installed, rather a representative sample of installed equipment was verified.

Lighting measures were the most common measures observed, accounting for over 55 percent of the electrical savings. Lighting controls were the second largest percent of savings, at 27 percent.

Operational data collected on site often differed from the standard assumptions for lighting operation assumed in the MEMD database. This was the major reason for differences in verified savings compared to program savings. Lighting calculations followed the fixture wattages provided in the MEMD and the site specific operating hours, where available.

Only one site installed VFDs under the prescriptive program, all for HVAC fans. The program approach used the prescriptive savings value, which is the same across the state. DNV KEMA reviewed the MEMD model for VFD projects for HVAC fans, and adjusted for geography. This reduced the savings significantly, as the customer's location was in a less severe weather location than the assumed climate for the deemed application. Despite the reduced savings compared to the ex ante values, the VFD measures totaled 17 percent of the sample savings for prescriptive measures.

The boiler tune-up measure was the only prescriptive gas measure in the sample. Both space heater and process boiler tune-ups were implemented and had reasonable savings estimates.

Two other prescriptive measures, demand control ventilation and vending machine equipment controllers, together accounted for one percent of the prescriptive measure savings in the sample. The methodology for the deemed savings for the demand control ventilation was unclear. DNV KEMA calculated the savings using the MEMD approach and site-specific conditions. The savings estimates for the vending machine controllers were verified as reasonable; no changes were made to these values.

9.3.2 Custom Project Review

Forty-eight customers participated in the custom portion of the C&I Program in the evaluation sample. Forty of the 48 customers participated in the evaluation. Three quarters of the projects in the initial population and 87 percent in the final sample were lighting. The remainder was split among custom VFD measures, domestic hot water and air curtains. The absence of HVAC is notable; in 2011 about one third

of the custom projects were HVAC measures. Table 78 shows all of the custom projects as well as their distribution across measures.

Table 78. Custom Project Distribution

Measure Description	Evaluated Projects	Total Sample Frame Projects
Air Compressor Replacement	1	1
Air Curtains	1	1
Domestic Hot Water	1	1
Custom Lighting and Controls	35	41
VFD	2	3
Wall Insulation	0	1
Total	**40**	**48**

In general, the paperwork for the custom projects was clear and sufficient information was provided to interpret how the savings were calculated. There were a few projects where the quality of the scanned documentation was poor, but overall it was better than 2011. In addition, for several projects, it was difficult to determine how the tracking savings were determined. None of the custom projects contained functioning calculation spreadsheets. For the majority of projects, the same or similar savings calculation methodology was used to determine verified savings as the tracking savings. The major differences between the tracked savings and the verified savings were that site-specific values were used instead of assumptions from secondary sources.

The lighting projects were similar to the prescriptive lighting projects, and the same basic methodology was used to calculate the savings. The engineers collected the relevant data on the number of fixtures, occupancy schedules, and wattages of the old and new equipment. There were adjustments for the following reasons:

- Operating schedules provided by site staff were used to determine annual operating hours;
- DNV KEMA used manufacturer specifications to determine fixture wattages
- A different number of fixtures was found to be installed or removed
- Employing savings for occupancy sensors based on the size of the facility

Tracked savings for the air compressor measure were verified as reasonable.

For the air curtain measure, no clear documentation was provided for the savings calculation methodology. DNV KEMA calculated the savings from the difference in heat loss rate from the thermal resistance of the baseline condition of plastic sheets compared to the installed air curtains.

The domestic hot water measure savings of one of the custom gas projects were based on the observed hot water temperature and the efficiency of the new and baseline equipment. Because the pre-existing equipment was at the end of its effective useful life, DNV KEMA used standard equipment efficiency as

the baseline. The tracking savings used the old, inefficient equipment as the baseline. Verified savings were less than 30 percent of the tracking savings.

The two custom VFD projects have different VGI savings than tracking savings due to different operating hours and load profiles. At one site, three pumps were found to be installed rather than two, increasing the savings. At the other VFD custom site, two large pumps were replaced with much smaller pumps, resulting in considerable savings. The differences in the savings results were due to different operating hours as described by the site contact, as well different assumptions for pump loading and efficiency.

9.3.3 Installation Rate

KEMA calculated the installation rate for each measure group in the C&I Program. We defined the installation rate as a binary variable which was equal to 100 percent if the respondent indicated that any measure was installed and zero percent if nothing was installed. Adjustments to correct for errors in the tracking quantity or other changes were addressed in the engineering adjustment factor. Table 79 shows the results.

The table shows an overall installation rate of 100 percent for both natural gas and kWh measures.

Table 79. Installation Rate, C&I

	kWh						ccf					
			90% Confidence Interval			%			90% Confidence Interval			%
Measure Group	n	Installation Rate	+/-	Lower Bound	Upper Bound	Program Savings	n	Installation Rate	+/-	Lower Bound	Upper Bound	Program Savings
CFL	6	100%	<0.1%	100%	100%	4%	0	-	-	-	-	0%
Lighting	66	100%	<0.1%	100%	100%	27%	0	-	-	-	-	0%
Boiler Tune-Up	0	-	-	-	-	0%	17	100%	<0.1%	100%	100%	6%
Custom	38	100%	<0.1%	100%	100%	53%	2	100%	<0.1%	100%	100%	35%
Faucet Aerator	0	-	-	-	-	0%	22	99%	1%	98%	100%	8%
Motors	7	100%	<0.1%	100%	100%	11%	0	-	-	-	-	0%
Showerhead	0	-	-	-	-	0%	25	100%	<0.1%	100%	100%	25%
Other	5	100%	<0.1%	100%	100%	5%	4	100%	<0.1%	100%	100%	19%
C&I Overall	**122**	**100%**	**<0.1%**	**100%**	**100%**	**100%**	**70**	**100%**	**<0.1%**	**100%**	**100%**	**100%**

9.3.4 Engineering Adjustment Factor

Table 80 shows the engineering adjustment factors. These factors take into account differences in quantities of equipment installed observed versus in the tracking data, as well as any adjustments DNV KEMA made to the tracking value of savings based on operating characteristics observed on site. The major adjustments were due to differences in operating schedule reported to the evaluator compared to the deemed savings. For example, many measures were adjusted because the operating hours at the facility were different than those assumed in the calculation. Overall, the program achieved an engineering adjustment factor of 99 percent for electricity and 72 percent for natural gas.

Table 80. Engineering Adjustment Factor, C&I

	kWh						ccf					
		Engineering	90% Confidence Interval			%		Engineering	90% Confidence Interval			%
Measure Group	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings
CFL	6	100%	<0.1%	100%	100%	4%	0	-	-	-	-	0%
Lighting	66	123%	30%	93%	152%	27%	0	-	-	-	-	0%
Boiler Tune-Up	0	-	-	-	-	0%	17	100%	<0.1%	100%	100%	6%
Custom	38	101%	8%	93%	110%	53%	2	31%	1%	30%	31%	35%
Faucet Aerator	0	-	-	-	-	0%	20	100%	<0.1%	100%	100%	8%
Motors	7	50%	<0.1%	50%	50%	11%	0	-	-	-	-	0%
Showerhead	0	-	-	-	-	0%	25	100%	<0.1%	100%	100%	25%
Other	5	97%	22%	75%	119%	5%	4	100%	<0.1%	100%	100%	19%
C&I Overall	**122**	**99%**	**15%**	**84%**	**113%**	**100%**	**68**	**72%**	**26%**	**46%**	**98%**	**100%**

9.3.5 Verified Gross Savings

The engineering adjustment factor and installation rate were combined into the gross savings adjustment factor, which is a single adjustment that can be applied to the tracking savings to determine verified gross savings. Table 81 shows the gross savings adjustment factor.[26]

Table 81. Gross Savings Adjustment Factor, C&I

	kWh						ccf					
		Gross Savings	90% Confidence Interval			%		Gross Savings	90% Confidence Interval			%
Measure Group	min n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings	min n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings
CFL	6	100%	<0.1%	100%	100%	4%	0	-	-	-	-	0%
Lighting	66	123%	30%	93%	152%	27%	0	-	-	-	-	0%
Boiler Tune-Up	0	-	-	-	-	0%	17	100%	<0.1%	100%	100%	6%
Custom	38	101%	8%	93%	110%	53%	2	31%	1%	30%	31%	35%
Faucet Aerator	0	-	-	-	-	0%	20	99%	1%	98%	101%	8%
Motors	7	50%	<0.1%	50%	50%	11%	0	-	-	-	-	0%
Showerhead	0	-	-	-	-	0%	25	100%	<0.1%	100%	100%	25%
Other	5	97%	22%	75%	119%	5%	4	100%	<0.1%	100%	100%	19%
C&I Overall	**122**	**99%**	**15%**	**84%**	**113%**	**100%**	**68**	**72%**	**26%**	**46%**	**98%**	**100%**

The gross savings adjustment factor was applied to the total savings reported for the 2012 C&I Program to produce the verified gross savings. Table 82 shows the tracking gross savings (an annual number); the gross saving adjustment factor determined from the evaluation; the verified gross annual savings; and the verified gross lifetime savings.[27] The verified gross annual savings is the tracking gross savings

[26] The gross savings adjustments reported in Table 81 (and throughout this report) are the LCNS gross savings adjustments used to produce the verified gross lifetime savings, which may differ slightly from the Y1NS gross adjustment factors used to produced the annual verified gross savings.

[27] The overall gross savings adjustment factors reported in Table 82 differ from Table 81 because they represent the proportion of verified savings to tracked savings in the final population. The mix of measures in the final population differed from the mix of measures in the sample frame used to develop the gross savings adjustments.

multiplied by the gross savings adjustment factor. The verified gross lifetime savings is the verified gross annual savings with the measure life applied. [28]

Table 82. Verified Gross Savings, C&I

Measure Group	kWh				ccf			
	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
CFL	835,296	100%	835,296	4,176,480				
Lighting	5,124,605	123%	6,308,416	72,649,848				
Boiler Tune-Up					174,466	100%	174,466	174,466
Custom	18,972,872	101%	19,222,142	230,665,706	2,997,107	31%	920,685	11,048,220
Faucet Aerator	28,054		27,864	250,774	51,306	99%	50,958	458,623
Furnace Tune-up					4,771		4,771	9,542
Motors	940,152	50%	468,275	7,024,124				
Showerhead	62,160		62,160	559,440	128,061	100%	128,061	1,152,549
Other	1,335,805	97%	1,275,166	17,210,612	885,902	100%	885,902	9,463,607
Boiler replacement					107,461		107,461	2,149,210
Boiler retrofit					27,293		27,293	491,282
C&I Overall	**27,298,944**	**103%**	**28,199,319**	**332,536,985**	**4,376,367**	**53%**	**2,299,597**	**24,947,500**

9.4 Attribution Results

The EU programs were not required to report net or attributable savings for the 2012 program year. However, discussions within the state of Michigan suggest that net savings may be required in future program years. DNV KEMA conducted a net savings analysis to provide the program with the information they will need for planning and implementation when moving toward net savings reporting.

9.4.1 Attribution Adjustment Factors

DNV KEMA calculated the attribution adjustment factor for each measure group in the C&I Program. The attribution adjustment factor is applied to the verified gross savings to produce net savings. It reflects the influence the program had on the timing, efficiency level, and scope of the energy efficiency measure installed.[29] Table 83 shows the results.

Many customers did not credit the program as the reason they implemented the energy saving measures, stating they would have done the same projects with or without the program. In particular, several customers who completed large custom projects and multiple prescriptive measures stated they would

[28] DNV KEMA's study did not complete any surveys addressing furnace tune-ups, water heaters, pre-rinse sprayers, boiler replacements or retrofits. In addition, no surveys were completed for Faucet Aerator or Showerhead electric savings. To estimate verified gross savings, DNV KEMA applied the gross savings adjustment factor found for the most similar program and measure group that was available. In the case of furnace tune-ups and boiler projects, DNV KEMA applied the ratio for boiler tune-ups. For measure groups where we completed projects with ccf savings, but no kWh savings, the ccf savings ratio was applied.

[29] Appendix G discusses the methodology used in the attribution analysis.

have done the project regardless. Thus the attribution is strongly affected by a relatively small number of customers. Overall, the attribution adjustment factor for electricity was 22 percent and for natural gas was 20 percent. There is more discussion about attribution results in Appendix G and the following section.

Table 83. Attribution Adjustment Factor, C&I

	kWh						ccf					
		Attribution	90% Confidence Interval			%		Attribution	90% Confidence Interval			%
Measure Group	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings	n	Adjustment Factor	+/-	Lower Bound	Upper Bound	Program Savings
CFL	4	*	*	*	*	4%	0	-	-	-	-	0%
Lighting	62	30%	25%	5%	54%	27%	0	-	-	-	-	0%
Boiler Tune-Up	0	-	-	-	-	0%	17	30%	23%	7%	53%	6%
Custom	33	21%	10%	11%	31%	53%	2	*	*	*	*	35%
Faucet Aerator	0	-	-	-	-	0%	15	46%	28%	18%	74%	8%
Motors	7	0%	<0.1%	0%	0%	11%	0	-	-	-	-	0%
Showerhead	0	-	-	-	-	0%	23	53%	19%	34%	72%	25%
Other	5	20%	2%	18%	21%	5%	4	*	*	*	*	19%
C&I Overall	**111**	**22%**	**10%**	**12%**	**31%**	**100%**	**61**	**20%**	**11%**	**9%**	**31%**	**100%**

*To protect respondent confidentiality, attribution factors for measure groups with less than 5 respondents were not reported.

9.4.2 Analysis of Survey Responses

DNV KEMA reviewed the measure level responses to the attribution question sequence used in the C&I survey to identify where the program was having an effect and where improvements could be made. We investigated the program's effect on timing, efficiency, and quantity, the three components of attribution. Appendix G has greater detail on the attribution analysis methodology and the methods used to combine the three components into a single attribution value.

Table 84. Attribution Question Sequence

Number	Question
Timing	
DAT1	Without EU, how likely is it that you would have installed the same type of equipment at this time?
DAT1a	Without EU, how different would the timing have been?
DAT1b	Approximately how many months later?
Efficiency	
DAT2	Without EU, how likely is it that you would have installed the same level of efficiency?
DAT2a	Without EU, how likely is it that you would have installed the same, greater, or lesser efficiency?
DAT2b	Without EU, what efficiency would you have installed?
Quantity	
DAT3	Without EU, how different would the quantity/size have been?
DAT3a	By what percentage did you change the quantity/size because of EU?

9.4.2.1 Likelihood of Installation

Respondents are asked a sequence of questions that address the likelihood of the equipment installation. Respondents are asked how likely it is that they would have installed equipment without the program

(DAT0). Respondents are asked the same question for each measure they installed; thus the total number of responses is larger than the number of customers interviewed.

- A response of "Yes" means that the customer would have installed the measure(s) regardless of program involvement.
- A response of "Probably Yes" means that the customer would probably have installed the measure(s) regardless of program involvement.
- A response of "Probably Not" means that the customer would probably not have installed the measure(s) regardless of program involvement.
- A response of "No" means that the customer would not have installed the measure(s) regardless of program involvement.

Table 85. Likelihood of Installation

DAT0. Without EU, what would you say the likelihood of installing was?			
Response	Responses	Percent kWh	Percent ccf
Yes	65	30%	39%
Probably yes	32	42%	6%
Probably not	38	8%	13%
No	33	17%	42%
Not Applicable	0	0%	0%
Don't Know/Refused	4	3%	0%

Respondents with sixty-five measures representing 30 percent of kWh and 39 percent of ccf savings mentioned that they would have installed the measures without the program. Respondents with 33 measures representing 17 percent of kWh and 42 percent of ccf savings would not have installed the measures without the presence of the program.

9.4.2.2 Timing

Respondents are asked a sequence of questions that address the timing of the equipment installation. First, respondents are asked how likely it is that they would have installed the same type of equipment at the same time without the program (DAT1a). Then respondents are asked how different the timing would have been (DAT1b). Respondents are asked the same question for each measure they installed; thus the total number of responses is larger than the number of customers interviewed.

- A response of "Same Time" means that the customer would have installed the measure(s) at the same time regardless of program involvement.

- A response of "Later" indicates that they would have waited to install the measure(s) if the program had not been present. This measure is called "accelerated." Respondents who answered "Later" are asked a follow-up question (DAT1b) about how much later they would have installed the equipment without the program.

Table 86 shows the responses to the DAT1a and DAT1b questions for C&I. The table shows the unweighted number of measure level responses in each category and the associated percentage of overall program energy savings represented by those responses. The number of responses does not reflect any survey weight or relative savings but the percentage of energy savings does.

The table outlines the skip pattern and attribution assignment for DAT1a and DAT1b. If a respondent indicates that they would have installed the equipment at the same time or earlier, the acceleration period is zero months and there is no timing effect. If the respondent indicates that they never would have installed the equipment without the program, then the program is credited with influencing the entire project and receives 100 percent attribution. The same effect is applied if the respondent indicates it would have been greater than four years before they would have installed the equipment without the program. If the response to DAT1a is Later and the response to DAT1b is a number less than 48, then the acceleration period is equal to that number of months.

Table 86. Determining Acceleration Period, C&I

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	105	45%	70%	0
Earlier	N/A	6	1%	0%	0
Later	Months < 48	42	41%	22%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	6	5%	4%	Average of DAT1b
Never	N/A	11	8%	3%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	2	0%	2%	Average of DAT1a

The table shows that the majority of equipment would have been installed by the respondents at the same time, with 105 responses representing 45 percent of kWh and 70 percent of gas savings (ccf). On the electric side, respondents representing 48 percent of kWh savings and 26 percent of gas savings (ccf) indicated that they would have installed their equipment later without the program. Eleven responses representing 8 percent of kWh savings and 3 percent of ccf savings indicated that the equipment would never have been installed without the program, which receives 100 percent attribution.

Table 87 through Table 91 show the DAT1a and DAT1b responses by measure category for measures with more than five responses. The Faucet Aerator measure groups were the most likely to be accelerated.

The Custom measure group had 14 out of 35 projects that would have been installed later or never, representing 57 percent of the group kWh savings and 3 percent of the gas savings (ccf). Nineteen respondents representing 41 percent of kWh and 97 percent of ccf savings would have installed custom measures at the same time without the presence of the program.

Table 87. Determining Acceleration Period, Boiler Tune-Up

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	13	0%	62%	0
Earlier	N/A	0	0%	0%	0
Later	Months < 48	3	0%	36%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	0	0%	0%	Average of DAT1b
Never	N/A	1	0%	2%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT1a

Table 88. Determining Acceleration Period, Custom

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	19	41%	97%	0
Earlier	N/A	2	2%	0%	0
Later	Months < 48	10	34%	0%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	2	14%	3%	Average of DAT1b
Never	N/A	2	9%	0%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT1a

Table 89. Determining Acceleration Period, Faucet Aerator

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	4	0%	6%	0
Earlier	N/A	0	0%	0%	0
Later	Months < 48	7	0%	52%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	2	0%	26%	Average of DAT1b
Never	N/A	2	0%	16%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT1a

Table 90. Determining Acceleration Period, Lighting

DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	48	64%	0%	0
Earlier	N/A	4	1%	0%	0
Later	Months < 48	7	20%	0%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	0	0%	0%	Average of DAT1b
Never	N/A	3	15%	0%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT1a

Table 91, Determining Acceleration Period, Showerhead

DAT1a. Without EU how different would the timing have been?					
DAT1b. Approximately how many months later?					
DAT1a Response	DAT1b Response	Responses	Percent kWh	Percent ccf	Timing Attribution
Same Time	N/A	8	0%	36%	0
Earlier	N/A	0	0%	0%	0
Later	Months < 48	8	0%	29%	Months / 48
	Months >= 48	0	0%	0%	100%
	Don't Know/Refused	2	0%	11%	Average of DAT1b
Never	N/A	3	0%	12%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	2	0%	12%	Average of DAT1a

9.4.2.3 Efficiency

Respondents are asked a sequence of questions that address the efficiency of the equipment installation. First, respondents are asked how likely it is that they would have installed the same, lesser, or greater efficiency without the program (DAT2a). Then respondents are asked how different the efficiency would have been (DAT2b).

- A response of "Same" means that the customer would have installed the same level of efficiency regardless of program involvement.
- A response of "Lower" indicates that they would have installed a less efficient piece of equipment if the program had not been there. Respondents who answered "Lower" are asked a follow-up question (DAT2b) about what equipment efficiency they would have installed without the program.

Table 92 shows the responses to the DAT2a question for each measure category. The table includes a response of Not Applicable, which represents measures that do not have variable efficiency themselves, but are added to the existing equipment or systems to make the overall operation more efficient. Examples are variable frequency drives, lighting controls, and programmable thermostat controls.

The table outlines the skip pattern and attribution assignment for DAT2a and DAT2b. If a respondent indicates that they would have installed the equipment of the same or higher efficiency, the efficiency attribution is zero. If the respondent indicates that they would have installed a lower efficiency then the efficiency attribution is some number between 30 and 100 percent, depending on the answer to DAT2b.

Table 92. Determining Efficiency Attribution, C&I

DAT2a. Without EU, would you have installed the same, higher, or lower efficiency?					
DAT2b. Without EU, what efficiency would you have installed?					
DAT2a Response	DAT2b Response	Responses	Percent kWh	Percent ccf	Efficiency Attribution
Same	N/A/Skipped	102	62%	65%	0%
Lower	Standard Efficiency	8	0%	4%	100%
	Slightly > Standard	1	0%	0%	70%
	Between Standard and High	2	0%	3%	50%
	Slightly < High	1	1%	0%	30%
	Don't Know/Refused	3	2%	1%	Average of DAT2b
	N/A	0	0%	0%	100%
Higher	N/A/Skipped	5	0%	2%	0%
Not Applicable	N/A	33	34%	18%	Not Asked
Don't Know/Refused	N/A	17	1%	7%	Average of DAT2a

The table shows that the majority of respondents stated they would have installed the same efficiency level without the program, with respondents representing 102 measures, 62 percent of program kWh

savings and 65 percent of program gas savings (ccf). Thirty-two responses representing 4 percent of program kWh savings and 15 percent of program gas savings (ccf) will receive some form of efficiency attribution by answering "Lower" or "Don't know/Refused" to DAT2a. Eight responses representing 4 percent of ccf savings will receive 100 percent efficiency attribution.

9.4.2.4 Quantity

Respondents are asked a sequence of questions that address the quantity of the equipment installed. First, respondents are asked how likely it is that they would have installed the same quantity of equipment without the program (DAT3). Then respondents are asked how much they changed the quantity (DAT3a).

- A response of "Same amount" means that the customer would have installed the same size or quantity regardless of program involvement.
- A response of "Less" indicates that the customer would have installed fewer units if the program had not been there. Respondents who answered "Less" are asked a follow-up question (DAT3a) about the quantity of equipment they would have installed without the program.
- A response of "More" indicates that the customer would have installed more units if the program had not been there. In these cases, the evaluation team assumes that the respondent would have installed a less efficient system without the EU assistance because it would have been oversized. Respondents who answered "More" are asked the same follow-up question (DAT3a) about the quantity of equipment they would have installed without the program.

Table 93 shows overall responses to the DAT3 question. The table outlines the skip pattern and attribution assignment for DAT3 and DAT3a. If a respondent indicates that they would have installed the same quantity or size, the quantity attribution is zero. If the respondent indicates that they would have installed more or less quantity/size, then the quantity attribution is some value between 0 and 100 percent. If the respondent indicates that they would not have installed any equipment without the program then the quantity attribution is 100 percent.

