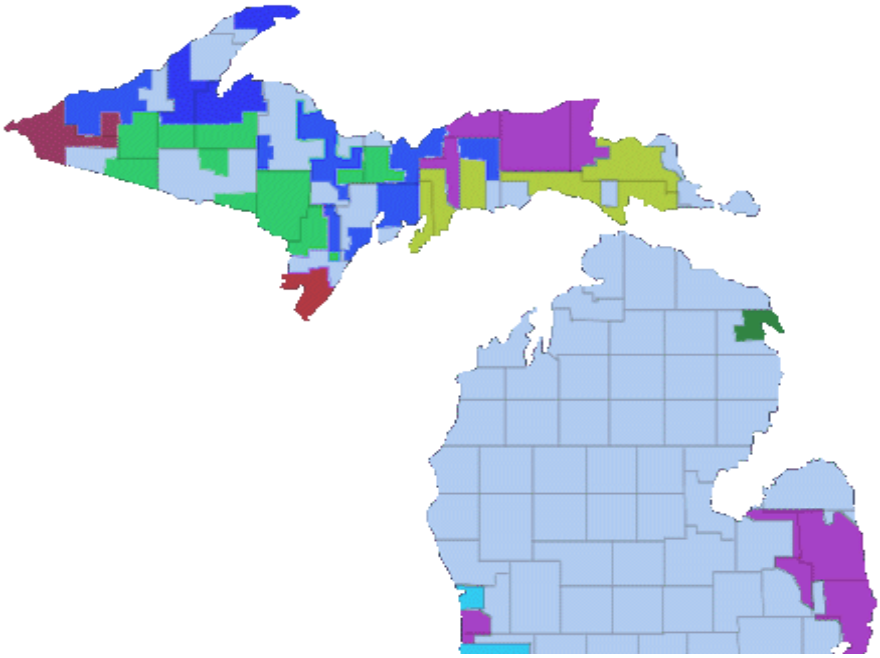
# Impact Evaluation of Electric and Natural Gas Energy Optimization Programs

## Impact Evaluation Results for Efficiency United



Michigan Community Action Agency Association (MCAAA)

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April 9, 2012

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# 1. Introduction

This report presents the verified gross energy savings achieved by Efficiency United (EU) from the Energy Optimization programs implemented during 2011. The savings were determined based on the impact evaluation results of the Energy Optimization (EO) programs administered by the Michigan Community Action Agency Association (MCAAA), the Michigan Electric Cooperative Association (MECA) Collaborative, and the MECA Upper Peninsula (MECA UP) Collaborative. The impact evaluation was conducted by KEMA, Inc. from August 2011 to March 2012.

The body of this report contains verified gross savings results specific to EU that were derived based on KEMA's impact evaluation of the EO/EU programs. We have also listed the conclusions and recommendations from our analysis. Appendices A through U provide background on the impact evaluation, including an overview of the programs, the methodology used in the evaluation, and overall program-specific impact evaluation results.

# 2. Verified Gross Energy Savings, MCAAA

Efficiency United participated in 17 energy optimization programs implemented by CLEAResult Consulting, Inc. in 2011. 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. Efficiency United Verified Gross Savings by Program[1]**

| Program | Verified Gross kWh | | Verified Gross ccf | |
|---|---|---|---|---|
| | Annual | Lifetime | Annual | Lifetime |
| ENERGY STAR | 2,652,942 | 23,160,885 | 61,197 | 629,074 |
| Appliance Recycling | 1,092,472 | 5,224,515 | | |
| Residential HVAC | 259,548 | 3,892,592 | 651,478 | 9,290,244 |
| Low Income | 1,520,960 | 17,254,142 | 152,555 | 1,911,382 |
| Online Audit | 588,113 | 5,793,327 | 36,615 | 374,308 |
| Onsite Audit | 1,772,090 | 17,466,740 | 225,336 | 2,490,245 |
| Residential New Construction | 3,300 | 59,402 | 7,831 | 140,967 |
| Commercial and Industrial | 22,862,137 | 261,147,664 | 1,255,123 | 13,561,859 |
| Market Rate Multi Family | 558,131 | 5,378,527 | 78,070 | 819,634 |
| Plug Load Residential Pilot | 1,832,656 | 1,832,656 | | |
| Residential Education | 477,743 | 477,743 | 60,850 | 60,850 |
| CSA Pilot | | | 16,761 | 16,761 |
| Home Performance - Residential Pilot | | | 231,487 | 231,487 |
| Behavioral Study | 243,587 | 243,587 | 9,642 | 9,642 |
| C&I Best Energy Pilot | 496,053 | 496,053 | 39,658 | 39,658 |
| C&I Education | 755,451 | 755,451 | 71,894 | 71,894 |
| C&I Retrocommissioning | 3,183,429 | 3,183,429 | 259,959 | 259,959 |
| **EU Overall** | **38,298,613** | **346,366,715** | **3,158,456** | **29,907,964** |

Table 2 shows the verified gross savings for Residential programs for each utility participating in the Efficiency United programs. Table 3 shows the verified gross savings for Commercial and Industrial (C&I) programs by utility.

**Table 2. Efficiency United Verified Gross Savings, Residential**

| Utility | Verified Gross kWh | | Verified Gross ccf | |
|---|---|---|---|---|
| | Annual | Lifetime | Annual | Lifetime |
| Alpena Power Company | 517,833 | 1,728,727 | | |
| Bayfield Electric Cooperative | 1,101 | 5,504 | | |
| Daggett Electric Company | 5,821 | 44,829 | | |
| Edison Sault Electric Company | 1,573,449 | 6,553,564 | | |
| Indiana Michigan Power Company | 8,738,127 | 49,569,490 | | |
| Michigan