Table 93. Determining Quantity Attribution, C&I

DAT3. Without EU, how different would the quantity/size have been?					
DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	134	81%	89%	0%
Less	Value < 100%	11	0%	4%	Value < 50%
	Value >= 100%	2	5%	0%	Value > 50%
	Don't Know/Refused	6	0%	3%	Average of DAT3a
More	Value < 100%	2	0%	0%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
None	N/A	13	13%	3%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	3	0%	0%	Average of DAT3

The table shows that customers gave 134 responses representing 81 percent of kWh savings and 89 percent of gas savings (ccf) indicating that they would have installed equipment of the same size or quantity without the program. Nineteen responses representing 5 percent of kWh savings and 7 percent of ccf savings indicated that they would have installed the measure without the program. Thirteen responses representing 13 percent of kWh savings and 3 percent of gas savings (ccf) indicated that they would not have installed any equipment, resulting in 100 percent quantity attribution.

Table 94 through Table 98 show the DAT3 and DAT3a responses by measure category for measures with more than five respondents. Four of the five measure groups shown had at least one respondent that said they would not have installed any project without the program. Faucet aerator responses indicated the strongest program attribution, with 20 percent of the savings receiving 100 percent attribution, and 35 percent of savings with some attribution. Custom measures had some attribution for 26 percent of kWh savings and none for ccf savings. Boiler Tune-up measures had 6 percent savings with some attribution.

Table 94. Determining Quantity Attribution, Boiler Tune-Up

DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3. Without EU, how different would the quantity/size have been?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	15	0%	94%	0%
Less	Value < 100%	2	0%	6%	Value < 50%
	Value >= 100%	0	0%	0%	Value > 50%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
More	Value < 100%	0	0%	0%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
None	N/A	0	0%	0%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT3

Table 95. Determining Quantity Attribution, Custom

DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3. Without EU, how different would the quantity/size have been?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	29	74%	100%	0%
Less	Value < 100%	1	0%	0%	Value < 50%
	Value >= 100%	2	16%	0%	Value > 50%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
More	Value < 100%	0	0%	0%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
None	N/A	2	10%	0%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT3

Table 96. Determining Quantity Attribution, Faucet Aerator

DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3. Without EU, how different would the quantity/size have been?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	6	0%	45%	0%
Less	Value < 100%	1	0%	15%	Value < 50%
	Value >= 100%	0	0%	0%	Value > 50%
	Don't Know/Refused	2	0%	16%	Average of DAT3a
More	Value < 100%	2	0%	4%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
None	N/A	4	0%	20%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT3

Table 97. Determining Quantity Attribution, Lighting

DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3. Without EU, how different would the quantity/size have been?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	52	68%	0%	0%
Less	Value < 100%	5	1%	0%	Value < 50%
	Value >= 100%	0	0%	0%	Value > 50%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
More	Value < 100%	0	0%	0%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
None	N/A	4	31%	0%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	1	0%	0%	Average of DAT3

Table 98. Determining Quantity Attribution, Showerhead

DAT3a. By what percentage did you change the amount installed because of EU?					
DAT3. Without EU, how different would the quantity/size have been?					
DAT3 Response	DAT3a Response	Responses	Percent kWh	Percent ccf	Quantity Attribution
Same Amount	N/A	14	0%	58%	0%
Less	Value < 100%	2	0%	11%	Value < 50%
	Value >= 100%	0	0%	0%	Value > 50%
	Don't Know/Refused	4	0%	18%	Average of DAT3a
More	Value < 100%	0	0%	0%	Value < 100%
	Value >= 100%	0	0%	0%	Value = 100%
	Don't Know/Refused	0	0%	0%	Average of DAT3a
None	N/A	3	0%	12%	100%
Not Applicable	N/A	0	0%	0%	Not Asked
Don't Know/Refused	N/A	0	0%	0%	Average of DAT3

9.4.2.5 Overall Attribution

DNV KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 99 shows the three effects together with "Yes" indicating some (not necessarily full) attribution while "No" indicates responses that did not receive any attribution.

The table shows that only fourteen responses representing zero percent of kWh savings and 4 percent of gas savings (ccf) received all three types of attribution. One-hundred-sixty-nine responses representing 43 percent of kWh savings and 46 percent of gas savings (ccf) did not receive any timing, efficiency, or quantity attribution.

Table 99. Simplistic Representation of Overall Attribution, C&I

Attribution			Responses	Percent kWh	Percent ccf
Timing	Efficiency	Quantity			
Yes	Yes	Yes	14	0%	4%
Yes	No	Yes	12	9%	0%
Yes	No	No	63	36%	21%
Yes	Yes	No	8	0%	1%
No	Yes	Yes	18	3%	4%
No	Yes	No	14	0%	5%
No	No	Yes	33	9%	19%
No	No	No	169	43%	46%

9.5 Comparison of 2011 and 2012 Program Results

DNV KEMA compared the results of the 2011 program evaluation to the results of the 2012 program evaluation.

9.5.1 Overall Comparison

Table 100 shows the tracking savings, number of measures, and total incentives paid for each program period. The final column shows the difference between the two, with a negative value representing a decrease from 2011 and a positive value representing an increase.

Overall, the table shows a significant increase in the incentives paid (84%) and the number of measures (56%). Electric savings increased 24 percent, and gas savings increased 165 percent.

The increase in the number of measures is related to two factors:

- Participation in the direct install
- Increase in custom measures

Average savings per measure is less in 2012 compared to 2011. This is because of inclusion of 416 direct install measures that represent about 30 percent of total measures. Direct install measures typically have less savings per measure.

Table 100: Comparison of 2011 and 2012 C&I Program Results

Metric	Program Period Jan to Dec 2011	Program Period Jan to Dec 2012	2011 to 2012 Change
Tracking kWh Savings	22,029,835	27,298,944	24%
Tracking ccf Savings	1,651,308	4,376,367	165%
Total # Measures	869	1,355	56%
Total Incentive	$1,420,908	$2,617,637	84%

9.5.2 Adjustment Factors

Table 101 shows the 2011 and 2012 installation rate, gross savings adjustment factor, and attribution adjustment factor. Highlighted cells show a statistically significant difference from the 2011 to 2012 program periods at the 90 percent confidence interval.

From 2011 to 2012, the program saw a consistent installation rate, with a statistically significant, but not meaningful difference for kWh. Between the two program periods, the gross savings adjustment decreased for both electric and gas savings but the difference was not statistically significant. The differences were due primarily to operating conditions on site which were different from deemed savings or custom calculations.

Attribution adjustment for electricity savings reflects the fairly weaker attribution for kWh savings in 2012 compared to 2011. This is because the attribution was lower for CFL, Lighting, Motors, and Others in 2012 compared to the attribution these measures received in 2011. Attribution for gas measures increased in 2012 but was not statistically significant. Attribution was particularly high for Boiler Tune-ups in 2012 compared to 2011.

Table 101: Comparison of 2011 and 2012 C&I Adjustment Factors

Adjustment Factor	kWh		ccf	
	2011	2012	2011	2012
Installation Rate	100%	100%	100%	100%
Gross Savings Adjustment Factor	121%	99%	92%	72%
Attribution Adjustment Factor	67%	22%	10%	20%

10. Multifamily Program Impact Evaluation

This section reports on the methodology and overall results of DNV KEMA's evaluation of the Market Rate Multifamily (MF) Program.

- Section 10.1 provides a description of the program.
- Section 10.2 gives an overview of the evaluation approach.
- Section 10.3 looks at survey results and determines verified gross savings.

10.1 Program Description

The Multifamily Program began implementation in August 2010. The program provides energy-saving products free of charge to multifamily building managers. The program also offers incentives for installations paid either to contractors or directly to maintenance staff, though all payments in 2012 were made to contractors. The MF program offered incentives for both gas and electric savings to customers in the EU utility service territories. The program estimates energy savings based on calculations outlined in the Michigan Statewide Energy Measures Library/Database (MEMD).

Under the MF program, participants receive the following products:

- Compact Fluorescent Lamps (CFLs)
- Bathroom Faucet Aerators
- Kitchen Faucet Aerators
- Low Flow Showerheads
- Handheld Low Flow Showerheads
- Pipe Wrap
- Programmable Thermostats
- Furnace Tune-ups

Table 102 shows the accomplishments for the MF Program based on the program tracking data. The table shows the tracking savings, number of projects rebated, and incentives paid for the entire 2011 and 2012 program years.

Table 102. Overview of MF Program Accomplishments per Program Tracking

Metric	Evaluation Period Jan to Aug 2012	Program Period Jan to Dec 2012
Projects	12	44
Measures Installed	2,641	10,611
kWh	145,279	320,413
ccf	17,588	106,061
Incentives	$90,737	$89,459

10.2 General Approach

The evaluation work plan set one objective for the 2012 MF Program impact evaluation: determine program lifetime verified gross savings. To meet this objective, DNV KEMA attempted to complete the following tasks:

- Verify proper tracking assignments (Appendix D)
- Verify proper documentation with a sample of participating applications
- Survey 10 participating property owners/managers to verify installation and collect equipment operating characteristics
- Conduct verified gross savings analysis

DNV KEMA did not attempt to determine attribution for this program.

10.3 Survey Results and Verified Gross Savings

DNV KEMA verified the installation of measures tracked during the 2012 program year through a survey completed with building owners and managers. The work plan specified 10 interviews, but the program had completed projects with only 11 customers at the time the sample was pulled. After attempting to call each participant six times, we were able to complete five interviews, representing seven projects. DNV KEMA asked the owners and managers to verify the quantity of measures installed and confirm that they were still installed. At the time of the interview, the program had not completed any furnace tune-ups. Therefore none of these made it into the evaluation.

Survey respondents had difficulty recalling the exact quantities of equipment installed. Some respondents reported quantities that differed from the tracking data. Where differing quantities were reported, respondents did not express great confidence in their estimates or have paperwork to back them up.

When asked whether the equipment was still installed, respondents almost universally stated something to the effect of, “as far as I know.” In 2011, respondents said that contractors had left extra CFLs and faucet aerators behind (not installed), and that some products had been removed after installation due to failure.

This year, according to the respondents, all products were installed and remained installed at the time of the interview.

Table 103 shows the program measures and quantity installed, removed, and put in storage per the survey responses.

Table 103. Installation Rate, Multifamily

Measure	Products Installed	Failed	Verified	Extras	Installation Rate	Standard Error
CFL	586	0	586	0	100%	0.00%
Faucet Aerator	482	0	482	0	100%	0.00%
Showerhead	183	0	183	0	100%	0.00%
Thermostat	129	0	129	0	100%	0.00%
Pipe Wrap	140	0	140	0	100%	0.00%
Multifamily Overall	**1,380**	**0**	**1,380**	**0**	**100.0%**	0.00%

In developing the installation rate, DNV KEMA gave the program the benefit of the doubt where possible. Measures were assumed to be verified unless the site contact definitively stated that they had failed or been removed. Therefore, these installation rate results likely overstate the persistence of measures such as CFLs, because it is possible that measures that are easy to remove are taken from the apartment when tenants change addresses. Other measures that are more permanently installed, like pipe wrap, are likely accurate.

DNV KEMA also conducted a documentation review of 11 applications from the Multifamily Program. We found that the program effectively and accurately entered the application into the tracking database, resulting in a documentation review adjustment factor of 100 percent. Therefore, the gross savings adjustment factor is equal to the installation rate reported in Table 103.

The gross savings adjustment factor was applied to the total savings reported for the Multifamily Program in 2012 to produce the verified gross savings for the program. Table 104 shows the tracking gross savings (an annual number), the gross savings adjustment factor determined from the evaluation, the verified gross annual savings, and the verified gross lifetime savings. The verified gross annual savings is the tracking gross savings multiplied by the gross savings adjustment factor. The verified gross lifetime savings is the verified gross annual savings with the measure life applied. For Furnace Tune-ups, the value was borrowed from the HVAC Program because the Multifamily Program did not perform any of these during the sample period.

Table 104. Verified Gross Savings, Multifamily

Measure Group	kWh				ccf			
	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
CFL	148,785	100%	148,785	1,339,065				
Faucet Aerator	58,432	100%	58,432	584,320	26,036	100%	26,036	260,355
Furnace Tune-up					6,295	100%	6,295	31,476
Pipe Wrap	35,496	100%	35,496	461,448	7,254	100%	7,254	79,794
Thermostat					23,681	100%	23,681	260,489
Showerhead	77,700	100%	77,700	777,000	42,795	100%	42,795	427,950
Multifamily Overall	**320,413**	**100%**	**320,413**	**3,161,833**	**106,061**	**100%**	**106,061**	**1,060,064**

11. Conclusions and Recommendations

This section addresses the portfolio and program-level conclusions and recommendations drawn from DNV KEMA's evaluation of the Efficiency United programs.

11.1 Conclusions

This section summarizes DNV KEMA's findings across the programs that made up this evaluation.

11.1.1 Documentation Verification

DNV KEMA verified the accuracy and consistency of the program records by checking a sample of completed program application forms for the ENERGY STAR, HVAC and Onsite Weatherization portions of the Home Performance Program, C&I, and Multifamily Programs. We did not review applications for the Appliance Recycling or Online Audit portion of the Home Performance program because they do not use paper applications, and we did not repeat our 2010 review of the Low Income documentation. The program provided DNV KEMA application forms for a sample of projects tracked in the program's Pulse database on December 7, 2012. DNV KEMA was also able to download a sample of application forms for projects tracked in the program's Quickbase database directly from the program's document repository on December 10, 2012.

DNV KEMA's review resulted in the following adjustments, which were included in the gross savings adjustment factors:

- ENERGY STAR: DNV KEMA found washing machines with an incorrect dryer type assumption and small discrepancies in one faucet aerator, one CFL and one showerhead.
- HVAC: DNV KEMA found one ground source heat pump categorized as a central air conditioner, one A/C unit with the wrong SEER and measures on applications that were not entered in the database.
- Onsite Weatherization: DNV KEMA found several large homes with conditioned basements did not received savings for the basement.
- Multifamily: DNV KEMA did not find any errors.

11.1.2 Tracking Verification

DNV KEMA reviewed the CLEAResult tracking database to verify that the deemed savings values from the MEMD were being applied correctly. We conducted our review for all of the programs in this round of evaluation.

The review of the tracking database was complicated by the mid-year migration from the Quickbase database into the Pulse database. DNV KEMA found a decrease in the database savings assignment functionality from the Quickbase to Pulse databases. Some of the issues we found were:

- The Pulse database uses a single measure description for measures with multiple savings estimates, with other variables used to determine which savings should be assigned. For example, the clothes washer measure has different savings depending on the efficiency tier, hot water fuel, and dryer fuel in the home.
  - In Quickbase, there was one measure description for each unique combination (and savings estimate).
  - In Pulse, there were additional variables that needed to be referenced to determine which savings should be assigned. The additional variables were not always fully populated, which restricted our ability to verify the energy savings.
  - The Pulse database does not have a field that identifies hot water fuel, though CLEAResult has a history of assigning savings to the incorrect hot water fuel.
- The quantity variable did not always reflect consistent units, even within a given measure. For example, a quantity of "1" for pipe wrap in the Onsite Weatherization Program sometimes referred to 6 linear feet of pipe wrap and sometimes referred to 3 linear feet of pipe wrap. The database did not indicate when the different units should be used.
- CLEAResult did not communicate equipment caps to DNV KEMA and the database does not identify when caps are in place. For example, if energy savings are capped at 2 faucet aerators per customer, the database may show a quantity of 4 but energy savings for only 2. This results in per-unit savings that do not match the MEMD.

11.1.3 Installation Rates

Overall installation rates across the HVAC, C&I and Low Income, Onsite Weatherization, and Multifamily Programs ranged from 91 percent to 100 percent. Together these five programs represent 68 percent of the portfolio kWh savings and 97 percent of ccf savings in the 2012 programs.

The only statistically significant program level change in installation rate from the 2011 program year to the 2012 program year was an increase in Online Audit kWh.

Across programs, the installation rate for less expensive kit measures (faucet aerators, pipe wrap, and showerheads) remained low, while attribution for these same measures was generally higher than when the technology was purchased outside of a kit. The higher attribution indicates that kits are an effective way of getting people to try these technologies when they otherwise would not, but only when the technologies are actually installed. Many participants simply never install these technologies, while a portion of participants install and then remove them due to a lack of satisfaction with their performance.

11.1.4 Verified Gross Savings Evaluated 2012 Portfolio

Table 105 shows the verified gross energy savings for every evaluated program in the Efficiency United portfolio.

For programs other than C&I, the gross savings adjustment accounts for the installation rate and the documentation review, the latter of which had little effect on the overall adjustment factors. The gross savings adjustments for C&I include the installation rate, documentation review and in depth engineering reviews DNV KEMA conducted using project documentation and on-site verification surveys.

Overall DNV KEMA verified 89 percent of the kWh and 67 percent of the ccf claimed by the program. The C&I Program drove these rates: 55 percent of tracked kWh savings and 64 percent of tracked ccf savings came from the C&I Program in 2012.

Table 105. Verified Gross Energy Savings, Evaluated Portfolio

	kWh				ccf			
Program	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings	Tracking Gross Savings	Gross Savings Adjustment Factor	Verified Gross Annual Savings	Verified Gross Lifetime Savings
ENERGY STAR	9,121,534	63%	5,723,797	54,519,410	158,414	60%	94,961	969,660
Appliance Recycling	1,888,634	68%	1,285,014	5,241,667				
HVAC	256,986	104%	268,029	3,037,268	599,794	100%	598,799	9,142,270
Low Income	1,806,171	96%	1,729,528	17,629,707	471,924	98%	462,824	4,802,547
Online Audit	4,751,030	63%	2,983,338	28,959,258	62,915	57%	35,606	366,700
Onsite Weatherization	4,466,831	91%	4,056,896	39,834,727	1,042,257	93%	972,653	10,595,330
C&I	27,298,944	103%	28,199,319	332,536,985	4,376,367	53%	2,299,597	24,947,500
Multifamily	320,413	100%	320,413	3,161,833	106,061	100%	106,061	1,060,064
Overall	**49,910,542**	**89%**	**44,566,333**	**484,920,853**	**6,817,731**	**67%**	**4,570,499**	**51,884,071**

11.1.5 Verified Gross Savings Full 2012 Portfolio

Efficiency United participated in 12 energy optimization programs implemented by CLEAResult Consulting, Inc. in 2012. Table 106 shows the annual and lifetime verified gross savings achieved for the programs that were certified as part of this evaluation. The table shows the kWh and ccf savings achieved

annually for each program and the lifetime savings that will be achieved over the measure lives of the equipment installed.[30]

Table 106. Efficiency United Verified Gross Savings by Program[31]

Program	Verified Gross kWh		Verified Gross ccf	
	Annual	Lifetime	Annual	Lifetime
ENERGY STAR	5,723,797	54,519,410	94,961	969,660
Appliance Recycling	1,285,014	5,241,667		
Residential HVAC	268,029	3,037,268	598,799	9,142,270
Low Income	1,729,528	17,629,707	462,824	4,802,547
Online Audit	2,983,338	28,959,258	35,606	366,700
Onsite Weatherization	4,056,896	39,834,727	972,653	10,595,330
Commercial and Industrial	28,199,319	332,536,985	2,299,597	24,947,500
Market Rate Multi Family	320,413	3,161,833	106,061	1,060,064
Residential Pilot	985,421	985,421	140,786	140,786
Residential Education	610,423	610,423	86,940	86,940
Commercial and Industrial Pilot	1,461,431	1,461,431	177,138	177,138
Commercial and Industrial Education	522,511	522,511	60,528	60,528
EU Overall	**48,146,120**	**488,500,640**	**5,035,891**	**52,349,463**

Table 107 shows the verified gross savings for Residential programs for each utility participating in the Efficiency United programs. Table 108 shows the verified gross savings for Commercial and Industrial (C&I) programs by utility.

[30] The verified savings presented in this section do not include any carryover savings from the 2011 program year that the program may be claiming in 2012.

[31] The measure life used for the Pilot and Residential Programs is one year. The measure life is necessary to determine lifetime program savings.

Table 107. Efficiency United Verified Gross Savings, Residential

Utility	Verified Gross kWh		Verified Gross ccf	
	Annual	Lifetime	Annual	Lifetime
Alpena Power Company	727,718	5,789,997		
Baraga Electric Utility	52,046	412,952		
Bayfield Electric Cooperative	1,335	13,095		
The City of Crystal Falls	90,283	736,063		
Daggett Electric Company	12,251	121,494		
The City ofGladstone Department of Power and Light	159,909	1,430,424		
Hillsdale Board of Public Utilities	472,108	3,686,922		
Indiana Michigan Power Company	11,532,305	89,107,204		
L'Anse Electric Utility	76,739	641,199		
The City of Negaunee Electric Department	160,467	1,297,217		
The City of Norway Department of Power and Light	151,314	1,228,093		
The City of South Haven	434,389	3,292,273		
Upper Peninsula Power Company	3,581,680	29,311,121		
We Energies	1,245,380	9,677,034		
Wisconsin Public Service Corporation	623,999	4,035,604	50,204	513,943
XCEL Energy	624,879	5,182,963	30,670	300,580
Michigan Gas Utilities Corporation			1,231,592	12,215,746
SEMCO Energy Gas Company			1,423,828	14,371,695
EU Residential Overall	**19,946,801**	**155,963,655**	**2,736,294**	**27,401,963**

Table 108. Efficiency United Verified Gross Savings, C&I

Utility	Verified Gross kWh		Verified Gross ccf	
	Annual	Lifetime	Annual	Lifetime
Alpena Power Company	1,075,624	13,829,992		
Baraga Electric Utility	163,727	2,041,483		
Bayfield Electric Cooperative				
The City of Crystal Falls	61,864	742,370		
Daggett Electric Company				
The City ofGladstone Department of Power and Light	205,570	2,410,357		
Hillsdale Board of Public Utilities	923,608	11,044,484		
Indiana Michigan Power Company	16,378,499	189,972,913		
L'Anse Electric Utility	99,489	1,269,381		
The City of Negaunee Electric Department	54,255	671,260		
The City of Norway Department of Power and Light	183,860	2,640,928		
The City of South Haven	1,028,581	11,895,627		
Upper Peninsula Power Company	4,148,741	51,060,964		
We Energies	1,110,747	11,536,154		
Wisconsin Public Service Corporation	1,872,844	22,697,013	85,025	995,820
XCEL Energy	891,909	10,724,059	14,345	117,929
Michigan Gas Utilities Corporation			830,939	9,055,499
SEMCO Energy Gas Company			1,369,288	14,778,252
EU Commercial and Industrial Overall	**28,199,319**	**332,536,985**	**2,299,597**	**24,947,500**

Table 109 shows the overall verified gross savings by utility for the 2012 Efficiency United programs studied in this evaluation.

Table 109. Efficiency United Verified Gross Savings by Utility

Utility	Verified Gross kWh		Verified Gross ccf	
	Annual	Lifetime	Annual	Lifetime
Alpena Power Company	1,803,342	19,619,989		
Baraga Electric Utility	215,773	2,454,434		
Bayfield Electric Cooperative	1,335	13,095		
The City of Crystal Falls	152,147	1,478,433		
Daggett Electric Company	12,251	121,494		
The City ofGladstone Department of Power and Light	365,479	3,840,782		
Hillsdale Board of Public Utilities	1,395,716	14,731,406		
Indiana Michigan Power Company	27,910,804	279,080,116		
L'Anse Electric Utility	176,228	1,910,581		
The City of Negaunee Electric Department	214,722	1,968,477		
The City of Norway Department of Power and Light	335,175	3,869,021		
The City of South Haven	1,462,970	15,187,900		
Upper Peninsula Power Company	7,730,420	80,372,085		
We Energies	2,356,127	21,213,188		
Wisconsin Public Service Corporation	2,496,843	26,732,617	135,229	1,509,762
XCEL Energy	1,516,787	15,907,022	45,015	418,509
Michigan Gas Utilities Corporation			2,062,531	21,271,245
SEMCO Energy Gas Company			2,793,116	29,149,947
EU Overall	**48,146,120**	**488,500,640**	**5,035,891**	**52,349,463**

Overall, Efficiency United realized 488,500,640 lifetime kWh savings and 52,349,463 lifetime ccf savings resulting from programs implemented in 2012. In terms of annual savings, the program realized 48,146,120 kWh/yr and 5,035,891 ccf/yr savings from programs implemented in 2012.

11.1.6 Attribution Adjustment Factor

Table 110 shows the attribution adjustment factor calculated in this round of evaluation for every evaluated program in the Efficiency United portfolio.

The attribution adjustment factors are relatively low based on DNV KEMA's experience with other programs of this type. We have a few theories that possibly explain the low values:

- Energy efficiency programs often have lower attribution in early program years. This may be because people who are already interested in implementing energy efficiency measures are more motivated to research and seek out rebates for the measures they install. As the program matures, these early adopters may no longer be as much of a factor and marketing and education efforts will make greater inroads in the general public.

- The program incentives may be too low to influence customers who are undecided about energy efficiency measures and influence them to install. If this is the case, the program would only be reaching customers that were already committed to energy efficiency.

- The evaluation data may not be representative of the entire program period. To meet the utility filing deadlines, DNV KEMA evaluated projects installed through August of 2012. All programs saw a large amount of savings come in after the evaluation period. Changes in the program that led to the large amount of end-of-year savings may have had a different free ridership rate than previous months.

The only statistically significant program level changes in attribution from the 2011 program year to the 2012 program year were improvements for the HVAC program kWh and large declines in C&I and Onsite Weatherization Program kWh. C&I Programs often see large swings in adjustment factors from year-to-year because one large project or customer can influence the results for the entire program.

Table 110. Attribution Adjustment Factors, Portfolio

Program	KWh				ccf			
	Attribution Adjustment Factor	90% Confidence Interval			Attribution Adjustment Factor	90% Confidence Interval		
		+/-	Lower Bound	Upper bound		+/-	Lower Bound	Upper bound
ENERGY STAR	37%	10%	27%	47%	55%	14%	41%	69%
Appliance Recycling	47%	2%	45%	49%	-	-	-	-
HVAC	26%	7%	18%	33%	10%	3%	8%	13%
Low Income	N/A							
Online Audit	48%	6%	43%	54%	42%	6%	36%	48%
Onsite Weatherization	59%	8%	50%	67%	65%	7%	58%	72%
C&I	22%	10%	12%	31%	20%	11%	9%	31%
Multifamily	N/A							

11.2 Recommendations

This section summarizes DNV KEMA's recommendations across the programs that made up this evaluation.

- **Documentation:** Consider designing and implementing a quality control program to ensure that the information entered in the tracking data is correct.

- **Installation Rate:** Consider the following changes to increase installation rate:

  - Limit the maximum number of qualifying CFLs to increase the likelihood that they will be installed instead of placed into storage.

- Implement changes to increase the installation rate of programmable thermostats. Provide increased education and improved instruction. Several thermostats were removed due to issues learning how to operate it.

- Work to ensure only quality products are rebated or provided through the programs. Many of the small measures (faucet aerators, showerheads and thermostats) that the evaluation learned were not installed were removed due to quality issues.

- **Attribution:** Consider the following changes that may increase attribution:

  - Increase marketing to reach customers that are not already interested in installing energy efficiency equipment.

  - Increase trade ally involvement to help sell energy efficient equipment to potential participants.

  - Consider increasing incentives for or eliminating some measures that show poor attribution.

- **Database:**

  - **Improve nonresidential tracking:** The current database does not track needed information for nonresidential participants (C&I projects are still tracked in the older Quickbase database). Contact names for someone at the business should be recorded, in a dedicated field. A field should also be used to identify a customer as either residential or nonresidential (for programs that serve both). The database should also include unique Company IDs that can be used to identify a single company with multiple locations.

  - **Track trade ally activity:** Trade allies are important players in the implementation of energy efficiency programs and should be tracked not only to facilitate program outreach efforts but also to track program activity and measure contractor diversity. The business name, address, phone number and project contact name should be tracked along with a trade ally ID number. Trade ally IDs should be linked to projects so the program can measure trade ally activity and so evaluators know which trade allies to contact for additional information about a given project.

  - **Consider adjusting the Quantity definition:** For some measures, it may make more sense to track feet (pipe wrap) rather than units or bulbs rather than packs (CFL multi-packs). Make the units in a single field consistent: use one field for number of packages and another for the multiplier

- **ENERGY STAR Program:**
  - Work with trade allies to improve market penetration of the appliance portion of the program, which should improve participation and attribution.
  - Take steps to increase the installation of low flow showerheads and faucet aerators.
  - Request participating upstream lighting manufacturers to submit actual sales data at the retail level, as opposed to a simple summary of bulbs sold.
- **Appliance Recycling:**
  - Change the equipment operating assumption from 24 hours per day, 365 days per year to a value that more accurately reflects secondary unit operation.
  - Improve attribution by targeting the secondary market rather than units that would have been removed from service in the absence of the program.
- **Low Income:**
  - Improve communication with field staff and customers. Fifteen percent of pipe wrap was reported to be not installed, with most of the customers indicating that it was not even offered to them.
- **Online Audit:**
  - Take steps to increase the installation of low flow showerheads and faucet aerators.
- **Onsite Weatherization**:
  - Improve quality control on entering data from forms into the database.
  - Provide increased education to recipients of programmable thermostats. Several thermostats were removed due to issues learning how to operate it.
  - Improve communication with field staff. There were several reports of auditors leaving behind rather than installing CFLs, faucet aerators and showerheads.
- **Commercial and Industrial:**
  - Change savings calculation assumptions to allow for a range of equipment operating schedules, not a single schedule that applies to all C&I facilities. In particular, consider an option for industrial and other 24 hour facilities for lighting measures.

- For VFD measures that use the MEMD calculation, provided deemed values by region rather than one value for the state.
- Provide clear discussion of ex ante calculations, showing methodology and providing sufficient information for the calculations to be duplicated by the evaluator.
- Provide live unlocked spreadsheets for custom projects to evaluators. Without these files it is difficult to understand how calculations were done and identify sources of errors.

12. Pilot Programs

The law creating the energy efficiency programs in Michigan allows them to claim a percentage of the overall savings goal equivalent to the amount of money spent on pilot programs, up to five percent. In other words, if the program spends 4.3 percent of the budget goal on pilot programs, they may claim 4.3 percent of the total savings goal as a result. Pilot savings must be split between the residential and commercial/industrial budgets.

Table 111 and Table 112 show the savings for the Efficiency United residential and commercial/industrial pilot programs respectively, by utility. These savings are based on the savings reported in the final database received by DNV KEMA on February 22, 2013. Overall, the program was able to claim 2,446,852 kWh and 317,924 ccf through the pilot programs.

Table 111. Efficiency United Residential Pilot Savings

Utility	kWh	ccf
Alpena Power Company	45,001	
Baraga Electric Utility		
Bayfield Electric Cooperative		
Crystal Falls, The City of	3,918	
Daggett Electric Company		
Gladstone Department of Power and Light, The City of	7,364	
Hillsdale Board of Public Utilities	19,483	
Indiana Michigan Power Company	628,610	
L'Anse Electric Utility	2,355	
The City of Negaunee Electric Department	5,459	
The City of Norway Department of Power & Light	8,124	
The City of South Haven	24,439	
Upper Peninsula Power Company	113,512	
We Energies	84,329	
Wisconsin Public Service Corporation	28,602	527
XCEL Energy	14,225	1,323
Michigan Gas Utilities Corporation		48,673
SEMCO Energy Gas Company		90,264
EU Residential Pilot Overall	**985,421**	**140,786**

Table 112. Efficiency United Commercial and Industrial Pilot Savings

Utility	kWh	ccf
Alpena Power Company		
Baraga Electric Utility	7,885	
Bayfield Electric Cooperative		
Crystal Falls, The City of	4,287	
Daggett Electric Company		
Gladstone Department of Power and Light, The City of		
Hillsdale Board of Public Utilities	44,243	
Indiana Michigan Power Company	838,966	
L'Anse Electric Utility	4,216	
The City of Negaunee Electric Department	5,189	
The City of Norway Department of Power & Light	6,478	
The City of South Haven	41,130	
Upper Peninsula Power Company	275,217	
We Energies	87,162	
Wisconsin Public Service Corporation	104,434	3,912
XCEL Energy	42,223	1,576
Michigan Gas Utilities Corporation		58,880
SEMCO Energy Gas Company		112,770
EU Commercial and Industrial Pilot Overall	**1,461,431**	**177,138**

13. Education Programs

The law creating the energy efficiency programs in Michigan allows them to claim a percentage of the overall savings goal equivalent to the amount of money spent on education programs, up to three percent. In other words, if the program spends 2.3 percent of the budget goal on education programs, they may claim 2.3 percent of the total savings goal as a result. Education savings must be split between the residential and commercial/industrial budgets.

Table 113 and Table 114 show the savings for the Efficiency United residential and commercial/industrial education programs respectively, by utility. Overall, the program was able to claim 1,132,935 kWh and 147,467 ccf through the education programs.

Table 113. Efficiency United Residential Education Savings

Utility	kWh	ccf
Alpena Power Company	26,782	
Baraga Electric Utility	906	
Bayfield Electric Cooperative	58	
Crystal Falls, The City of	2,332	
Daggett Electric Company	327	
Gladstone Department of Power and Light, The City of	1,035	
Hillsdale Board of Public Utilities	11,596	
Indiana Michigan Power Company	375,109	
L'Anse Electric Utility	1,555	
The City of Negaunee Electric Department	3,376	
The City of Norway Department of Power & Light	5,079	
The City of South Haven	14,547	
Upper Peninsula Power Company	82,226	
We Energies	50,204	
Wisconsin Public Service Corporation	19,447	936
XCEL Energy	15,845	558
Michigan Gas Utilities Corporation		30,389
SEMCO Energy Gas Company		55,057
EU Residential Education Overall	**610,423**	**86,940**

Table 114. Efficiency United Commercial and Industrial Education Savings

Utility	kWh	ccf
Alpena Power Company	19,663	
Baraga Electric Utility	2,692	
Bayfield Electric Cooperative		
Crystal Falls, The City of	2,059	
Daggett Electric Company		
Gladstone Department of Power and Light, The City of	2,527	
Hillsdale Board of Public Utilities	15,099	
Indiana Michigan Power Company	286,311	
L'Anse Electric Utility	1,439	
The City of Negaunee Electric Department	1,771	
The City of Norway Department of Power & Light	3,112	
The City of South Haven	14,039	
Upper Peninsula Power Company	93,980	
We Energies	29,764	
Wisconsin Public Service Corporation	35,644	1,336
XCEL Energy	14,411	538
Michigan Gas Utilities Corporation		20,103
SEMCO Energy Gas Company		38,552
EU Commercial and Industrial Education Overall	**522,511**	**60,528**

A. Audit Program Spillover

The evaluation plan tasked DNV KEMA with investigating whether any participant spillover occurred as a result of the Online Audit (OA) or Onsite Weatherization (AW) Programs.

Participant spillover refers to actions undertaken by program participants but not tracked by the program. This section attempts to understand potential participant spillover, but not to quantify it in terms of kWh or ccf savings.

A.1.1 Methodology

DNV KEMA asked respondents questions intended to assess how many energy efficiency upgrades they made to their homes, comparing customers of Efficiency United utilities who did not participate in any EU programs (non-participants) to participants in the two audit programs. Non-participants were asked about energy efficiency actions taken in the past year, while audit program participants were asked about energy efficiency actions taken since their audit. Comparing the audit participants to non-participants allowed us to determine whether audit participants took more energy efficiency actions than non-participants.

A.1.2 Responses

The following tables compare the responses of OA program participants and AW program participants to the responses of non-participants (Population). Each table shows the percent of respondents who took any energy efficiency actions in a general category, followed by the percent of respondents who took specific actions.

The tables include the following columns:

- **Weighted Percent** - Refers to the percent of respondents who provided each response, case weighted to the population as described in the process evaluation.[32] Asterisks indicate whether the difference between the audit program participant responses and the population responses differ at a statistically significant level of 90 percent confidence based on a 2 sample Z test.[33]
- **Wt. Pct. Done with Program Rec.** - Refers to the percentage of respondents who took the action who remember the action being recommended in their audit.

[32] DNV KEMA: *Process Evaluation of Electric and Natural Gas Energy Optimization Programs*. Prepared for Michigan Community Action Agency Association (MCAAA). March 2013.
[33] The 2 sample Z test uses the Bernoulli distribution to convert each proportion to a z-score. It then takes the difference of the z-scores. Any difference with an absolute value greater than 1.65 was considered statistically significant.

Evidence for potential spillover exists when two conditions are met:

- the percentage of audit participants who implement an action is statistically greater than the percentage of non-participants who implemented the same action.
- audit program participants who took an action remember the audit recommending the action.

Table 115 shows the weighted percent of respondents who took actions to reduce infiltration from doors and windows. OA participants took steps to reduce shell infiltration at a higher rate than the general population, a difference that is statistically significant. AW participants did not differ from the general population for the in taking general actions to reduce door and window infiltration.

Most of the differences between OA program participants and the general population in taking specific actions reach statistical significance and many of the participants recalled that the audit recommended the specific action. For example, 15 percent of OA participants added window shades or curtains to their windows compared to 7 percent of non-participants. Of the participants who added shades or curtains, 60 percent remembered the audit recommended this action. AW participants did not take many more specific actions than the general population.

Table 115. Responses to Question EE1 and EE2

EE1. In the past 12 months have you taken any actions to reduce drafts coming in through your home's door or windows?					
	Population (n=782)	Online Audit (n=300)		Onsite Weatherization (n=250)	
Response	Weighted Percent	Weighted Percent	Wt. Pct. Done with Program Rec.**	Weighted Percent	Wt. Pct. Done with Program Rec.**
Yes	49%	60% *	n/a	46%	n/a
EE2. Which of the following have you done?					
Installed weather stripping on windows or doors	16%	26% *	73%	16%	51%
Caulked windows or doors	15%	21% *	61%	14%	49%
Put plastic on windows	11%	18% *	47%	16% *	35%
Added insulation	8%	9%	46%	7%	65%
Added window shades or curtains	7%	15% *	60%	6%	33%
Added weather stripping to attic access doors	5%	7% *	57%	3%	43%
Installed a new threshold	2%	4% *	27%	2%	20%
Installed a crawl space vapor shield	1%	3% *	25%	2% *	80%

* Indicates program weighted percent is statistically significantly different than the population at the 90 percent confidence level.
** Percents in this column are the percent of those who took the action.

The table also shows that OA participants performed a number of specific actions at a higher rate than the general population, and most of the respondent who took action remembered their audit recommending the measure. AW survey participants performed a few actions at a higher rate, such as “Installed new products,” though only 22 percent recall hearing about those products during their audit.

Table 116 shows the weighted percent of respondents who took actions to reduce heat loss in their ductwork, plumbing, or chimney. OA participants took general steps to reduce heat loss at a higher rate than the general population, though AW participants did not.

The table also shows that OA participants performed a number of specific actions at a higher rate than the general population, and most of the respondent who took action remembered their audit recommending the measure. AW survey participants performed a few actions at a higher rate, such as "Installed new products," though only 22 percent recall hearing about those products during their audit.

Table 116. Responses to Question EE3 and EE4

EE3. In the past 12 months, have you taken any actions to reduce heat loss in your air ducts, water pipes, or chimney?	Population (n=782)	Online Audit (n=300)		Onsite Weatherization (n=250)	
Response	Weighted Percent	Weighted Percent	Wt. Pct. Done with Program Rec.**	Weighted Percent	Wt. Pct. Done with Program Rec.**
Yes	14%	28% *	n/a	16%	n/a
EE4. Which of the following have you done?					
Insulated hot water pipes	7%	18% *	60%	8%	65%
Insulated air ducts	4%	5%	43%	1%	33%
Sealed air ducts	1%	5% *	56%	2% *	33%
Insulated attic access doors	2%	4% *	62%	2%	25%
Installed damper or internal seal on chimney	3%	4% *	64%	2%	17%
Cleaned ducts	0%	4% *	62%	2% *	0%
Installed new products	0%	5% *	36%	4% *	22%

* Indicates program weighted percent is statistically significantly different than the population at the 90 percent confidence level.
** Percents in this column are the percent of program respondents who took the action.

Table 117 shows the weighted percent of respondents who performed maintenance on their heating equipment in the past 12 months. The table shows that OA participants performed maintenance at a higher rate than the general population, though AW participants did not.

Among other differences, this table shows that both OA and AW participants claim to "regularly monitor and maintain appliances" at a higher rate than the general population. This difference shows statistical significance for the both groups, though less than half of them report their audit recommending this action.

Table 117. Responses to Question EE5 and EE6

EE5. In the past 12 months, have you done any maintenance on your furnace, boiler or heat pump?	Population (n=782)	Online Audit (n=300)		Onsite Weatherization (n=250)	
Response	Weighted Percent	Weighted Percent	Wt. Pct. Done with Program Rec.**	Weighted Percent	Wt. Pct. Done with Program Rec.**
Yes	32%	42% *	n/a	32%	n/a
EE6. Which of the following have you done?					
Had furnace or boiler tuned-up by a professional	20%	14%	46%	8%	30%
Replaced furnace or heat pump filter	14%	24% *	37%	14%	31%
Replace/ clean	0%	13% *	29%	8% *	57%
Insulate	0%	3% *	25%	0% *	n/a
Regularly monitor and maintain appliances	0%	11% *	32%	6% *	29%

* Indicates program weighted percent is statistically significantly different than the population at the 90 percent confidence level.
** Percents in this column are the percent of program respondents who took the action.

Table 118 shows the weighted percent of respondents who took action to reduce energy use in their major appliances. The table shows that both OA and AW participants took actions to reduce appliance energy use at a higher rate than the general population. This difference shows statistical significance for both programs.

The table shows that OA participants engaged in all actions at a higher rate than the general population, and most who took action remember the action being recommended by the audit. AW participants cleaned their dryer vents at a higher rate, though most participants do not recall the audit recommending this.

Table 118. Responses to Question EE7 and EE8

EE7. In the past 12 months, have you done anything to reduce how much energy your major home appliances	Population (n=782)	Online Audit (n=300)		Onsite Weatherization (n=250)	
Response	Weighted Percent	Weighted Percent	Wt. Pct. Done with Program Rec.**	Weighted Percent	Wt. Pct. Done with Program Rec.**
Yes	17%	40% *	n/a	20% *	n/a
EE8. Which of the following have you done?					
Set back thermostat temperature	7%	19% *	67%	6%	79%
Lowered water heater temperature	5%	14% *	81%	5%	100%
Replaced or cleaned dryer vent	3%	18% *	59%	7% *	33%
Used clothesline to dry clothes	2%	11% *	47%	2%	20%
Increase refrigerator or freezer temperature	2%	9% *	85%	2%	60%
Installed a water heater blanket	1%	3% *	38%	1%	100%
Added occupancy or daylight sensors to lights	1%	4% *	55%	1%	100%

* Indicates program weighted percent is statistically significantly different than the population at the 90 percent confidence level.
** Percents in this column are the percent of program respondents who took the action.

A.1.3 Comparison of 2011 and 2012

This section compares results from 2011 to 2012. Each table shows the various measures, and indicates for each measure whether there was a statistically significant difference from the general population in that year.[34]

These tables present the results of an initial question about whether respondents took actions in a general category, followed by responses to a question about which specific actions they took.

Table 119 shows that only OA participants in 2012 had significantly higher numbers respondents who took general actions to reduce door and window infiltration.

The table shows that OA participants in both years took some specific actions at higher rates than the general population, including caulking and weather-stripping attic access doors and installing new thresholds. AW participants did not take any actions to reduce door and window infiltration at higher rates than the population in both years.

Table 119. 2011-2012 Statistical Significance Comparison Question EE1 and EE2

EE1. In the past 12 months have you taken any actions to reduce drafts coming in through your home's door or windows?				
	Online Audit		Onsite Weatherization	
Response	2011 n=200	2012 n=300	2011 n=96	2012 n=250
Yes	No	Yes	No	No
EE2. Which of the following have you done?				
Installed weather stripping on windows or doors	No	Yes	No	No
Caulked windows or doors	Yes	Yes	No	No
Put plastic on windows	-	Yes	-	Yes
Added insulation	-	No	-	No
Added window shades or curtains	No	Yes	-	No
Added weather stripping to attic access doors	Yes	Yes	No	No
Installed a new threshold	Yes	Yes	No	No
Installed a crawl space vapor shield	No	Yes	No	Yes

"-" Indicates that no respondents gave this response in a given year.

[34] The survey given to AW participants in 2011 did not have the same question sequence as in 2012, which made it impossible to compare the results of the two years for some questions.

Table 120 shows that OA participants in both 2011 and 2012 took general actions to reduce heat loss in air ducts, water pipes and chimneys.

The table also shows that the only specific action taken more frequently by participants than non-participants in both years was by OA participants, who insulated their hot water pipes at a higher rate. AW respondents were not asked most of these questions in 2011.

Table 120. 2011-2012 Statistical Significance Comparison Question EE3 and EE4

EE3. In the past 12 months, have you taken any actions to reduce heat loss in your air ducts, water pipes, or chimney?				
	Online Audit		Onsite Weatherization	
Response	2011 n=200	2012 n=300	2011 n=96	2012 n=250
Yes	Yes	Yes	*	No
EE4. Which of the following have you done?				
Insulated hot water pipes	Yes	Yes	*	No
Insulated air ducts	No	No	*	No
Sealed air ducts	No	Yes	*	Yes
Insulated attic access doors	No	Yes	Yes	No
Installed damper or internal seal on chimney	No	Yes	Yes	No
Cleaned ducts	-	Yes	*	Yes
Installed new products	-	Yes	*	Yes

* The 2011 Onsite Weatherization survey had a different question sequence that did not include several response options.
"-" Indicates that no respondents gave this response in a given year.

Table 121 shows that in both 2011 and 2012 OA participants performed maintenance on their heating systems at higher rates than non-participants. The only specific action that OA participants performed at higher rates than non-participants in both years was to replace air filters. AW participants performed some actions at higher rates in 2011 and others in 2012, but did not have any actions that they took at higher rates in both years.

Table 121. 2011-2012 Statistical Significance Comparison Question EE5 and EE6

EE5. In the past 12 months, have you done any maintenance on your furnace, boiler or heat				
	Online Audit		Onsite Weatherization	
Response	2011 n=200	2012 n=300	2011 n=96	2012 n=250
Yes	Yes	Yes	No	No
EE6. Which of the following have you done?				
Had furnace or boiler tuned-up by a professional	Yes	No	Yes	No
Replaced furnace or heat pump filter	Yes	Yes	Yes	No
Replace/ clean	-	Yes	-	Yes
Insulate	-	Yes	-	Yes
Regularly monitor and maintain appliances	-	Yes	-	Yes

"-" Indicates that no respondents gave this response in a given year.

Table 122 shows that OA participants engaged in actions to reduce major appliance energy use at a higher rate than the general population in both years. OA participants consistently engaged in almost all actions at a higher rate than non-participants. AW participants were not asked this question in 2011. AW participants were not asked this question in 2011.

Table 122. 2011-2012 Statistical Significance Comparison Question EE7 and EE8

EE7. In the past 12 months, have you done anything to reduce how much energy your major home appliances use?				
	Online Audit		Onsite Weatherization	
Response	2011 n=200	2012 n=300	2011 n=96	2012 n=250
Yes	Yes	Yes	Not Asked	Yes
EE8. Which of the following have you done?				
Set back thermostat temperature	Yes	Yes	Not Asked	No
Lowered water heater temperature	Yes	Yes		No
Replaced or cleaned dryer vent	Yes	Yes		Yes
Used clothesline to dry clothes	Yes	Yes		No
Increase refrigerator or freezer temperature	No	Yes		No
Installed a water heater blanket	Yes	Yes		No
Added occupancy or daylight sensors to lights	Yes	Yes		No

"-" Indicates that no respondents gave this response in a given year.

A.1.4 Summary and Conclusions

There is evidence of potential spillover from the OA program in all categories. In both 2011 and 2012, OA Participants took actions at significantly higher rates in:

- **Reducing infiltration from doors and windows:** OA participants took more actions generally to reduce infiltration than non-participants, and specifically were more likely to caulk and install

weather stripping on doors and windows. The majority of respondents who took these actions also recalled most of these measures as being recommended by the audit in 2012.

- **Reducing heat loss from ducts, pipes, chimneys:** OA participants insulated their hot water pipes at a higher rate than the general population. The majority of respondents recall this being recommended by the audit in 2012.
- **Heating maintenance:** OA participants replaced their furnace filters at a higher rate than the general population.
- **Home Appliances:** OA participants took a number of actions at higher rates than the general population, including adjusting temperature settings, adding occupancy sensors, and using clothes lines.

There is no evidence of potential spillover from AW participation. Overall, AW participants had few statistically significant differences in the actions they took versus the actions that non-participants took. They took no actions in rates that were statistically significantly different in both years. Additionally, of those actions that were statistically different, most participants who took the action did not recall their audits recommending these measures in 2012.

In 2012, more of the categories showed statistically significant differences between participants and non-participants than 2011, particularly with regard to the Online Audit. This is likely due to the 2012 evaluation completing surveys with a larger number of participants than in 2011. The program did not make any significant changes to the Online Audit between years, nor were there significant demographic differences. This suggests that the larger sample size may have given us a clearer picture of program effects that were present in both years (though not to the level of statistical significance in 2011).

OA participants appear to have installed measures outside of their program at a higher rate than AW participants, and higher than the general population. This suggests that either the OA program increases uptake of these measures, or that OA participants are more likely to install these measures for other reasons that also motivated their participation in the program (such as being energy efficiency minded or having just purchased a new home). See the process evaluation for further discussion of participant characteristics.[35]

[35] DNV KEMA: *Process Evaluation of Electric and Natural Gas Energy Optimization Programs*. Prepared for Michigan Community Action Agency Association (MCAAA). March 2013.

B. Geographical Comparison – UP / LP

DNV KEMA compared installation rates and attribution for the programs in Michigan's Upper Peninsula (UP) and Lower Peninsula (LP) to determine whether there was a difference in program participation based on the cultural differences between the two locations. In particular, program implementers were concerned that the conservative mindset and geographical separation of the UP would result in a lower installation rate than in the LP.

Table 123 and Table 124 show program installation rates by UP/LP for electricity and natural gas respectively. Highlighted cells show a statistically significant difference in the results from UP and LP participants.

Only one program, ENERGY STAR, had statistically significant differences in installation rate for electricity and no programs showed a significant difference for gas. ENERGY STAR participants living in the LP had a 23 percent lower electric installation rate than those living in the UP. Online Audit participants in the LP had an 11 percent lower installation than that of OA participants in the UP, but it is not statistically significant. The installation rates for other programs, including electricity and gas, are similar.

Table 123. UP vs. LP Electric Installation Rate, by Program

Program	UP		LP	
	n	Installation Rate	n	Installation Rate
ENERGY STAR	70	81%	70	58%
Appliance Recycling	305	100%	205	100%
HVAC	12	100%	43	100%
Low Income	100	98%	64	97%
Online Audit	162	67%	326	56%
Onsite Weatherization	258	91%	125	92%
C&I	29	100%	93	100%

Table 124. UP vs. LP Natural Gas Installation Rate, by Program

Program	UP		LP	
	n	Installation Rate	n	Installation Rate
ENERGY STAR	18	76%	50	73%
Appliance Recycling	0	0%	0	0%
HVAC	22	100%	243	100%
Low Income	68	99%	585	99%
Online Audit	96	57%	430	56%
Onsite Weatherization	335	93%	123	94%
C&I	2	100%	68	100%

Table 125 and Table 126 show program attribution rates by UP/LP for electricity and natural gas respectively. Highlighted cells show a statistically significant difference in the results from UP and LP participants.

Appliance Recycling is the only program with a statistically significant difference in attribution rate. Appliance Recycling participants living in the LP had a 21 percent higher attribution rate participants living in the UP. The attribution rates for other programs, including electricity and gas, are different but there is no consistency in whether upper or lower has higher or lower attribution. In order to preserve respondent confidentiality, we cannot report attribution for the gas portion of the C&I program (only 2 respondents).

Table 125. UP vs. LP Electric Attribution Rate, by Program

Program	UP		LP	
	n	Attribution	n	Attribution
ENERGY STAR	63	38%	55	36%
Appliance Recycling	305	47%	205	68%
HVAC	12	18%	43	27%
Low Income	N/A			
Online Audit	117	44%	215	50%
Onsite Weatherization	242	61%	116	49%
C&I	23	45%	88	14%

Table 126. UP vs. LP Natural Gas Attribution Rate, by Program

Program	UP		LP	
	n	Attribution	n	Attribution
ENERGY STAR	17	49%	40	57%
Appliance Recycling	0	0%	0	0%
HVAC	22	14%	242	10%
Low Income	N/A			
Online Audit	55	48%	217	40%
Onsite Weatherization	300	63%	113	68%

C. Measure Life

DNV KEMA's analysis of the EU programs produced verified lifetime energy savings. Since the program tracking database reports annual savings only, DNV KEMA applied a measure life (effective useful life) to the annual savings to produce lifetime savings. DNV KEMA reviewed the measure life estimates in the MEMD database (most without citation) and compared them to two other sources: a KEMA measure life study from 2009 and the most recent California DEER database. [36] Since the KEMA study was conducted for a commercial and industrial program, its applicability to residential measures is limited. The DEER database is based on an extensive review of secondary sources and provides a measure life for most residential measures included in the EU programs.

C.1 Residential

Table 127 shows the measure, program estimate, KEMA study estimate, DEER estimate (and range, when applicable), and the value used in the evaluation for residential measures. We also include the 2011 evaluation estimate to show changes from round 2 to round 3 of the evaluation. In most cases, DNV KEMA chose to use the DEER value in our evaluation. Most of the program estimates did not cite a source, making it difficult to judge the validity of the assumption. The DEER database is well supported by extensive research and secondary source review. Though it was developed to support programs in California, DNV KEMA feels that the results are applicable to Michigan for most technologies.

DNV KEMA changed the recommendation from 2011 for LED Holiday Lights, Furnaces, and ECM Furnace Motors. These changes are based on values found in a more detailed group of estimates found in an appendix to the KEMA study.

For ENERGY STAR new homes, DNV KEMA reviewed the measures that are addressed in the ENERGY STAR review. Savings for ENERGY STAR homes are dominated by insulation (20 years), furnace (15 years), and air sealing (11 years) components. Combining those, DNV KEMA recommends a measure life estimate of 18 years for the house as a whole.

[36] Miriam Goldberg, J. Ryan Barry, Brian Dunn, Mary Ackley, Jeremiah Robinson, Darcy Deangelo-Woolsey. *Business Programs: Measure Life Study*. August 25, 2009.

Table 127. Measure Life Estimates for Residential Programs

Measure	EU Program	DEER 2008	KEMA Study	EU Evaluation Value	
				2011	2012
Air Sealing	13	11	20	11	11
Boiler	20	20	20	20	20
Ceiling Fan	10	15	n/a	15	15
Central Air Conditioner	15	15	15	15	15
CFL	9	4-11 (range)	n/a	9	9
Clothes Dryer	14	n/a	n/a	14	14
Clothes Washer	14	11	11	11	11
Dehumidifier	12	n/a	15	n/a	15
Dishwasher	11	11	10	11	11
Door Strips	n/a	n/a	20	n/a	20
ECM Furnace Motor	10	n/a	n/a	15	10
Faucet Aerator	12	10	9	10	10
Furnace	15	20	18	15	20
Furnace Tune-up	5	n/a	n/a	5	5
Heat Pump	15	15	20	15	15
Insulation	20	20	20	20	20
LED Holiday Lights	10	16	n/a	16	10
LED Night Light	12	n/a	n/a	16	16
Low Flow Showerhead	12	10	9	10	10
Pipe Wrap	11 (WD) 6 (NWD)	13 (electric) 11 (gas)	10	13 (electric) 11 (gas)	13 (electric) 11 (gas)
Programmable Thermostat	9	11	n/a	11	11
Recycling - Freezer	8	5	n/a	5	5
Recycling - Refrigerator	8	4	n/a	4	4
Refrigerator	12	14	19	14	14
Smart Strip	5	n/a	n/a	5	5
Water Heater - Tank	15	13 (electric) 11 (gas)	15	13 (electric) 11 (gas)	13 (electric) 11 (gas)
Water Heater - Tankless	15	20	15	20	20
Window Replacement	20	20	20	20	20
ENERGY STAR Homes	20	20	n/a	20	18

C.2 Commercial and Industrial

Table 128 shows the measure, program estimate, DNV KEMA study estimate, DEER estimate (and range, when applicable), and the value used in the evaluation for commercial and industrial measures. We also include the 2011 evaluation estimate to show changes from round 2 to round 3 of the evaluation. Most of the program estimates did not cite a source, making it difficult to judge the validity of the assumption. DNV KEMA relied primarily on the measure life study conducted for the Focus on Energy Business programs in Wisconsin in 2009 to determine the evaluation value. We chose this source because of its extensive and detailed list of values (the DEER study often showed measure life for more general categories rather than specific pieces of equipment) and its focus on commercial and industrial measures.

When a value was not available from the KEMA study, preference was given to the DEER data and, if necessary, to the existing program estimate.

DNV KEMA changed recommendations from 2011 for LED Exit signs, Linear Fluorescent Lighting, Occupancy Sensors, LED Lamps / Fixtures, CFLs, and Motors. These changes are based on values found in a more detailed group of estimates found in an appendix to the KEMA study.

Table 128. Measure Life Estimates for Commercial and Industrial Program

Measure	Program	DEER 2008	KEMA Study	Evaluation Value	
				2011	2012
A/C Economizer	15	10	10	n/a	10
Air conditioning	15	15	15	n/a	15
Boiler Controls	15	n/a	5	n/a	5
Boiler replacement	20	20	20	n/a	20
Boiler Tune-Up	2	n/a	1	1	1
Cooler door gaskets	4	4	n/a	n/a	4
Demand Controlled Ventilation	15	10	5	n/a	10
Faucet Aerator	12	10	9	n/a	9
Furnace replacement	15	20	18	15	20
Furnace Tune-up	2	n/a	5	n/a	2
Infrared Heater	15	n/a	15	15	15
IR Film	5	5	15	n/a	5
LED Traffic	6	n/a	10	n/a	10
Lighting - CFL	2	varies	5	4	5
Lighting - De-Lamping	12	n/a	n/a	10	10
Lighting - LED Exit	15	16	16	10	16
Lighting - LED Lamps	8 (lamp) 15 (fixture)	n/a	15 (fixture)	20	8 (lamp) 15 (fixture)
Lighting - Linear Fluorescent	12	15	13	12	13
Lighting - Occupancy Sensor	10	8	9	10	9
Motors	15	15	15	16	15
Night Covers	17	5	5	n/a	5
Pipe Wrap	20	13 (electric) 11 (gas)	10	n/a	10
Pool Heater	15	5	n/a	5	5
Pre-rinse Sprayer	5	n/a	5	n/a	5
Programmable Thermostat	9	11	n/a	n/a	11
Refrigeration - Anti-Sweat Controls	15	12	12	n/a	12
Refrigeration - ECM Motor	15	15	15	n/a	15
Showerhead	12	n/a	9	n/a	9
Steam Trap	5	6	5	5	5
Vending Equipment Controller	10	5	5	n/a	5
Water Heater - Tank	15	13 (electric) 11 (gas)	15	13 (electric) 11 (gas)	13 (electric) 11 (gas)
Water Heater - Tankless	15	20	15	20	20

D. Tracking Review

DNV KEMA reviewed the CLEAResult tracking database to verify that the deemed savings values from the MEMD were applied correctly. We conducted our verification on multiple versions of the database received prior to CLEAResult's final year-end reporting. As a result, the errors found in the tracking review were corrected before the year-end savings were produced and were not included in the adjustment factors in this report. This section outlines the errors that were found as part of the review.

The tracking verification in this round was particularly difficult to perform because CLEAResult changed databases in the middle of the program year. The new database (Pulse) treated per-unit savings, measure identification, and other information differently from the previous database (Quickbase) and used different measure descriptions, which required twice the verification (once for a measure in the old database, once for the same measure in the new database) than before.

DNV KEMA found a decrease in the database savings assignment functionality from the Quickbase to Pulse databases. Some of the issues we found were:

- The Pulse database uses a single measure description for measures with multiple savings estimates, with other variables used to determine which savings should be assigned. For example, the clothes washer measure has different savings depending on the efficiency tier, hot water fuel, and dryer fuel in the home.
  - In Quickbase, there was one measure description for each unique combination (and savings estimate).
  - In Pulse, there were additional variables that needed to be referenced to determine which savings should be assigned. The additional variables were not always fully populated, which restricted our ability to verify the energy savings.
  - The Pulse database does not have a field that identifies hot water fuel, though CLEAResult has a history of assigning savings to the incorrect hot water fuel.
- The quantity variable did not always reflect consistent units, even within a given measure. For example, a quantity of "1" for pipe wrap in the Onsite Weatherization Program sometimes referred to 6 linear feet of pipe wrap and sometimes referred to 3 linear feet of pipe wrap. The database did not indicate when the different units should be used.
- CLEAResult did not communicate equipment caps to DNV KEMA and the database does not identify when caps are in place. For example, if energy savings are capped at 2 faucet aerators per

customer, the database may show a quantity of 4 but energy savings for only 2. This results in per-unit savings that do not match the MEMD.

DNV KEMA found the following errors for each program:

- ENERGY STAR:
  - Eleven CFL measures used 44 kWh/unit energy savings instead of 39 kWh/unit. These were corrected.
  - Some faucet aerator measures were assigned energy savings that were twice as high as they should have been. These were corrected.
  - DNV KEMA found an inconsistency between the program definition of efficiency and the MEMD definition of efficiency for dishwasher measures. The MEMD calculated savings based on equipment that qualified for ENERGY STAR in two tiers: Tier 1 for energy factor (EF) > 0.65, and Tier 2 for EF >= 0.68. The program rebated dishwashers that qualified for CEE Tier 1, EF > 0.7. Therefore, the program changed all savings claims for dishwashers to Tier 2.
- HVAC:
  - Some programmable thermostat, high efficiency furnace, and furnace tune-up measures were assigned the 2011 savings instead of the 2012 savings. These were corrected.
  - The energy savings for one air source heat pump measure were incorrect. These were corrected.
  - Five high efficiency furnace measures used kBtuh to calculate energy savings instead of Btuh. These were corrected.
  - The energy savings for one central air conditioner were incorrect. These were corrected.
- Low Income:
  - The energy savings for band joist insulation were incorrectly calculated based on linear feet of insulation installed instead of square feet of conditioned space for one measure. These were corrected.
  - One furnace tune-up measure used the wrong savings. These were corrected.
  - A number of infiltration reduction measures used incorrect savings estimates. These were corrected.

  - A number of programmable thermostat measures used the wrong multiplier or did not have the correct multiplier entered in the tracking database. These were corrected.

- Onsite Weatherization:

  - Thirty-three programmable thermostat measures had conditioned square footage greater than home square footage. These were corrected.

  - Three programmable thermostat measures had the wrong savings assigned. These were corrected.

  - Three window replacement measures had the wrong savings assigned. These were corrected.

- Other:

  - Many showerhead, faucet aerator, and pipe wrap kits assigned savings to the wrong fuel according to the water heater fuel entered in the database. For example, the database would show kWh savings though the water heater used natural gas. These were corrected.

  - A number of measures such as CFLs, faucet aerators, LED night lights, combo kits, and smart strips have maximum savings, which was not communicated in the tracking data. These measures do not have per-unit energy savings equal to the MEMD. Although the energy savings are correct according to what can be claimed, the quantity of equipment installed is inconsistent with those savings. This was not changed.

E. Documentation Verification

DNV KEMA verified the accuracy and consistency of the program records by checking a sample of completed program application forms for the ENERGY STAR, HVAC, Onsite Weatherization, New Construction, C&I, and Multifamily programs. We did not review applications for the Appliance Recycling or Online Audit program because they do not use paper applications, and we did not repeat our 2010 review of the Low Income documentation. The program provided DNV KEMA application forms for a sample of projects tracked in the program's Pulse database on December 7, 2012. DNV KEMA was also able to download a sample of application forms for projects tracked in the program's Quickbase database directly from the program's document repository on December 10, 2012.

DNV KEMA found an unusually large number of mistakes in the data this year, including some missing measures, measures in the database with no application, and measures which were miscategorized or calculated using the wrong CEE Tier. Some of these errors may stem from confusion resulting from the tracking database switch. Documentation review adjustments of more than one or two percent for a measure group are unusual, but several measure groups received tracking review adjustments of greater than five percent this year.

E.1.1 ENERGY STAR

Table 129 shows the savings represented by the documentation downloaded for the ENERGY STAR Program (ESP). DNV KEMA downloaded documentation representing 152,484 kWh and 6,091 ccf.

Table 129. ESP Documentation Verification Results

Measure Group	kWh			ccf		
	Tracking	Verified	Adj. Factor	Tracking	Verified	Adj. Factor
Faucet Aerator	7,318	7,318	100%	2,443	2,469	101%
CFL	16,176	16,098	100%			
Clothes Dryer	864	864	100%	4	4	100%
Kit - CFL	104,656	104,656	100%	1,252	1,252	100%
Dishwasher	405	405	100%	118	108	92%
Kit - No CFL				119	119	100%
LED Night Light	1,430	1,430	100%			
Pipe Wrap				5	5	100%
Showerhead	18,648	18,648	100%	1,296	1,215	94%
Smart Strip	4,737	4,737	100%			
Washing Machine	4,092	4,092	100%	553	536	97%
Energy Star Overall	**158,325**	**158,247**	**100%**	**5,790**	**5,707**	**99%**

DNV KEMA's review found a number of issues with individual measures. These include washing machines with savings calculated assuming an incorrect dryer type, and measures which were not shown

on the application. These findings resulted in an adjustment to the tracking savings which was included in the gross savings adjustment factor in the program-specific reporting sections.

E.1.2 ENERGY STAR Upstream Lighting

DNV KEMA verified the quantity of utility-discounted products sold by participating retailers as part of the Efficiency United ENERGY STAR program. In July of 2012, the ENERGY STAR lighting program launched a retailer based program. In the current program, participating retailers selling efficient lighting products are rebated on the basis of their sales of energy efficient lighting products (CFLs). To verify the program's savings for this program, we conducted an invoice verification exercise comparing a sample of program invoices/applications against information contained in program tracking database.

We analyzed shipment trends in order to select the appropriate sample of invoices/applications. Total as well as average shipments were reviewed by distribution channel (e.g., discount, home improvement store, etc.) and by type of agreement with Efficiency United (2-way MOUs compared to 3-way MOUs).

For each invoice/application selected for verification, we compared the program tracking data to what is provided in either paper or electronic form. In addition to the quantity of utility-discounted products shipped, we attempted to verify the following key metrics:

- Manufacturer name
- Measure name
- Product type
- Retailer name and location
- Per unit rebate
- Total rebate paid
- Shipment and sales dates

A sample of invoices was requested and reviewed. Due to issues with isolating specific invoice data within the overall program tracking data a few invoices were unable to be reviewed. These invoices were dropped from the analysis. Table 130shows the requested and verified sample.

Table 130. Sample Design for Invoice Verification

Verification Group	Invoice Verification Sample			
	Target Sample # of Invoices	Percentage of Strata to be Reviewed	Final Sample Reviewed	Percentage of Strata Reviewed
Retailers with 2-Way MOUs	6	49%	6	49%
Retailers with 3-Way MOUs	10	60%	5	18%
Overall	**16**	**59%**	**11**	**22%**

The results from the invoice/application verification assessment are shown by sample group in Table 131. The overall invoice verification rate was determined to be 100 percent for retailers with a 2-way MOU and 94 percent for retailers/manufacturers with a 3-way MOU. Table 131 shows the verification rates that that resulted from the analysis.

Table 131. Upstream Lighting Verification Factor

Verification Group	Claimed Units	Verified Units	Verification Rate (%)
Retailers with 2-Way MOUs	7,327	7,294	100%
Retailers with 3-Way MOUs	18,239	17,659	94%
Overall	**25,566**	**24,953**	**95%**

In summary, the invoice verification findings were good for a new upstream program and the complexity it entails. A few recommendations for further improving the tracking data would be to ensure that the invoice number be consistently recorded for each invoice, so that the tracking data can be more easily linked to a specific invoice, and to encourage manufacturers to submit actual sales data at the retail level, as opposed to a simple summary of bulbs sold.

E.1.3 HVAC

Table 132 shows the savings represented by the documentation downloaded for the HVAC Program. DNV KEMA downloaded documentation representing 23,682 kWh and 24,592 ccf.

Table 132. HVAC Documentation Verification Results

Measure Group	kWh			ccf		
	Tracking	Verified	Adj. Factor	Tracking	Verified	Adj. Factor
Boiler				3,075	3,075	100%
CAC	2,327	2,567	110%			
ECM	16,790	17,540	104%			
Furnace Tune-up				578	578	100%
Furnace				19,565	19,517	100%
Water Heaters				103	103	100%
Thermostat				3,584	3,584	100%
HVAC Overall	**19,117**	**20,107**	**105%**	**26,905**	**26,858**	**100%**

DNV KEMA's review found a number of items with various calculation issues. These include a ground source heat pump categorized as an air conditioner, A/C units with the SEER entered incorrectly, and measures which were found on the application but not in the database. These findings resulted in an adjustment to the tracking savings which was included in the gross savings adjustment factor in the program-specific reporting sections.

E.1.4 Onsite Weatherization

Table 133 shows the savings represented by the documentation downloaded for the Onsite Weatherization Program. DNV KEMA downloaded documentation representing 100,161 kWh and 18,175 ccf.

Table 133. Onsite Weatherization Documentation Verification Results

Measure Group	kWh			ccf		
	Tracking	Verified	Adj. Factor	Tracking	Verified	Adj. Factor
Air Sealing				141	187	133%
Insulation				478	570	119%
Faucet Aerator	14,110	14,110	100%	2,576	2,576	100%
CFL	54,561	54,561	100%			
Pipe Wrap	9,486	9,486	100%	1,981	1,997	101%
Showerhead	23,310	23,310	100%	4,455	4,509	101%
Thermostat				8,570	8,481	99%
Window Replacement				341	345	101%
Onsite Audit Overall	**101,467**	**101,467**	**100%**	**18,541**	**18,664**	**101%**

DNV KEMA's review found a number of items with various calculation issues. These include measures on the application but not in the database and measures in the database but not on the application. For Insulation and Air Sealing measures, the large adjustments result from relatively large homes with conditioned basements which had not received savings for the basement. While we only found a few projects with this issue, the relatively small number of projects reviewed (3 air sealing and 12 insulation projects) caused this to become a large adjustment. These findings resulted in an adjustment to the tracking savings which was included in the gross savings adjustment factor in the program-specific reporting sections.

E.1.5 Multifamily

DNV KEMA reviewed the documentation for 11 Multifamily participants. We found that the program accurately entered all of the information into the database for all participants.

These findings resulted in an adjustment to the tracking savings (in this case the adjustment was 100 percent), which was included in the gross savings adjustment factor in the program-specific reporting sections.

E.1.6 Conclusions and Recommendations

Because of the large number of mistakes across all programs this year, DNV KEMA recommends that the program make an effort to refine its error-checking strategy for the future. The mid-year change in databases makes this issue more understandable this year, and also leaves room for improvement as staff become more familiar with the new database.

Because the errors fall into many categories, we cannot recommend a single change at this time, or a single parameter to double-check, but encourage more vigilance in general regarding tracking data entry and calculation.

F. Sample Design and Disposition

F.1 Sample Design

DNV KEMA drew our sample from frames developed from the program database through August 31, 2012. The data was provided in the form of eight Excel files sent on September 21, 2012.

The primary objective of DNV KEMA's sample designs was to target a relative precision of ± 10 percent at the 90 percent confidence level for each program overall, sometimes referred to as 90/10 precision. The secondary objective was to produce technology-level results at a precision high enough to allow for reliable interpretation, though not necessarily as precise as 90/10 precision. DNV KEMA used a model-based sampling approach to develop efficient sample designs and to assess the likely statistical precision.

DNV KEMA targeted customers who made a larger contribution to the total program savings, though the sample was designed to ensure that we would complete surveys with customers that had smaller contributions as well. Targeting customers with greater savings allowed us to achieve a more precise savings estimate while limiting evaluation data collection costs by limiting the number of surveys. DNV KEMA used a model based sampling approach for some designs and targeted a census of customers for others.

DNV KEMA collected data from customers based on a randomized order within the stratum. When a given measure was up for completion, DNV KEMA called that customer until either the survey was completed, or the customer was "killed." A customer is "killed" when they refuse to participate in the survey, terminate the survey before the responses are completed, or when the survey house fails to make contact within six attempts on different days at different times of the day.

Many customers received rebates for multiple measures: a CFL and a washing machine, for example. Since measures are randomized within a stratum, a customer could be eligible for a survey regarding their CFL but not yet eligible for a survey regarding their washing machine. However, DNV KEMA could complete the survey regarding the CFL and the customer could then later become eligible for a survey regarding their clothes washer. To avoid customer burden and repeated attempts at reaching the same person, DNV KEMA asked customers about all of the measures they installed regardless of where each fell within the call order. When DNV KEMA completed a survey with a customer, we asked about all measures that were installed by that customer whether or not those measures fell into the sample. This prevented DNV KEMA from having to make multiple calls to a single house that could annoy the customer. For surveys conducted on measures that were not included in the sample or would not have come up in the normal call order, the results were included in the analysis but given a weight of one, meaning they represented only themselves and no other measures in the population.

DNV KEMA was unable to recruit all of the desired sample targets by strata, especially for those strata where we conducted a census. For that situation, DNV KEMA created a backup strategy that transferred a sample point from the stratum that we were unable to complete to the stratum with the largest contribution to total savings that had sites available in the population to sample. For example, if the sample design for water heaters targeted a census and DNV KEMA was unable to recruit one of those sites, then that sample point would then be allocated to the furnace sample. In that way DNV KEMA was still able utilize the entire sample and target the optimal precision for the sample design.

F.1.1 Sample Design Strategy

DNV KEMA used the same general sample design approach for the ENERGY STAR, HVAC, Online Audit, Onsite Weatherization, and Low Income programs. For each program, DNV KEMA mapped the individual measure codes into sampling groups that combined like items in an effort to increase the final precision for each group. We then assigned each record to strata defined by measure group, geography (upper or lower peninsula), and fuel (gas or electric savings). For each program, DNV KEMA targeted the number of completes shown in Table 134. Table 135 through Table 140 summarize the sample frame and measure group mapping for each of the programs.

DNV KEMA did not prepare a formal sample design for the Multifamily, Appliance Recycling, or Commercial and Industrial programs. For Commercial and Industrial and Appliance Recycling, DNV KEMA attempted to complete surveys with a census of the sample frame. For Multifamily, we simply ordered a random sample of participants and called until we reached the target number of completes.

Table 134. Completion Targets by Program

Program	Completion Target	Unit of Completion
ENERGY STAR	350	Measure
Appliance Recycling	Census	Measure
HVAC	200	Measure
Low Income	250	Measure
Online Audit	300	Measure
Onsite Weatherization	250	Measure
Commercial and Industrial	Census	N/A
Multifamily	10	Participant

Table 135. Sample Frame Summary, ENERGY STAR

Measure Code	Measure Description	Measure Category	# Measures	# Customers	kWh	ccf
0198CFL	CFL:Participant:Incentive:0198CFL	CFL	49	48	10,218	0
0199WMA	Washing Machine:Participant:Incentive:0199WMA	Washing Machine	47	47	4,836	474
0200LFS	Low Flow Showerhead:Participant:Incentive:0200LFS	Showerhead	1	1	518	0
0202PST	Smart Power Strip:Participant:Incentive:0202PST	Smart Strip	10	10	848	0
0203LED	LED Night Light:Participant:Incentive:0203LED	LED Night Light	5	5	198	0
0205FAE	Low Flow Sink Aerator:Participant:Incentive:0205FAE	Faucet Aerator	1	1	26	0
0209CDR	Clothes Dryer:Participant:Incentive:0209CDR	Clothes Dryer	7	7	720	7
0210DWA	Dishwasher:Participant:Incentive:0210DWA	Dishwasher	22	22	405	249
0864KIT	Kit 1:Participant:Rebate:0864KIT	Kit - No CFL	3	3	0	179
0923KIT	Combo Kit 2:Participant:Rebate:0923KIT	Kit - CFL	59	50	39,768	1,848
1105	Hand Held Shower Wand:Participant:Incentive:1105	Showerhead	32	30	8,806	540
CFL EVENT PACK	CFL 3 PACK - EVENT	CFL	43	43	15,795	0
CKIT1(ELEC) GWH EVENT	COMBO KIT 1 (ELEC SIDE) GWH - EVENT [12 CFL, 2 LED Night Light]	Kit - CFL	41	41	20,992	0
CKIT2(ELEC) EWH EVENT	COMBO KIT 2 (ELEC) EWH - EVENT [12 CFL, 2 LED Night Light, 1 Kitchen FA, 1 FA, 1 SH, 6ft P	Kit - CFL	64	62	106,752	0
ESCD	Clothes Dryer	Clothes Dryer	8	8	1,152	0
ESCFL	COMPACT FLUORESCENT BULBS	CFL	32	32	7,683	0
ESCFLIRC	CFL Instant Rebate Coupon	CFL	107	100	23,555	0
ESDW	DISHWASHER	Dishwasher	17	17	405	184
ESLFS	LOW FLOW SHOWERHEAD 1.75GPM	Showerhead	4	4	1,036	108
ESMFSHE20	High Efficiency Showerhead Electric Online Order Double	Showerhead	1	1	1,036	0
ESMFSHE3O	High Efficiency Showerhead Electric Online Order 2 HH or 1 HH & 1 Simple	Showerhead	2	2	2,072	0
ESMFSHEG2O	High Efficiency Showerhead Gas Online Order Double	Showerhead	5	5	0	270
ESMFSHEG3O	High Efficiency Showerhead Gas Online Order - 2 HH or 1 HH & 1 Simple	Showerhead	2	2	0	108
ESPW	PIPE WRAP - 5 FT	Pipe Wrap	3	3	0	16
ESWMT2EE	Washing Machine T2 electric, electric dryer	Washing Machine	5	5	1,610	0
ESWMT2GE	Washing Machine T2 gas, electric dryer	Washing Machine	4	4	0	36
ESWMT2GG	Washing Machine T2 gas, gas dryer	Washing Machine	7	7	0	96
ESWMT3EE	Washing Machine T3 electric, electric dryer	Washing Machine	14	14	5,208	0
ESWMT3EG	Washing Machine T3 electric, gas dryer	Washing Machine	2	2	450	0
ESWMT3GE	Washing Machine T3 gas, electric dryer	Washing Machine	23	23	0	225
ESWMT3GG	Washing Machine T3 gas, gas dryer	Washing Machine	61	61	0	958
HHSW EVENT	HAND HELD SHOWER WAND - EVENT	Showerhead	50	50	13,468	810
KIT1(ELEC) EVENT	KIT 1 (ELEC) - EVENT [1 Kitchen FA, 1 FA, 1 SH, 6ft PW]	Kit - No CFL	2	2	2,312	0
KIT1(GAS) EVENT	KIT 1 (GAS) - EVENT [1 Kitchen FA, 1 FA, 1 SH, 6ft PW]	Kit - No CFL	66	66	0	3,934
LEDNL EVENT	LED NIGHT LIGHT - EVENT	LED Night Light	52	52	2,618	0
LFFA EVENT	LOW FLOW FAUCET AERATOR - EVENT	Faucet Aerator	12	12	4,980	204
LFSH EVENT	LOW FLOW SHOWER HEAD - EVENT	Showerhead	15	15	3,626	378
SPS EVENT	SMART POWER STRIP - EVENT	Smart Strip	105	105	11,241	0
Total ENERGY STAR Frame			**983**	**962**	**292,334**	**10,623**

Table 136. Sample Frame Summary, Appliance Recycling

Measure Code	Measure Description	Measure Category	# Measures	# Customers	kWh
0183REF	Refrigerator Recycling:Participant:Rebate:0183RE	Refrigerator	343	340	603,592
0184FRE	Freezer Recycling:Participant:Rebate:0184FRE	Freezer	100	100	159,753
ARFR	Freezer (Actual cost per unit - $150)	Freezer	65	64	105,468
ARRF	Refrigerator (Actual cost per unit - $150)	Refrigerator	179	175	302,632
Total Appliance Recycling Frame			**687**	**679**	**1,171,445**

Table 137. Sample Frame Summary, HVAC

Measure Code	Measure Description	Measure Category	# Measures	# Customers	kWh	ccf
0555STH	Setback Thermostat:Participant:Incentive:0555STH	Thermostat	115	115	0	9,088
0560ASH	ASHP:Participant:Incentive:0560ASH	Heat Pump	3	3	3,409	0
0561CAC	CAC:Participant:Incentive:0561CAC	CAC	18	18	8,921	0
0564ECM	ECM Furnace Fan:Participant:Incentive:0564ECM	ECM	28	28	20,440	0
0566GWH	Super Efficiency Gas WH:Participant:Incentive:0566GWH	Water Heaters	1	1	0	36
0568BOI	Boiler:Participant:Incentive:0568BOI	Boiler	1	1	0	746
0570FUR	High Eff Furnace:Participant:Incentive:0570FUR	Furnace	191	190	0	42,797
0572OMT	O&M TuneUp-Gas:Participant:Incentive:0572OMT	Furnace Tune-up	7	7	0	445
HVACASHP15	AIR SOURCE HEAT PUMP 15 SEER	Heat Pump	1	1	770	0
HVACASHP15	Air Source Heat Pump SEER 15	Heat Pump	2	2	1,967	0
HVACASHP16	Air Source Heat Pump SEER 16	Heat Pump	3	3	4,380	0
HVACASHP17	Air Source Heat Pump SEER 17	Heat Pump	2	2	3,426	0
HVACASHP18	Air Source Heat Pump SEER 18	Heat Pump	2	2	3,787	0
HVACB92	Boiler AFUE 92% - 94%	Boiler	5	5	0	6,111
HVACB95	Boiler AFUE 95% + NOV PROMO ('12 Savings)	Boiler	2	2	0	2,488
HVACCAC14	CENTRAL AIR CONDITIONER SEER 14	CAC	1	1	329	0
HVACCAC15	Central Air Conditioner SEER 15	CAC	7	7	3,132	0
HVACCAC16	Central Air Conditioner SEER 16	CAC	7	7	2,516	0
HVACCAC17	Central Air Conditioner SEER 17	CAC	2	2	1,647	0
HVACECM	ECM blower- average	ECM	82	82	59,860	0
HVACF95	Furnace, High Efficiency, 95%	Furnace	490	489	0	114,518
HVACF95	Furnace, High Efficiency, 95% - NOV PROMO	Furnace	14	14	0	3,840
HVACF95	Furnace, High Efficiency, 95% - NOV PROMO ('12 Savings)	Furnace	42	42	0	10,220
HVACFTU	Furnace Tune Up	Furnace Tune-up	77	77	0	5,659
HVACFTU	HVAC FURNACE TUNE UP - NOV PROMO	Furnace Tune-up	6	6	0	561
HVACFTU	HVAC FURNACE TUNE UP - NOV PROMO ('12 Savings)	Furnace Tune-up	13	10	0	1,004
HVACFTU<100	HVAC FURNACE TUNE UP - NOV PROMO Cost < $100	Furnace Tune-up	3	3	0	223
HVACFTU<100	HVAC FURNACE TUNE UP - NOV PROMO Cost < $100 ('12 Savings	Furnace Tune-up	3	3	0	240
HVACGSHP19	Ground Source Heat Pump EER 19, EER Base	Heat Pump	1	1	3,354	0
HVACSTM	Thermostat, Moderate Setback	Thermostat	302	301	0	21,894
HVACSTM	Thermostat, Moderate Setback - NOV PROMO	Thermostat	9	9	0	685
HVACSTM	Thermostat, Moderate Setback - NOV PROMO ('12 Savings)	Thermostat	24	24	0	1,708
HVACSWH	Water Heater, SUPER EfficienT, >67%	Water Heaters	1	1	0	36
HVACSWH	Water Heater, Super Efficient, >67%	Water Heaters	7	7	0	252
HVACWH	Water Heater, High Efficiency, >62%	Water Heaters	1	1	0	10
HVACWHT	Water Heater, Tankless	Water Heaters	5	5	0	335
Total HVAC Frame			**1,478**	**1,472**	**117,936**	**222,895**

Table 138. Sample Frame Summary, Low Income

Measure Code	Measure Description	Measure Category	# Measures	# Customers	kWh	ccf
CFL	CFL DIRECT INSTALL	CFL	47	45	19,929	0
CFL (B)	CFL DIRECT INSTALL (GROUP B)	CFL	36	34	15,522	0
CFL-CIM	CFL - CONTRACTOR INSTALL & MEASURE	CFL	8	7	48,360	0
FTU (B)	O&M Furance Tune Up (GROUP B)	Furnace Tune-up	102	95	0	6,248
KFA	KITCHEN FAUCET AERATOR	Faucet Aerator	46	45	3,486	247
KFA-E (B)	KITCHEN FAUCET AERATOR (GROUP B)	Faucet Aerator	14	14	2,490	0
KFA-G (B)	KITCHEN FAUCET AERATOR (GROUP B)	Faucet Aerator	787	772	0	6,885
KFA-G_B	KITCHEN FACUET AERATOR - BETA TEST	Faucet Aerator	176	175	0	1,496
LFA-E	LOW FLOW FAUCET AERATOR	Faucet Aerator	18	18	3,320	0
LFA-E (B)	LOW FLOW FAUCET AERATOR (GROUP B)	Faucet Aerator	13	13	2,988	0
LFA-G	LOW FLOW FAUCET AERATOR	Faucet Aerator	30	28	0	357
LFA-G (B)	LOW FLOW FAUCET AERATOR (GROUP B)	Faucet Aerator	750	732	0	9,070
LFHH	LOW FLOW HANDHELD SHOWERHEAD	Showerhead	4	4	518	81
LFHH-E (B)	LOW FLOW HANDHELD SHOWERHEAD (GROUP B)	Showerhead	2	2	1,036	0
LFHH-G (B)	LOW FLOW HANDHELD SHOWERHEAD (GROUP B)	Showerhead	124	122	0	3,618
LFS-E	LOW FLOW SHOWERHEAD	Showerhead	16	16	9,324	0
LFS-E (B)	LOW FLOW SHOWERHEAD (GROUP B)	Showerhead	13	13	6,734	0
LFS-G	LOW FLOW SHOWERHEAD	Showerhead	25	24	0	837
LFS-G (B)	LOW FLOW SHOWERHEAD (GROUP B)	Showerhead	694	684	0	23,274
LFS-G_B	LOW FLOW SHOWERHEAD - BETA TEST	Showerhead	127	126	0	3,429
LIBJI	Band Joist Insulation	Insulation	10	10	0	477
LICFL	CFL distribution - Compact Fluorescent Bulbs	CFL	205	202	75,075	0
LICFL	Compact Fluorescent Bulbs	CFL	316	313	137,592	0
LICI-SQ	Attic Insulation	Insulation	102	102	0	3,760
LIF92	Furnace, High Efficiency, 92%	Boiler and Furnace	17	17	0	2,753
LIF95	Furnace, High Efficiency, 95%	Boiler and Furnace	25	25	0	5,055
LIFA-G_B	LOW FLOW FAUCET AERATOR - BETA TEST	Faucet Aerator	173	172	0	1,879
LIFTU	Furnace Tune-up, O&M	Furnace Tune-up	202	201	0	11,216
LIGB	Boiler 92% plus AFUE	Boiler and Furnace	2	2	0	2,139
LIIR20	Air Sealing - 20%	Air Sealing	2	2	0	63
LIIR30	Air Sealing - 30%	Air Sealing	11	11	0	464
LIIR40	Air Sealing - 40%	Air Sealing	4	4	0	264
LIIR50	Air Sealing - 50%	Air Sealing	7	7	0	599
LIMHBI	Mobile Home Belly (Floor) Insulation	Insulation	2	2	0	94
LIRF	Refrigerators	Refrigerator	137	137	171,250	0
LISTM	Thermostat, Moderate Setback	Thermostat	204	203	0	8,022
LIWI-SQ	Wall Insulation	Insulation	50	50	0	1,091
MFCFL	COMPACT FLUORESCENT BULBS - MF	CFL	3	3	19,461	0
MFFTUC	FURNACE TUNE-UP, O&M CONTRACTOR	Furnace Tune-up	1	1	0	2,489
MFKFA	KITCHEN Faucet Aerator	Faucet Aerator	2	2	0	2,176
MFKFAC	KITCHEN FAUCET AERATOR CONTRACTOR	Faucet Aerator	2	2	0	689
MFKFA_IC	KITCHEN FAUCET AERATOR - CONTRACTOR INSTALL & MEASURE	Faucet Aerator	11	9	12,450	3,536
MFLFA	Low Flow Faucet Aerator	Faucet Aerator	2	2	0	1,896
MFLFAC	LOW FLOW FAUCET AERATOR CONTRACTOR	Faucet Aerator	2	2	0	510
MFLFA_IC	LOW FLOW FAUCET AERATOR - CONTRACTOR INSTALL & MEASURE	Faucet Aerator	10	9	9,960	1,666
MFLFHH	LOW FLOW HANDHELD SHOWERHEAD	Showerhead	1	1	0	2,484
MFLFHHC	LOW FLOW HANDHELD SHOWERHEAD CONTRACTOR	Showerhead	2	2	0	1,134
MFLFHSH_IC	LOW FLOW HANDHELD SHOWERHEAD - CONTRACTOR INSTALL & MEASUR	Showerhead	9	6	32,634	4,347
MFLFS	Low Flow Showerhead	Showerhead	2	2	0	5,292
MFLFSC	LOW FLOW SHOWERHEAD CONTRACTOR	Showerhead	2	2	0	1,377
MFLFSH_IC	LOW FLOW SHOWERHEAD - CONTRACTOR INSTALL & MEASURE	Showerhead	8	7	10,878	5,805
MFPW	Pipe Wrap	Pipe Wrap	1	1	0	1,856
MFPWC	PIPE WRAP CONTRACTOR	Pipe Wrap	1	1	0	796
MFPW_IC	PIPE WRAP - CONTRACTOR INSTALL & MEASURE	Pipe Wrap	2	2	0	203
MFTSATC	THERMOSTAT, PROGRAMMABLE - CONTRACTOR	Thermostat	1	1	0	1,290
MFTSTAT_IC	THERMOSTAT, PROGRAMMABLE - CONTRACTOR INSTALL & MEASURE	Thermostat	7	5	0	10,095
PW-E	PIPE WRAP	Pipe Wrap	10	10	3,060	0
PW-E (B)	PIPE WRAP (GROUP B)	Pipe Wrap	9	9	2,754	0
PW-G	PIPE WRAP	Pipe Wrap	19	18	0	296
PW-G (B)	PIPE WRAP (GROUP B)	Pipe Wrap	448	440	0	6,989
STM	THERMOSTAT, PROGRAMMABLE	Thermostat	32	31	0	1,867
STM (B)	THERMOSTAT, PROGRAMMABLE (GROUP B)	Thermostat	880	847	0	39,446
Total Low Income Frame			**5,968**	**5,844**	**588,821**	**189,654**

Table 139. Sample Frame Summary, Online Audit

Measure Code	Measure Description	Measure Category	# Measures	# Customers	kWh	ccf
0577OAK	Online Audit Kit (ECK 200): CLEAResult: Incentive: 0577OAK	Kit 200	64	62	66,880	0
0577OAK	Online Audit Kit (ECK 201): CLEAResult: Incentive: 0577OAK	Kit 201	90	89	21,510	0
0577OAK	Online Audit Kit (ECK 203): CLEAResult: Incentive: 0577OAK	Kit 203	318	268	0	20,543
OAKEE200	Online Audit Kit # 200 Electric Water Heater	Kit 200	404	403	422,180	0
OAKG203	Online Audit Kit # 203 Gas Water Heater	Kit 203	377	374	0	24,354
OAKNE201	Online Audit Kit # 201 Elec Cust Gas Water Heater	Kit 201	625	619	149,375	0
Total Online Audit Frame			**1,878**	**1,815**	**659,945**	**44,897**

Table 140. Sample Frame Summary, Onsite Weatherization

Measure Code	Measure Description	Measure Category	# Measures	# Customers	kWh	ccf
0549CFL	CFL Bulbs:Participant:Incentive:0549CFL	CFL	1,578	1,473	641,940	0
0550LFS	Low Flow Showerhead:Participant:Incentive:0550LFS	Showerhead	1,745	1,623	390,054	39,069
0551FAE	Low Flow Faucet Aerator:Participant:Incentive:0551FAE	Faucet Aerator	1,671	1,576	122,840	13,099
0552KAE	Low Flow Kitchen Aerator:Participant:Incentive:0552KAE	Faucet Aerator	1,567	1,480	88,976	9,520
0553PWR	Pipe Wrap:Participant:Incentive:0553PWR	Pipe Wrap	1,440	1,353	146,880	14,976
0555STH	Setback Thermostat:Participant:Incentive:0555STH	Thermostat	1,063	1,000	0	64,155
1140LFH	Low Flow Showerhead Handheld:Participant:Incentive:1140LFH	Showerhead	4	4	518	81
AWXAS	AIR SEAL, 10%	Air Sealing	26	26	0	1,044
AWXBJI	BAND JOIST INSULATION	Insulation	37	37	0	1,893
AWXBWI	BASEMENT WALL INSULATION	Insulation	6	6	0	287
AWXBWI	BASEMENT WALL INSULATION ('11 $s, '12 savings)	Insulation	3	3	0	143
AWXCI	CEILING INSULATION	Insulation	45	45	0	2,607
AWXCI	CEILING INSULATION ('12 savings)	Insulation	11	11	0	652
AWXCWI	CRAWLSPACE WALL INSULATION	Insulation	5	5	0	157
AWXCWI	CRAWLSPACE WALL INSULATION ('12 Savings)	Insulation	2	2	0	38
AWXFI	FLOOR INSULATION	Insulation	3	3	0	66
AWXICCFL	DIRECT INSTALL CFL INDEPENDENT CONTRACTOR	CFL	107	98	40,365	0
AWXICCFLMF	CFL BULBS MATERIALS & FEES	CFL	165	159	65,754	0
AWXICFA	DIRECT INSTALL FAUCET AREATOR INDEPENDENT CONTRACTO	Faucet Aerator	488	412	3,486	7,191
AWXICLFBAMF	LOW FLOW BATH FAUCET AERATOR MATERIALS & FEES	Faucet Aerator	309	267	4,980	3,341
AWXICLFKAMF	LOW FLOW KITCHEN FAUCET AERATOR MATERIALS & FEES	Faucet Aerator	283	242	3,154	2,457
AWXICLFSMF	LOW FLOW SHOWERHEAD MATERIALS & FEES	Showerhead	312	270	17,094	9,720
AWXICPW	DIRECT INSTALL PIPE WRAP 6FT INDEPENDENT CONTRACTOR	Pipe Wrap	469	394	3,978	7,114
AWXICPWMF	LOW FLOW PIPE WRAP MATERIALS & FEES	Pipe Wrap	310	270	6,732	4,493
AWXICSH	DIRECT INSTALL SHOWER HEAD INDEPENDENT CONTRACTOR	Showerhead	431	360	4,662	12,393
AWXICSTMMF	SETBACK THERMOSTAT - MODERATE MATERIALS & FEES	Thermostat	307	266	0	20,215
AWXICTSTAT	DIRECT INSTALL T-STAT INDEPENDENT CONTRACTOR	Thermostat	626	553	0	42,669
AWXWESCFL	DIRECT INSTALL CFL WES 13 WATT	CFL	288	264	125,541	0
AWXWESCFL	DIRECT INSTALL CFL WES 19 WATT	CFL	2	2	880	0
AWXWESFA	DIRECT INSTALL FAUCET AREATOR WES	Faucet Aerator	601	555	38,512	8,143
AWXWESFA	DIRECT INSTALL FAUCET AREATOR WES ('11)	Faucet Aerator	3	3	0	43
AWXWESKFA	DIRECT INSTALL KITCHEN FAUCET AREATOR WES	Faucet Aerator	7	7	166	68
AWXWESPW	DIRECT INSTALL PIPE WRAP 6FT WES	Pipe Wrap	360	330	18,972	4,649
AWXWESSH	DIRECT INSTALL SHOWER HEAD WES	Showerhead	540	502	65,268	13,932
AWXWESSH	DIRECT INSTALL SHOWER HEAD WES ('11)	Showerhead	2	2	0	81
AWXWESTSTAT	DIRECT INSTALL T-STAT WES	Thermostat	262	247	0	19,340
AWXWI	WALL INSULATION	Insulation	9	9	0	408
AWXWI	WALL INSULATION ('12 Savings)	Insulation	3	3	0	230
AWXWR	WINDOW REPLACEMENT	Window Replacement	43	43	0	4,572
Total Onsite Weatherization Frame			**15,133**	**13,905**	**1,790,752**	**308,843**

F.1.2 Sampling Methodology

DNV KEMA used the MBSS™ methodology to develop efficient sample designs and to assess the likely statistical precision. The target variable of analysis, denoted *y*, is the energy savings of the project. The primary stratification variable, the estimated energy savings of the project, is denoted *x*. Because there were measures that saved both electricity and gas in the program, DNV KEMA used a single "energy"

measure that recognizes the difference in energy cost between electricity and natural gas.[37] A ratio model was formulated to describe the relationship between *y* and *x* for all units in the population, e.g., all program participants.

The MBSS™ ratio model consists of two equations called the primary and secondary equations:

$$\begin{aligned} y_k &= \beta x_k + \varepsilon_k \\ \sigma_k &= sd(y_k) = \sigma_0 x_k^{\gamma} \end{aligned}$$

where

- $x_k > 0$ is known throughout the population.
- K denotes the sampling unit, i.e., the measure.
- $\{\varepsilon_1, \ldots, \varepsilon_N\}$ are independent random variables with an expected value of zero, and
- β, σ_0, and γ (gamma) are parameters of the model.

The primary equation can also be written as

$$\mu_k = \beta x_k$$

Under the MBSS ratio model, it is assumed that the expected value of *y* is a simple ratio or multiple of *x*. Here, y_k is a random variable with expected value μ_k and standard deviation σ_k.

Both the expected value and standard deviation generally vary from one unit to another depending on x_k, following the primary and secondary equations of the model. In statistical jargon, the ratio model is (usually) a heteroscedastic regression model with zero intercept.

One of the key parameters of the ratio model is the error ratio, denoted *er*. The error ratio is a measure of the strength of the association between *y* and *x*. The error ratio is suitable for measuring the strength of a heteroscedastic relationship and for choosing sample sizes. It is *not* equal to the correlation coefficient. It *is* somewhat analogous to a coefficient of variation except that it describes the association between two or more variables rather than the variation in a single variable.

Using the model discussed above, the error ratio, *er*, is defined to be:

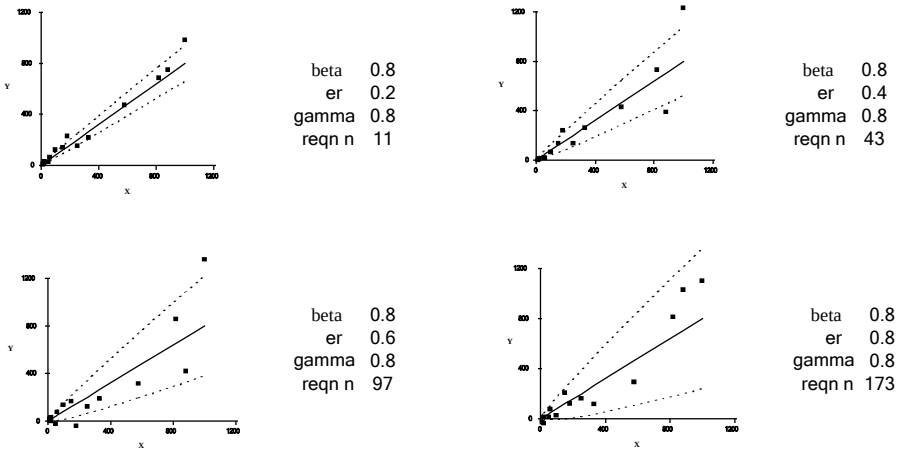
[37] The energy measure used for sampling was calculated using this equation: 3 * 3,412 * kWh savings + 99,976 * ccf savings * 1.025.

$$er = \frac{\sum_{k=1}^{N}\sigma_k}{\sum_{k=1}^{N}\mu_k} = \frac{\frac{1}{N}\sum_{k=1}^{N}\sigma_k}{\frac{1}{N}\sum_{k=1}^{N}\mu_k}$$

Figure 8 gives some typical examples of ratio models with different error ratios. An error ratio of 0.2 represents a very strong association between *y* and *x*, whereas an error ratio of 0.8 represents a weak association. Loosely speaking, an error ratio of 0.75 implies that the measured savings is typically within ± 75 percent of the tracking estimate of savings adjusted for the realization rate. The smaller the error ratio, the stronger the association between tracking and measured savings, and the smaller the sample size needed to estimate the program realization rate with a fixed precision.

As Figure 8 indicates, the error ratio is the principal determinant of the sample size required to satisfy the 90/10 criteria for estimating *y*. If the error ratio is small, then the required sample is correspondingly small.

Figure 8. Examples of MBSS Ratio Models



F.2 Sample Disposition

The sample designs discussed in the previous section represent the optimal distribution of the data collection targets. However, the actual data collected is limited by the willingness of the respondents to complete the survey. Respondents may refuse to participate in the survey, which may result in strata that do not meet their completion targets. In those cases, DNV KEMA often moved targets from one stratum to another to achieve the overall number of target completes.

F.2.1 Participant Surveys

Table 141 through Table 148 show the sample disposition for each survey delivered for the impact evaluation. The first column shows the strata number, the second column the measure description that corresponds to the sample design, and the third column the number of measures in the sample frame. The tables also show the target completes, sample completes, percentage of reported frame savings represented by each stratum, and the percentage of reported frame savings represented by the completed surveys. The final column, Status, indicates whether or not every customer was "killed" in each stratum. If the entry says, "Exhausted," then DNV KEMA attempted to contact every customer in that stratum.

DNV KEMA completed a census of program participants for the ENERGY STAR, C&I, and Appliance Recycling and Multifamily samples. All were designed to be census samples: we knew that we would be unlikely to achieve our desired customer completes, even calling everyone in the program.

DNV KEMA did not complete a census of the Low Income, Onsite Weatherization, HVAC, or Online Audit programs. Low Income exceeded its target by completing surveys representing 817 measures out of a targeted 250 measures, For HVAC, we completed 320 out of 200 targeted measures; for Onsite Weatherization, 853 out of 250; for Online Audit, 326 out of 300. Low Income, HVAC and Onsite Weatherization ended up completing significantly more measures than targeted because our customer-level sample (used to track completes for the survey house) was designed to **guarantee** enough measure completes to meet our measure-level targets. Given the factor of safety included in the design, we were usually able to meet our measure-level targets despite missing our customer-level targets.

Multifamily worked off of a participant-level rather than measure-level sample design.

Table 141. ENERGY STAR Sample Disposition

Stratum	Measure Code	Measures in Frame	Target Completes	Sample Completes	Fraction of Frame Total Reported Savings				Status
					Frame		Sample		
					kWh	ccf	kWh	ccf	
5020101011	CFL	74	10	11	4%	0%	1%	0%	Exhausted
5020101012	CFL	33	10	8	5%	0%	1%	0%	Exhausted
5020102011	CFL	69	10	7	3%	0%	0%	0%	Exhausted
5020102012	CFL	31	10	7	3%	0%	1%	0%	Exhausted
5020102013	CFL	24	10	5	4%	0%	1%	0%	Exhausted
5020801011	Clothes Dryer	2	2	0	0%	0%	0%	0%	Exhausted
5020801021	Clothes Dryer	1	1	0	0%	0%	0%	0%	Exhausted
5020802011	Clothes Dryer	11	7	5	1%	0%	0%	0%	Exhausted
5020802021	Clothes Dryer	1	1	0	0%	0%	0%	0%	Exhausted
5021001011	Faucet Aerator	4	2	1	0%	0%	0%	0%	Exhausted
5021001012	Faucet Aerator	1	1	0	0%	0%	0%	0%	Exhausted
5021001021	Faucet Aerator	1	1	1	0%	0%	0%	0%	Exhausted
5021001022	Faucet Aerator	1	1	1	0%	0%	0%	0%	Exhausted
5021002011	Faucet Aerator	1	1	0	1%	0%	0%	0%	Exhausted
5021002021	Faucet Aerator	2	2	0	0%	0%	0%	0%	Exhausted
5021002022	Faucet Aerator	3	3	0	0%	1%	0%	0%	Exhausted
5022001011	LED Night Light	26	10	7	0%	0%	0%	0%	Exhausted
5022002011	LED Night Light	20	8	4	0%	0%	0%	0%	Exhausted
5022002012	LED Night Light	11	7	3	0%	0%	0%	0%	Exhausted
5022301021	Pipe Wrap	2	2	1	0%	0%	0%	0%	Exhausted
5022302021	Pipe Wrap	1	1	1	0%	0%	0%	0%	Exhausted
5022801011	Showerhead	13	8	4	2%	0%	1%	0%	Exhausted
5022801012	Showerhead	14	8	2	2%	0%	0%	0%	Exhausted
5022801013	Showerhead	11	7	4	3%	0%	1%	0%	Exhausted
5022801021	Showerhead	45	9	7	0%	15%	0%	3%	Exhausted
5022802011	Showerhead	7	5	0	1%	0%	0%	0%	Exhausted
5022802012	Showerhead	4	4	1	2%	0%	0%	0%	Exhausted
5022802021	Showerhead	7	5	3	0%	2%	0%	1%	Exhausted
5022802022	Showerhead	7	4	1	0%	2%	0%	0%	Exhausted
5022802023	Showerhead	4	4	1	0%	2%	0%	1%	Exhausted
5022901011	Smart Strip	28	7	4	1%	0%	0%	0%	Exhausted
5022901012	Smart Strip	19	7	7	1%	0%	0%	0%	Exhausted
5022902011	Smart Strip	41	7	13	1%	0%	0%	0%	Exhausted
5022902012	Smart Strip	27	7	6	1%	0%	0%	0%	Exhausted
5023001011	Washing Machine	9	3	5	1%	0%	1%	0%	Exhausted
5023001021	Washing Machine	58	8	8	0%	7%	0%	1%	Exhausted
5023001022	Washing Machine	48	7	8	0%	7%	0%	1%	Exhausted
5023002011	Washing Machine	25	7	13	3%	0%	2%	0%	Exhausted
5023002021	Washing Machine	23	4	8	0%	3%	0%	1%	Exhausted
5023601011	Dishwasher	3	3	0	0%	0%	0%	0%	Exhausted
5023601021	Dishwasher	27	22	8	0%	3%	0%	1%	Exhausted
5023602011	Dishwasher	3	3	0	0%	0%	0%	0%	Exhausted
5023602021	Dishwasher	6	3	1	0%	1%	0%	0%	Exhausted
5024701011	Kit - No CFL	1	1	0	0%	0%	0%	0%	Exhausted
5024701021	Kit - No CFL	24	9	3	0%	13%	0%	2%	Exhausted
5024701022	Kit - No CFL	25	9	6	0%	14%	0%	3%	Exhausted
5024702011	Kit - No CFL	1	1	1	0%	0%	0%	0%	Exhausted
5024702021	Kit - No CFL	20	17	5	0%	11%	0%	3%	Exhausted
5024801011	Kit - CFL	41	9	8	8%	0%	1%	0%	Exhausted
5024801012	Kit - CFL	19	9	2	11%	0%	1%	0%	Exhausted
5024801013	Kit - CFL	19	9	2	11%	0%	1%	0%	Exhausted
5024801014	Kit - CFL	19	8	5	11%	0%	3%	0%	Exhausted
5024801021	Kit - CFL	31	19	5	0%	17%	0%	3%	Exhausted
5024802011	Kit - CFL	20	9	5	8%	0%	2%	0%	Exhausted
5024802012	Kit - CFL	15	8	0	9%	0%	0%	0%	Exhausted
Total ENERGY STAR		**983**	**350**	**208**	**100%**	**100%**	**19%**	**20%**	

Table 142. Appliance Recycling Sample Disposition

Measure	Measures in Frame	Target Completes	Measure Completes	Fraction of Frame Total Reported Savings		Status
				Frame	Sample	
Refrigerator	171	Census	230	77%	75%	Exhausted
Freezer	542	Census	75	23%	25%	Exhausted
Total Appliance Recycling	**713**		**305**	**100%**	**100%**	

Table 143. HVAC Sample Disposition

Stratum	Measure Code	Measures in Frame	Target Completes	Sample Completes	Fraction of Frame Total Reported Savings				Status
					Frame		Sample		
					kWh	ccf	kWh	ccf	
22020401021	Boiler	4	4	0	0%	2%	0%	0%	Exhausted
22020401022	Boiler	2	2	2	0%	2%	0%	2%	Exhausted
22020402021	Boiler	1	1	0	0%	0%	0%	0%	Exhausted
22020402022	Boiler	1	1	1	0%	0%	0%	0%	Exhausted
22020601011	CAC	21	9	6	6%	0%	2%	0%	Exhausted
22020601012	CAC	14	8	7	8%	0%	4%	0%	Exhausted
22020901011	ECM	81	14	24	50%	0%	15%	0%	Available
22020902011	ECM	29	16	12	18%	0%	7%	0%	Exhausted
22021201021	Furnace	163	16	31	0%	13%	0%	3%	Available
22021201022	Furnace	140	16	27	0%	13%	0%	3%	Available
22021201023	Furnace	126	15	26	0%	14%	0%	3%	Available
22021201024	Furnace	118	15	26	0%	14%	0%	3%	Available
22021201025	Furnace	101	15	22	0%	14%	0%	3%	Exhausted
22021202021	Furnace	50	8	16	0%	4%	0%	1%	Available
22021202022	Furnace	39	7	11	0%	5%	0%	1%	Available
22021301021	Furnace Tune-up	84	5	11	0%	3%	0%	0%	Available
22021302021	Furnace Tune-up	25	2	1	0%	1%	0%	0%	Exhausted
22022401021	Thermostat	250	10	34	0%	6%	0%	1%	Available
22022401022	Thermostat	149	10	37	0%	7%	0%	2%	Exhausted
22022402021	Thermostat	51	3	14	0%	2%	0%	0%	Exhausted
22023101021	Water Heaters	13	8	5	0%	0%	0%	0%	Exhausted
22023102021	Water Heaters	2	1	1	0%	0%	0%	0%	Exhausted
22025901011	Heat Pump	4	4	2	3%	0%	2%	0%	Exhausted
22025901012	Heat Pump	3	3	0	3%	0%	0%	0%	Exhausted
22025901013	Heat Pump	6	6	4	9%	0%	6%	0%	Exhausted
22025902011	Heat Pump	1	1	0	3%	0%	0%	0%	Exhausted
Total HVAC		**1,478**	**200**	**320**	**100%**	**100%**	**35%**	**23%**	

Table 144. Low Income Sample Disposition

Stratum	Measure Code	Measures in Frame	Target Completes	Sample Completes	Fraction of Frame Total Reported Savings				Status
					Frame		Sample		
					kWh	ccf	kWh	ccf	
7020101011	CFL	120	8	23	7%	0%	1%	0%	Available
7020101012	CFL	78	8	12	7%	0%	1%	0%	Exhausted
7020101013	CFL	56	7	8	8%	0%	1%	0%	Exhausted
7020102011	CFL	162	8	23	8%	0%	1%	0%	Available
7020102012	CFL	130	8	8	9%	0%	1%	0%	Available
7020102013	CFL	68	7	16	12%	0%	1%	0%	Exhausted
7020102014	CFL	1	1	0	3%	0%	0%	0%	Exhausted
7020301021	Air Sealing	20	4	5	0%	1%	0%	0%	Exhausted
7020302021	Air Sealing	3	1	2	0%	0%	0%	0%	Exhausted
7020302022	Air Sealing	1	1	1	0%	0%	0%	0%	Exhausted
7021001011	Faucet Aerator	26	6	6	1%	0%	0%	0%	Exhausted
7021001021	Faucet Aerator	851	10	88	0%	4%	0%	0%	Available
7021001022	Faucet Aerator	776	9	103	0%	4%	0%	1%	Available
7021001023	Faucet Aerator	275	9	30	0%	7%	0%	0%	Available
7021002011	Faucet Aerator	39	6	21	1%	0%	1%	0%	Exhausted
7021002012	Faucet Aerator	4	4	0	4%	0%	0%	0%	Exhausted
7021002021	Faucet Aerator	64	7	18	0%	1%	0%	0%	Exhausted
7021002022	Faucet Aerator	1	1	1	0%	0%	0%	0%	Exhausted
7021301021	Furnace Tune-up	188	7	24	0%	5%	0%	1%	Available
7021301022	Furnace Tune-up	116	6	21	0%	6%	0%	1%	Available
7021302021	Furnace Tune-up	1	1	1	0%	0%	0%	0%	Exhausted
7021501021	Insulation	126	3	24	0%	2%	0%	0%	Exhausted
7021502021	Insulation	38	3	11	0%	1%	0%	0%	Available
7022301011	Pipe Wrap	8	1	4	0%	0%	0%	0%	Exhausted
7022301021	Pipe Wrap	238	6	20	0%	2%	0%	0%	Available
7022301022	Pipe Wrap	212	6	29	0%	2%	0%	0%	Available
7022301023	Pipe Wrap	1	1	0	0%	1%	0%	0%	Exhausted
7022302011	Pipe Wrap	11	1	8	1%	0%	0%	0%	Exhausted
7022302021	Pipe Wrap	20	2	5	0%	0%	0%	0%	Exhausted
7022401021	Thermostat	706	9	82	0%	12%	0%	1%	Available
7022401022	Thermostat	382	9	58	0%	14%	0%	2%	Available
7022402021	Thermostat	34	5	13	0%	3%	0%	0%	Exhausted
7022402022	Thermostat	2	2	2	0%	3%	0%	3%	Exhausted
7022501011	Refrigerator	52	4	7	11%	0%	1%	0%	Exhausted
7022502011	Refrigerator	85	7	12	18%	0%	3%	0%	Available
7022801011	Showerhead	14	2	4	1%	0%	0%	0%	Exhausted
7022801021	Showerhead	233	8	28	0%	3%	0%	0%	Available
7022801022	Showerhead	233	8	16	0%	3%	0%	0%	Available
7022801023	Showerhead	234	8	20	0%	3%	0%	0%	Available
7022801024	Showerhead	163	8	15	0%	4%	0%	0%	Available
7022801025	Showerhead	91	8	12	0%	5%	0%	0%	Available
7022801026	Showerhead	3	3	0	0%	4%	0%	0%	Exhausted
7022802011	Showerhead	19	6	12	2%	0%	1%	0%	Exhausted
7022802012	Showerhead	2	2	0	7%	0%	0%	0%	Exhausted
7022802021	Showerhead	35	6	10	0%	2%	0%	1%	Exhausted
7022802022	Showerhead	2	2	1	0%	3%	0%	2%	Exhausted
7025001021	Boiler and Furnace	36	8	10	0%	4%	0%	1%	Exhausted
7025002021	Boiler and Furnace	8	3	3	0%	1%	0%	0%	Exhausted
Total Low Income		**5,968**	**250**	**817**	**100%**	**100%**	**13%**	**18%**	

Table 145. Online Audit Sample Disposition

Stratum	Measure Code	Measures in Frame	Target Completes	Sample Completes	Fraction of Frame Total Reported Savings				Status
					Frame		Sample		
					kWh	ccf	kWh	ccf	
23021601011	Kit 200	342	75	78	54%	0%	12%	0%	Exhausted
23021602011	Kit 200	126	56	22	20%	0%	3%	0%	Exhausted
23021701011	Kit 201	491	17	46	18%	0%	2%	0%	Available
23021702011	Kit 201	224	27	48	8%	0%	2%	0%	Available
23021801021	Kit 203	528	75	96	0%	76%	0%	14%	Available
23021802021	Kit 203	167	50	36	0%	24%	0%	5%	Exhausted
Total Online Audit		**1,878**	**300**	**326**	**100%**	**100%**	**19%**	**19%**	

Table 146. Onsite Weatherization Sample Disposition

Stratum	Measure Code	Measures in Frame	Target Completes	Sample Completes	Fraction of Frame Total Reported Savings				Status
					Frame		Sample		
					kWh	ccf	kWh	ccf	
21020101011	CFL	391	10	34	9%	0%	1%	0%	Available
21020102011	CFL	586	10	28	9%	0%	0%	0%	Available
21020102012	CFL	390	10	23	10%	0%	1%	0%	Available
21020102013	CFL	390	9	28	10%	0%	1%	0%	Available
21020102014	CFL	383	9	23	10%	0%	1%	0%	Available
21020301021	Air Sealing	22	1	2	0%	0%	0%	0%	Available
21020302021	Air Sealing	4	1	1	0%	0%	0%	0%	Exhausted
21021001011	Faucet Aerator	230	10	42	3%	0%	1%	0%	Available
21021001021	Faucet Aerator	1338	9	37	0%	6%	0%	0%	Available
21021002011	Faucet Aerator	1006	10	72	11%	0%	1%	0%	Available
21021002021	Faucet Aerator	1443	7	56	0%	4%	0%	0%	Available
21021002022	Faucet Aerator	912	6	39	0%	4%	0%	0%	Available
21021501021	Insulation	105	3	9	0%	2%	0%	0%	Available
21021502021	Insulation	19	1	7	0%	0%	0%	0%	Exhausted
21022301011	Pipe Wrap	109	5	21	2%	0%	0%	0%	Exhausted
21022301021	Pipe Wrap	816	7	19	0%	4%	0%	0%	Available
21022302011	Pipe Wrap	468	7	37	8%	0%	1%	0%	Available
21022302021	Pipe Wrap	1186	9	65	0%	6%	0%	0%	Available
21022401021	Thermostat	374	8	24	0%	5%	0%	0%	Available
21022401022	Thermostat	285	7	10	0%	5%	0%	0%	Available
21022401023	Thermostat	186	7	10	0%	6%	0%	0%	Available
21022402021	Thermostat	525	10	29	0%	7%	0%	0%	Available
21022402022	Thermostat	380	10	28	0%	7%	0%	1%	Available
21022402023	Thermostat	293	10	17	0%	8%	0%	0%	Available
21022402024	Thermostat	215	9	20	0%	9%	0%	1%	Available
21022801011	Showerhead	159	7	30	6%	0%	1%	0%	Available
21022801021	Showerhead	549	8	12	0%	5%	0%	0%	Available
21022801022	Showerhead	408	8	13	0%	5%	0%	0%	Available
21022802011	Showerhead	348	10	32	10%	0%	1%	0%	Available
21022802012	Showerhead	256	9	19	11%	0%	1%	0%	Available
21022802021	Showerhead	777	10	39	0%	7%	0%	0%	Available
21022802022	Showerhead	537	10	28	0%	8%	0%	0%	Available
21023901021	Window Replacement	38	2	2	0%	1%	0%	0%	Available
21023902021	Window Replacement	5	1	0	0%	0%	0%	0%	Exhausted
Total Onsite Weatherization		**15,133**	**250**	**856**	**100%**	**100%**	**8%**	**6%**	

Table 147. Commercial and Industrial Sample Disposition

Stratum	Measure Code	Measures in Frame	Target Completes	Sample Completes	Fraction of Frame Total Reported Savings				Status
					Frame		Sample		
					kWh	ccf	kWh	ccf	
302010101	Lighting	39	census	11	0%	7%	5%	0%	Exhausted
302010201	Lighting	9	census	2	0%	0%	0%	0%	Exhausted
302020101	Lighting	74	census	42	0%	7%	6%	0%	Exhausted
302020201	Lighting	33	census	6	0%	9%	2%	0%	Exhausted
302050102	Boiler Tune-Up	48	census	16	42%	14%	0%	14%	Exhausted
302050202	Boiler Tune-Up	1	census	1	1%	0%	0%	1%	Exhausted
302070101	Custom	21	census	18	0%	14%	19%	0%	Exhausted
302070102	Custom	2	census	1	18%	6%	0%	17%	Exhausted
302070201	Custom	24	census	20	0%	18%	11%	0%	Exhausted
302070202	Custom	1	census	1	1%	0%	0%	1%	Exhausted
302100101	Faucet Aerator	4	census	0	0%	0%	0%	0%	Exhausted
302100102	Faucet Aerator	63	census	22	6%	2%	0%	3%	Exhausted
302130102	Furnace Tune-up	15	census	0	1%	0%	0%	0%	Exhausted
302140102	Other	5	census	2	4%	1%	0%	1%	Exhausted
302210101	Motors	20	census	7	0%	5%	4%	0%	Exhausted
302230101	Pipe Wrap	1	census	0	0%	0%	0%	0%	Exhausted
302230102	Pipe Wrap	5	census	0	2%	1%	0%	0%	Exhausted
302230202	Pipe Wrap	1	census	1	4%	1%	0%	4%	Exhausted
302280101	Showerhead	3	census	0	0%	0%	0%	0%	Exhausted
302280102	Showerhead	59	census	25	18%	6%	0%	9%	Exhausted
302320101	Ventilation	3	census	2	0%	0%	0%	0%	Exhausted
302400101	Other	6	census	2	0%	0%	0%	0%	Exhausted
302400102	Thermostat	2	census	1	0%	0%	0%	0%	Exhausted
302410101	Occupancy Sensors	17	census	10	0%	3%	3%	0%	Exhausted
302410201	Occupancy Sensors	2	census	1	0%	0%	0%	0%	Exhausted
302460102	Pre-rinse Sprayer	1	census	0	0%	0%	0%	0%	Exhausted
302550101	Refrigeration controls	3	census	1	0%	2%	3%	0%	Exhausted
302550201	Refrigeration controls	1	census	0	0%	0%	0%	0%	Exhausted
302560201	Cooler door gaskets	1	census	0	0%	1%	0%	0%	Exhausted
302570102	Boiler replacement	2	census	0	2%	1%	0%	0%	Exhausted
302580102	Boiler retrofit	1	census	0	0%	0%	0%	0%	Exhausted
Total C&I		**467**	**census**	**192**	**100%**	**100%**	**53%**	**49%**	

Table 148. Multifamily Sample Disposition

Measure Code	Measures in Frame	Target Completes (Customers)	Sample Completes (Measures)	Frame		Completes		Status
				kWh	ccf	kWh	ccf	
CFL	1,069	10	586	41,691	0	22,854	0	Exhausted (5 complete)
Thermostat	291		258	0	6,259	0	5,424	
Faucet Aerator	633		515	35,524	3,562	21,082	2,219	
Showerhead	316		242	48,174	6,021	30,562	3,348	
Pipe Wrap	177		185	19,890	1,747	13,770	1,482	
Overall	**2,486**		**1,786**	**145,279**	**17,588**	**88,268**	**12,472**	

F.2.2 General Population Survey

DNV KEMA also completed a Residential General Population survey, which was intended to gather information about households within the territories of participating Efficiency United utilities that had not

participated in any of the rebate programs. The utilities could provide contact information for customers who participated in the programs, but not for non-participants. To acquire a non-participating population base, DNV KEMA contracted Relevate to provide all residential phone numbers for the zip codes within the territories of all Efficiency United utilities. Relevate provided DNV KEMA with over 655,000 phone numbers.

DNV KEMA contracted Research America (RA) to conduct computer-aided telephone interviews (CATI) of program participants. DNV KEMA ultimately released 9,095 phone numbers to RA. Of those numbers, about one-third (3,005) were deemed ineligible for the survey. Ineligibility resulted from several situations:

- *Disconnected phone numbers*: About 57 percent of the ineligible phone numbers were disconnected.
- *Ineligible household*: Respondents who did not purchase energy from a participating Efficiency United utility and those who said they participated in an energy efficiency program were considered ineligible. This category accounted for about 24 percent of the ineligible numbers.
- *Non-residential*: About seven percent reported that the phone number was for a business rather than a residence.
- *Fax/computer tones*: About five percent of the ineligible numbers were due to fax machines or computers answering the call.
- *Communication problems*: About five percent of the ineligible numbers were due to hearing and/or language barriers.
- *Blocked number*: The remaining three percent of numbers were blocked numbers or designated for text messages only.

Another 3,345 phone numbers were never answered. RA called these numbers at least eight times across at least two weeks before considering them unreachable. An additional 1,698 numbers asked RA to call back at another time but did not complete the survey before the target was reached. RA also contacted 241 households who answered the phone, but refused to take part in the survey.

The final estimated eligible sample was 6,081 phone numbers. RA completed interviews with 800 households in December 2012 and January 2013. This produced a final response rate of 13 percent.

Table 149. General Population Sample Disposition

Sample Description	Number	Percent
Starting Sample	**655,000**	
Never Called	645,000	
Sample Used	**9,095**	
Not eligible	3,005	33%
Sample - Valid	**6,081**	
Complete	800	13%
Refused	241	4%
Not completed	5,043	83%

The CATI survey covered the following topics:

- Program awareness
- Sources of information about energy efficiency programs
- Recent purchases of energy using equipment
- Demographics.

Participants were stratified based on the peninsula they were in (upper, lower) based on zip code. Results were weighted based on the number of participants in the population strata divided by the number of completed surveys.

G. Attribution Analysis Methodology

G.1 Attribution Analysis Methodology

This appendix provides a detailed explanation of the program attribution methodology used in this impact evaluation. The appendix begins with an explanation of the methodology used for most of the measures in the Commercial & Industrial, ENERGY STAR, Onsite Weatherization, and HVAC programs. Later sections explain the methodology for CFLs and energy kits, used in ENERGY STAR, Online Audits, and HVAC. The analysis methodology for the Appliance Recycling Program is described in the Appliance Recycling section. There was no attribution analysis for the Low Income or Multifamily programs.

G.1.1 Defining Attribution Analysis Parameters

The attribution analysis is used to determine the ratio between verified gross savings and net (attributable) savings for the program. Under a lifecycle savings analysis such as the one used for these programs, the verified gross savings analysis is a parameter that feeds into the net savings analysis. Previous sections of this report have explained the verified gross savings analysis that DNV KEMA conducted for each program to determine the gross savings adjustment. Any adjustments that occurred as a result of the verified gross savings analysis are also used to determine the net savings for a given measure. For the purposes of this discussion, the engineering verification factor is defined to refer to the portion of the gross savings adjustment that is not related to the installation rate. The engineering verification factor accounts for the adjustments from the documentation verification (correcting data entry errors), the tracking verification (correcting data entry errors and incorrect lookup savings) and the per-unit savings review (using lookup savings that are not the evaluation-approved per-unit savings).

The remainder of this section introduces the parameters used in the attribution analysis. The next section outlines the method used to combine those parameters into a single attribution value. The last sections describe, in detail, how the parameters are determined from the participant survey.

The attribution analysis is based on a number of parameters that are determined from the engineering verification review and participant survey.

- **Acceleration Period, m_a**: This reflects the effect the program had on *when* the equipment was installed. The acceleration period corresponds to the number of months between when the equipment was actually installed and when it would have been installed in the absence of the program. For respondents who say they would have installed the measure at the same time or earlier without the program, $m_a = 0$. For those who say they would have installed later, m_a is the number of months later they say they would have installed, up to a maximum of 48. This factor is based on responses to attribution questions in the participant survey.

- **Existing Equipment Efficiency:** This is the efficiency of the equipment the respondent replaced. Where necessary, DNV KEMA estimated this efficiency level based on the age of the replaced equipment, provided in responses to the participant survey. The Existing Equipment Efficiency is used as the baseline efficiency for gross savings calculations during the acceleration period; therefore, it is only used for accelerated measures or measures with $m_a > 0$.

- **Standard Equipment Efficiency:** This is the standard efficiency level for the type of measure installed at the time the respondent purchased the new equipment. The Standard Equipment Efficiency is used as the baseline efficiency level during the non-acceleration period and for measures with no acceleration effect. For some measures, such as lighting, the Standard Equipment Efficiency and the Existing Equipment Efficiency are the same. The Standard Equipment Efficiency is used for all measures, not just accelerated measures.

- **Efficiency Attribution, A_E**: This measures the effect the program had on the efficiency of the equipment installed. The efficiency attribution measures the proportion of savings attributable to the program for increasing the efficiency of the equipment above what would have been installed otherwise. This factor is based on responses to attribution questions in the participant survey.

- **Quantity Attribution, A_Q:** This measures the effect the program had on the quantity of the equipment installed. The quantity attribution measures the proportion of savings attributable to the program for increasing the quantity of equipment above what would have been installed otherwise. This factor is based on responses to attribution questions in the participant survey.

- **Measure Life**, **m_L**: This represents the average amount of time a piece of equipment will remain installed and operational before being replaced by a new piece of equipment. The measure life assignments for each measure are in the program-specific sections of this report.

The complement of attribution is free-ridership. Attribution measures the portion of the savings that result because of the actions of the program. Free-ridership measures the portion of the savings that would have happened in the absence of the program. The free-ridership equivalents of the attribution factors are used along with other factors to determine the overall program net savings. They are:

- **Efficiency Free-ridership, f_E**: This is the fraction of verified gross savings per unit that would have occurred without the program.

- **Quantity Free-ridership, f_Q:** This is the fraction of installed units that would have been installed without the program.

The free ridership values are easily calculated from the attribution factors.

$$f_E = 1 - A_E$$

$$f_Q = 1 - A_Q$$

G.2 Attribution Analysis

This section outlines the methods necessary to determine net program savings using the attribution analysis parameters defined in the previous section.

G.2.1 Simple Program Attribution (SPA) Calculation

The fraction of annual verified gross savings that would have occurred *without* the program is the product of the fraction of units that would have been installed without the program, f_Q, and the fractional unit savings that these units would have had without the program, f_E.

$$f_{QE} = f_Q f_E$$

For example, if two-thirds as many units would have been installed without the program ($f_Q = 2/3$), and the savings per unit would have been only half as much ($f_E = 1/2$), the portion of the savings that would have occurred without the program would be

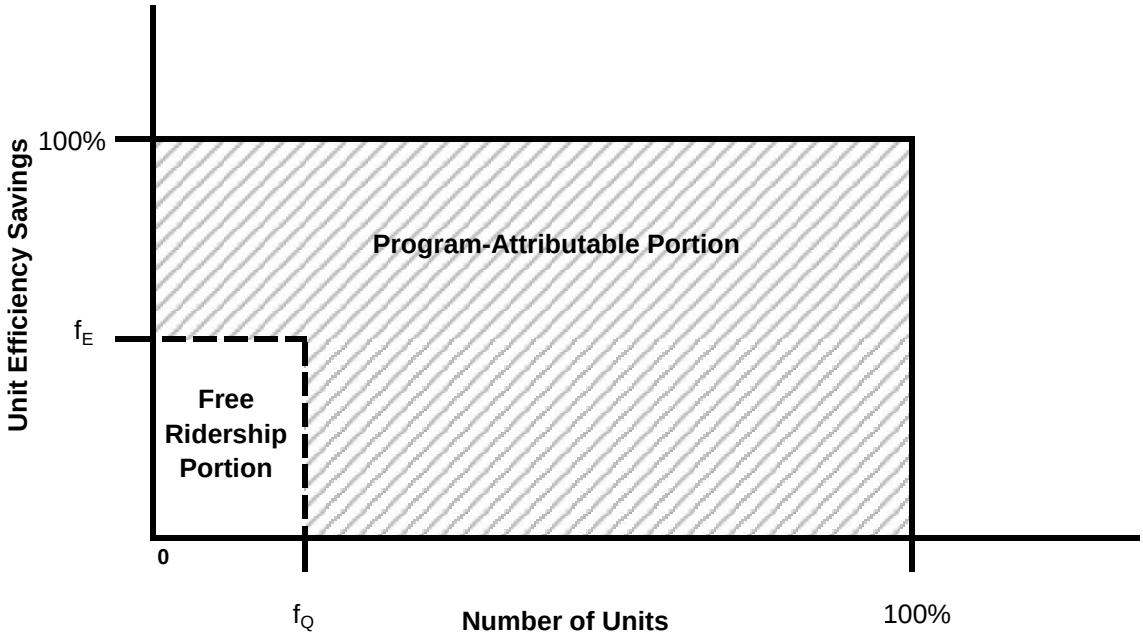
$$f_{QE} = (2/3) \times (1/2) = 1/3.$$

The Simple Program Attribution (SPA) is the complement of this free rider portion.

$$SPA = 1 - f_{QE} = 1 - f_Q f_E$$

The relationship is illustrated in Figure 9.

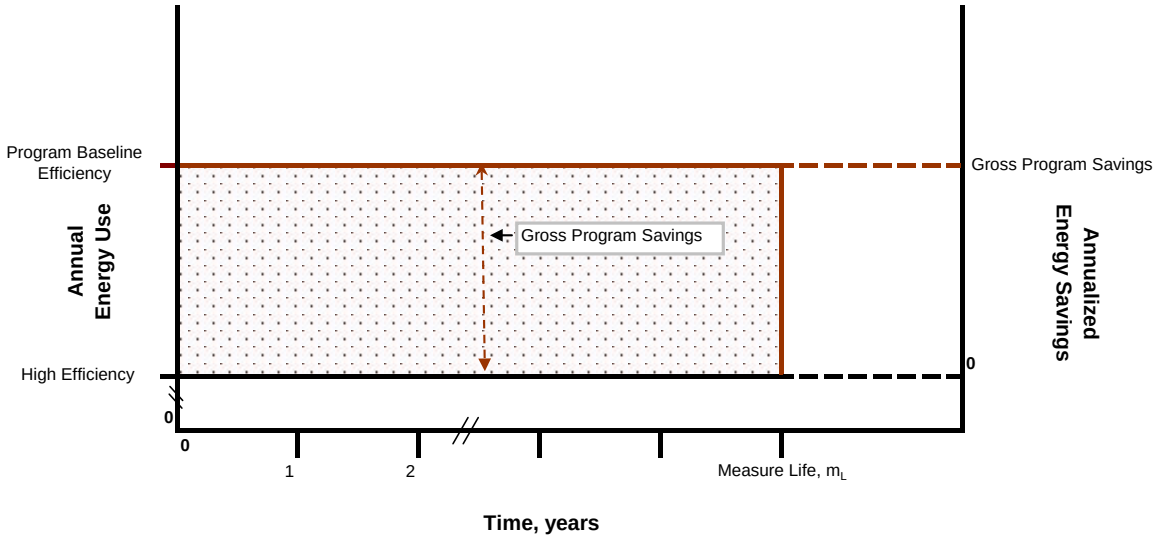
Figure 9. Graphical Derivation of the SPA Equation



G.3 Timing Effects

The goal of the attribution analysis is to produce an estimate of lifetime net savings. For measures without acceleration, the program-reported annual gross savings can be combined with the measure life, m_L to produce the simple lifetime gross savings, plotted in Figure 10. The simple lifetime savings are simply the first year savings multiplied by the measure life. First year savings are determined by the difference between the high efficiency that was installed and the baseline efficiency.

Figure 10. Simple Lifetime Savings of a Program Measure

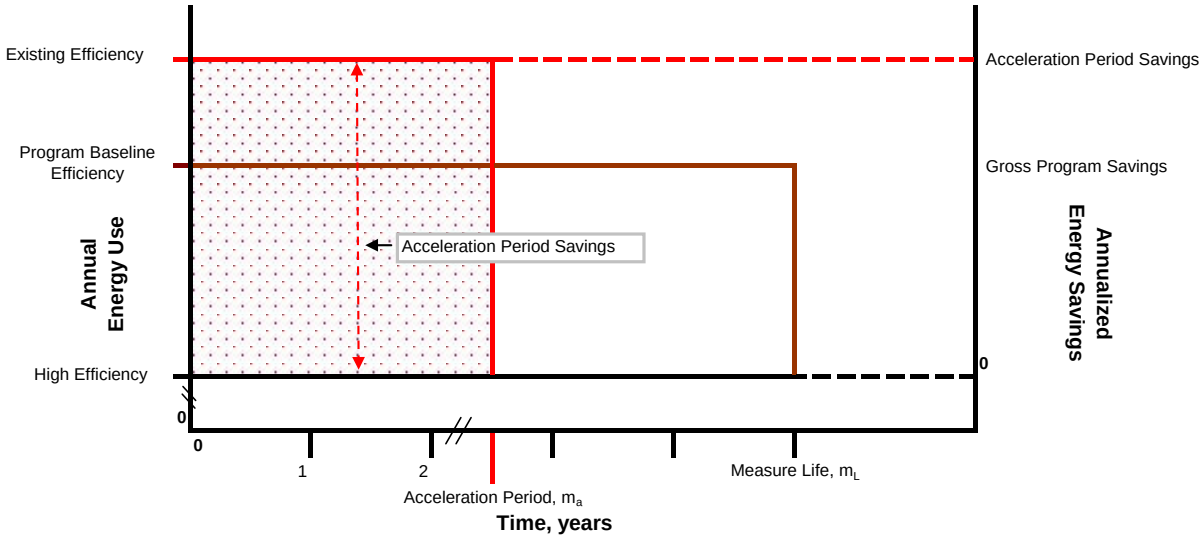


For a replacement measure with acceleration, the program caused the participant to install an energy efficiency measure before they originally intended to do so. During the acceleration period, the energy savings caused by the program are the difference between the energy use of the high efficiency equipment that was installed and the energy use of the equipment that was replaced. This could also be termed as the difference between the high efficiency equipment efficiency and the existing equipment efficiency. We call this value the Acceleration Period Savings.

The evaluating engineer is able to determine the Existing Equipment Efficiency from the age of the replaced equipment provided in the participant surveys. The engineer then uses a number of sources including the documentation provided by the program and secondary sources to estimate the Acceleration Period Savings for a particular measure.

Figure 11 shows the Acceleration Period Savings superimposed over the gross program savings. The lifetime acceleration period savings are the acceleration period savings multiplied by the acceleration period, m_a.

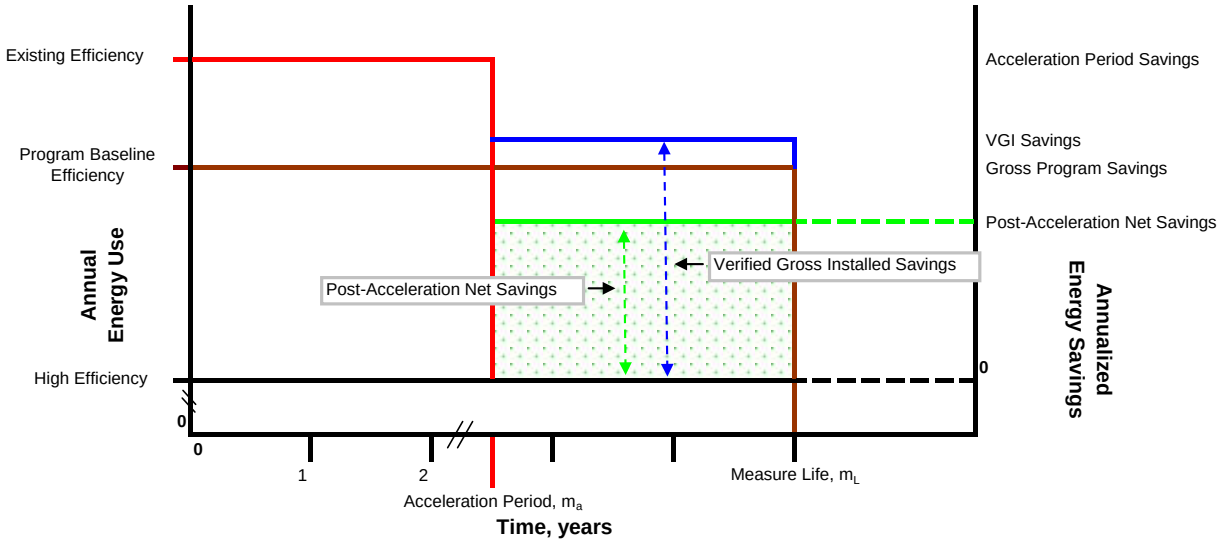
Figure 11. Acceleration Period Savings



There is no "net" or "gross" associated with the Acceleration Period Savings. The concept of acceleration already incorporates elements of net savings so no further adjustments to acceleration period savings are necessary.

The post-acceleration period savings are shown in Figure 12. The post-acceleration period verified gross savings (identified as verified gross installed (VGI) savings in the figure) are the evaluation-verified gross savings for the measure, which assume a Standard Equipment Efficiency to determine savings. They are also the product of the tracking savings, the installation rate, and the engineering verification factor. The post-acceleration period net savings are equal to the verified gross savings times the SPA calculated in Section G.2.1

Figure 12. Post-Acceleration Period Net Savings

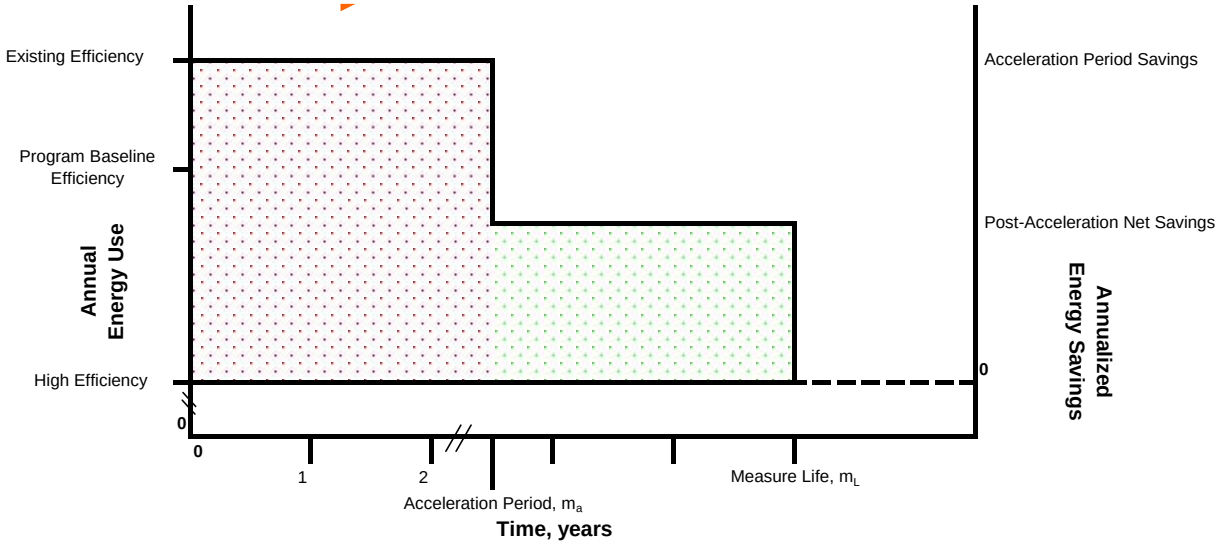


The lifetime net savings for an accelerated measure are the sum of the acceleration period savings and the post-acceleration net savings. This can also be written as

$$Lifetime\ net\ savings_{accelerated} = Acceleration\ Period\ Savings + Verified\ Gross_{post\text{-}accel} * SPA$$

The lifetime net savings are shown graphically in Figure 13.

Figure 13. Simple Lifetime Net Savings



G.4 Determining Attribution Parameters

The attribution factors defined in Section 1 are determined from the participant responses gathered during the survey. This section provides an overview of the survey data and how it is used to determine each attribution factor. It also includes more detailed sections for each factor that show exactly how all of the survey responses are handled. The assignments outlined in this section refer to the methodology that applies to the C&I, HVAC, and ENERGY STAR appliance analyses. The adjustments made to this methodology for the CFL and Online Audit and ENERGY STAR Kit measure analysis are described in later sections.

G.4.1 General Procedure

This section provides an overview of the attribution factors and how they are determined

- **Acceleration Period, m_a**: The acceleration period, m_a, is measured in months and provided directly by the respondent. For values of m_a greater than 48 (four years); we assume that the measure would never have been installed without the influence of the program.

- **Efficiency Attribution, A_E**: The efficiency attribution is based on the answers to questions DAT2a and DAT2b as shown in Table 150. Respondents who indicate that they would have installed a lesser-efficient piece of equipment in the absence of the program are asked what efficiency they would have installed instead. An efficiency attribution value is assigned based on the response.

Table 150. Efficiency Attribution Assignments

Efficiency That Would Have Been Installed without EU		
Coarse Cut (Dat2a)	**Finer Cut (Dat2b)**	**Efficiency Attribution, E**
Lesser	Standard efficiency or according to code	100%
	Slightly higher than standard efficiency	70%
	Between standard efficiency and the efficiency that was installed	50%
	Slightly lower than the high efficiency that was installed	30%
	Don't Know / Refused	Avg of above cases for measure group
Same	*NA*	0%
Greater	*NA*	0%
Don't Know	*NA*	Avg of all respondents for measure group
Refused		

- Quantity Attribution, AQ: The quantity attribution is based on the percent change in quantity or size caused by the program. The program could have caused the participant to install a lesser or

greater capacity or number of units. If the participant installed more units because of the program, we assume that it was an increase in project scope that would not have happened otherwise. If the participant installed fewer units (or capacity) because of the program, we assume that the equipment was "right sized" for greater efficiency. The respondent provides quantity change information directly. The quantity attribution is equal to AQ = |(Amount installed / Amount would have installed without program) - 100 percent|.

The next few sections deal with determining the timing, efficiency, and quantity attributions on a more detailed level.

G.4.2 Detailed Assignments

This section gives a detailed accounting of how the attribution factors are determined from the survey responses.

G.4.2.1 Acceleration Period

The acceleration period, m_a, is determined from the first set of attribution survey questions. These questions are used to determine whether or not the program accelerated implementation of a measure or caused it to be implemented before it would have been without the program. The two relevant questions are DAT1a and DAT1b.

DAT1a: "I'd like to know about the effect, if any that program incentives had on the timing of your decision to install the [equipment type]. I'm referring to your decision to install any [equipment type], not just a high efficiency one. Would have installed the [equipment type] at the same time, earlier, later, or never?"

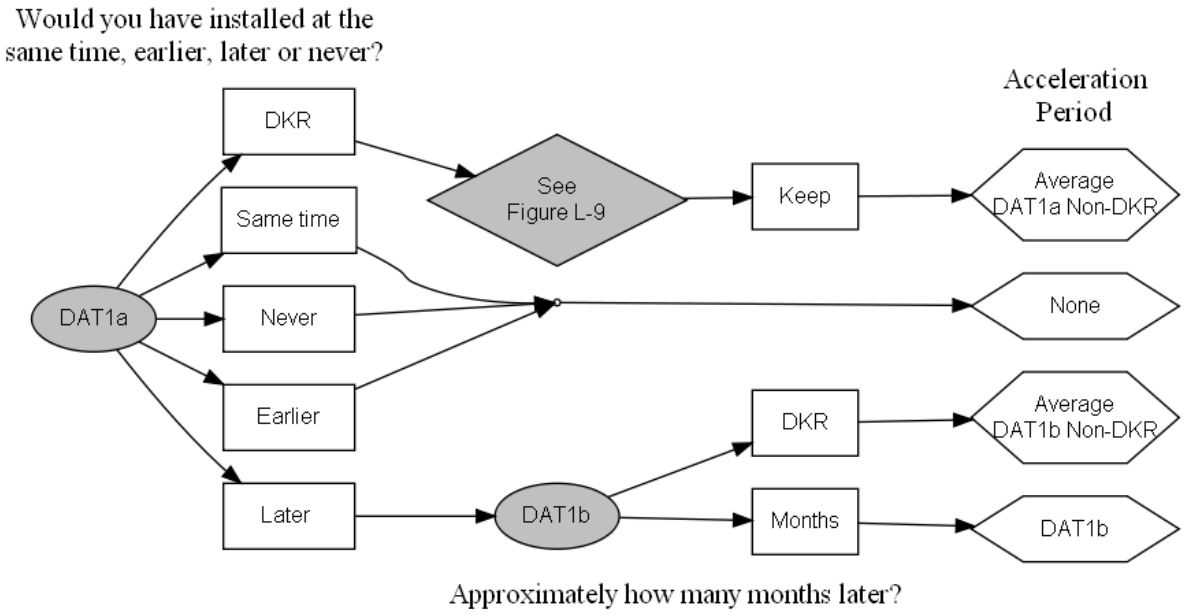
DAT1b: "Approximately how many months later?" (DAT1b is only asked if DAT1a is "Later.")

Note that these questions ask about the timing of installing equipment, not installation of efficient equipment in particular. For example, if the measure was replacement of a high-efficiency boiler, the question asks when the boiler would have been replaced without the program.

G.4.2.1.1 Determination of the Acceleration Period

Figure 14. Decision Tree for the Acceleration Period shows a decision tree for DAT1a and DAT1b. In the decision tree, "DKR" refers to "Don't Know" and "Refused."

Figure 14. Decision Tree for the Acceleration Period



The measure is considered accelerated if the respondent indicates that the measure would have been installed less than 48 months (four years) later without program influence. The acceleration period is determined based on the answer to DAT1b. If the respondent is unable to answer DAT1b, the measure is assigned the average acceleration period across all accelerated measures in the same measure group.

If the respondent answers DAT1a with "Don't Know" or "Refused" but does provide answers to inform the Quantity and Efficiency Attributions then the measure is assigned the average Acceleration Attribution for all measures in the same measure group.

G.4.2.2 Efficiency

Efficiency Attribution, A_E, gives the program credit for increasing the efficiency of a measure above what would have been installed in the absence of the program. The two relevant questions are DAT2a and DAT2b.

DAT2a: "Without the program, would you have installed [equipment type] of the same efficiency, lesser efficiency, or greater efficiency?"

DAT2b: "Without the program, would you have installed a [equipment type] that was "standard efficiency on the market at that time," "slightly higher than standard efficiency," "between standard efficiency and the efficiency that you installed," or "slightly lower

than the high efficiency that was installed?" (DAT2b is only asked if DAT2a is "Lesser.")

The program receives non-zero Efficiency Attribution if the respondent indicates that they would have installed a less efficient measure without the influence of the program. The magnitude of the Efficiency Attribution is determined based on the answer to DAT2b, as shown in Table 151. For measures with limited efficiency options, such as faucet aerators and showerheads, DNV KEMA combined the DAT2a and DAT2b questions and asked if respondents would have installed the same efficiency or standard efficiency equipment. Figure 15 shows the corresponding decision tree for DAT2a and DAT2b.

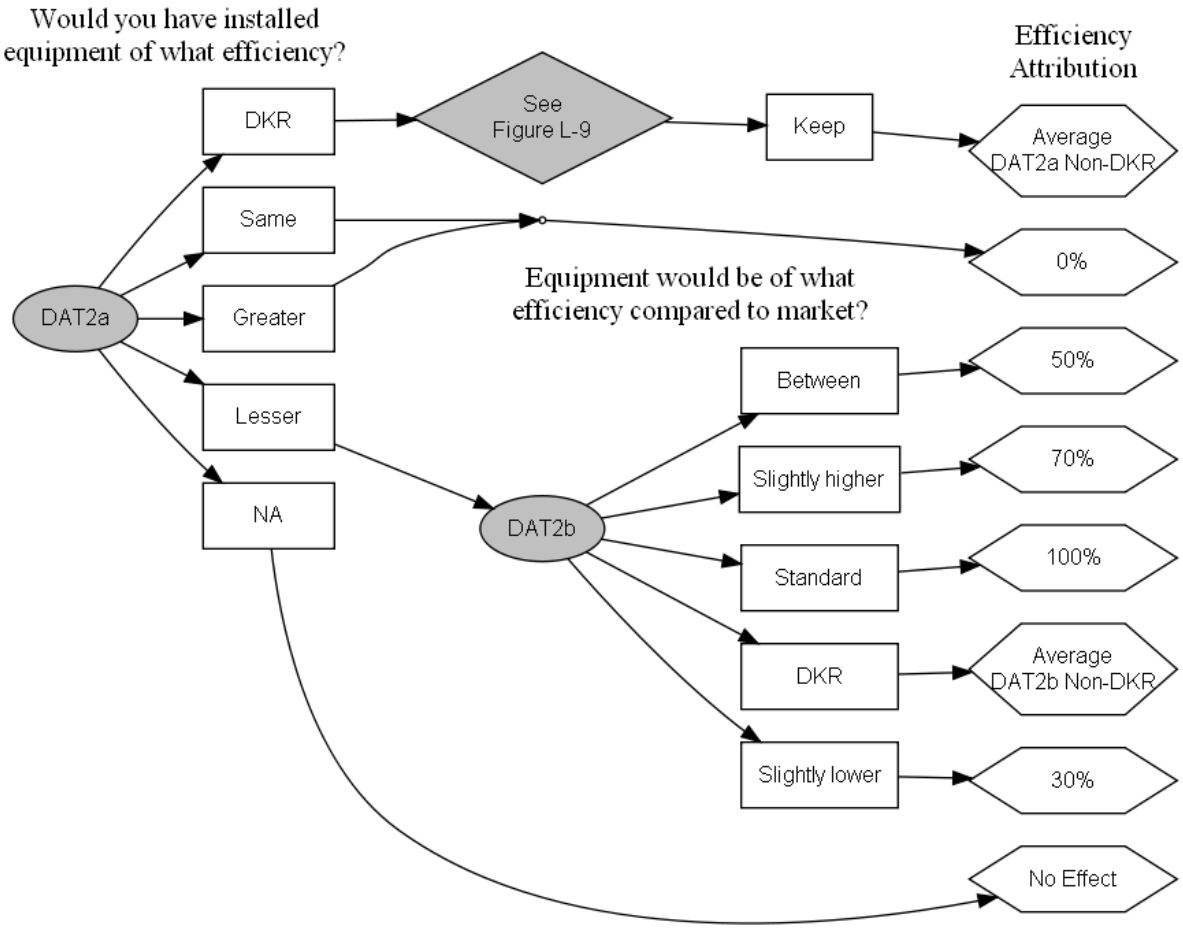
Table 151. Efficiency Attribution Assignments

Efficiency That Would Have Been Installed without EU		Efficiency Attribution, E
Coarse Cut (Dat2a)	Finer Cut (Dat2b)	
Lesser	Standard efficiency or according to code	100%
	Slightly higher than standard efficiency	70%
	Between standard efficiency and the efficiency that was installed	50%
	Slightly lower than the high efficiency that was installed	30%
	Don't Know / Refused	Avg of above cases for measure group
Same	*NA*	0%
Greater	*NA*	0%
Don't Know	*NA*	Avg of all respondents for measure group
Refused		

If the respondent answers DAT2a with Greater or Same then the survey skips to the next section and there is zero Efficiency Attribution. If the respondent answers DAT2a with "Don't Know" or "Refused", but does provide answers to inform the Quantity Attribution and Acceleration Period, then the measure is assigned the average Efficiency Attribution for all measures in the same measure group.

For some measures, efficiency is not applicable. These are measures for which there are no variable efficiency levels associated with the equipment. Measures that fit into this category are ECM motors, programmable thermostats, lighting controls, and variable frequency drives. For such measures, DAT2a and DAT2b are not asked and the Efficiency Attribution will not affect the Simple Program Attribution. Other measures, including showerheads and faucet aerators have only two possible efficiency levels: standard and efficient. For these measures efficiency attribution is depends only on the response to DAT2a and is ether 100 percent or zero percent. Figure 15 shows the standard decision tree for DAT2a and DAT2b.

Figure 15. Decision Tree for Efficiency Attribution



G.4.2.3 Quantity

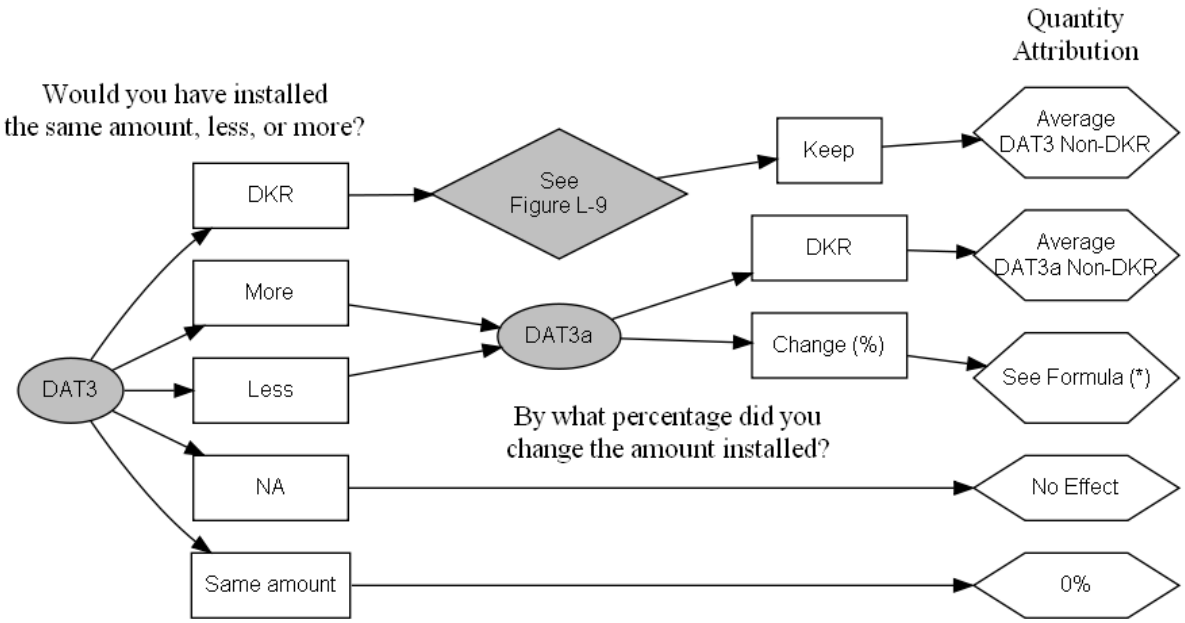
Quantity Attribution, A_Q, gives the program credit for increasing the quantity of a measure above what would have been installed in the absence of the program. The two relevant questions are DAT3 and DAT3a.

DAT3: "I'd like to know about the effect, if any, that program incentives and services had on the quantity of [equipment] that you installed. Without the program would you have installed the same amount, less, more, or none at all?"

DAT3a: "By what percentage did you change the quantity of [equipment type] installed because of the program?" (DAT3a is only asked if DAT3 is "Less.")

Figure 16 shows a decision tree for DAT3 and DAT3a.

Figure 16. Decision Tree for Quantity Attribution



The program could have caused the participant to install a lesser or greater number of units or equipment capacity. If the participant installed more units because of the program, we assume that it was an increase in project scope that would not have happened otherwise. If the participant installed fewer units (or capacity) because of the program, we assume that the equipment was "right sized" for greater efficiency. The respondent provides quantity change information directly. The quantity attribution is

$$A_Q = |(\textit{Amount installed / Amount would have installed without program}) - 100\%|.$$

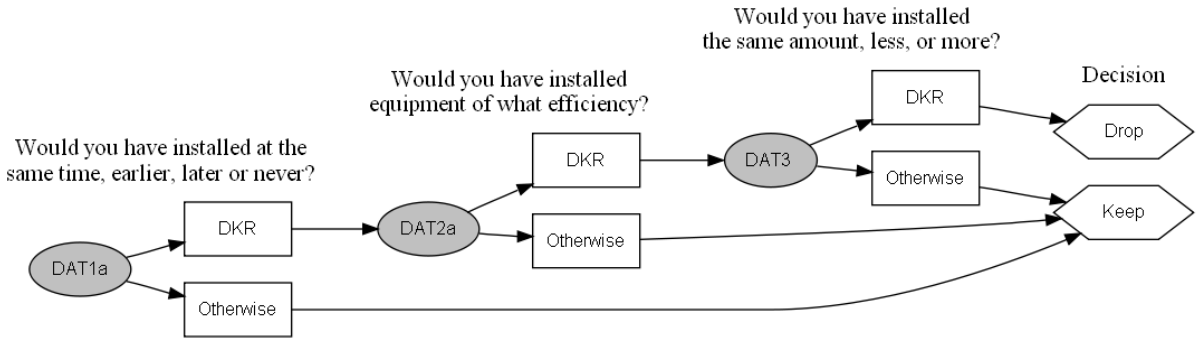
If the respondent answers DAT3 with Same Amount then the survey skips to the next section and there is zero Quantity Attribution. If the respondent answers DAT3 or DAT3a with "Don't Know" or "Refused" but does provide answers to inform the Efficiency Attribution and Acceleration Period then the measure is assigned the average Quantity Effect for all measures in the same sector.

G.4.2.4 What if they Don't Know or Refuse?

Some respondents are unable or unwilling to answer the relevant questions in the survey attribution sequence. If a participant is unable or unwilling to answer all of the attribution questions, then the participant is dropped from the attribution analysis. However, the respondent information will still be included as part of the installation rate and the engineering adjustment factor. Figure 17 shows a decision tree that indicates the relationship between the question responses and how they affect the attribution. If a

measure goes to the "Keep" decision then the ultimate resolution of each effect is shown in Figure 14, Figure 15, and Figure 16.

Figure 17. NTG Case Retention Decision Tree for Don't Know/Refused



G.5 Attribution Calculations for CFLs and Kits

The attribution analysis for the CFL and kit measures was born from the same principles but with slight changes.

G.5.1 CFLs

G.5.1.1 Timing Attribution

For CFLs, the survey included questions that asked when the respondent received the discounted CFLs, whether they replaced working bulbs and whether they would have replaced those bulbs in the absence of the program.

CFLI2. "Of the <<number of installed bulbs>> bulbs you installed, how many replaced a bulb that was still working?"

CFLI3. "Would you have replaced these working bulbs if the program had not discounted the CFLs you purchased?"

If the response to CFLI2 is "did not replace any working bulbs" or to CFLI3 is "Yes," then the acceleration period is zero. If the response to CFLI3 is "No," then the acceleration period is six months. If the response to CFLI3 is "don't know," then the acceleration period is the average acceleration period of all CFLs.

G.5.1.2 Efficiency Attribution

The survey included an additional question that asked about the type of bulb replaced.

> CFLI4. "You said earlier that you installed <<CFLI1>> CFLs. If the program had not discounted the CFLs, how many of each of the following types of bulbs would you have installed in the same fixtures?
>
> a. Incandescent
> b. CFLs
> c. LEDs
> d. Or Something else?"

The responses to CFLI4 resulted in numbers of bulb that would have been installed without the program. The number of non-CFLs and non-LEDs that would have been installed were considered attributable bulbs. Efficiency attribution was calculated as the number of attributable bulbs divided by the number of bulbs still installed.

G.5.1.3 Quantity Attribution

Quantity attribution was not a separate factor in the attribution sequence for CFLs because it was covered as part of the approach to efficiency attribution.

G.5.1.4 Acceleration Period Savings

The standard equipment efficiency for CFLs is assumed to be an incandescent lamp in the MEMD calculation. Incandescent lamps are often the equipment replaced when a CFL is installed. Therefore, DNV KEMA assumed that the Standard Equipment Efficiency and Existing Equipment Efficiency were the same. This means that for both purchased and giveaway CFLs, the acceleration period savings and post-acceleration period gross savings were the same.

G.5.2 Kits

The Online Audit and ENERGY STAR program survey asked questions about several types of measures included as parts of kits either purchased or sent to participants: CFLs, faucet aerators, low flow showerheads, pipe wrap, LED night lights, door strips, and smart power strips.

For each of these measure types we asked whether the measure would have been purchased had it not come in the kit. For example. for Faucet Aerators we asked:

> KIT2. "If they had not been part of kit, would you have bought the faucet aerators? Would you say...
>
> 1. Yes
> 2. Probably Yes
> 3. Probably Not

4. No

For measures where the respondent said that they definitely would not have bought the measure outside of the kit, the measure received full attribution and the respondent was not asked the rest of the attribution sequence in the interest of reducing customer burden. Measures where the response to their KIT question was something other than "No" went through the standard attribution sequence for their measure type.

G.5.2.1 Acceleration Period Savings

As with CFLs, the Standard Equipment Efficiency and Existing Equipment Efficiency are the same for faucet aerators and low flow showerheads. Therefore, the acceleration period savings were equal to verified gross savings for all three measures.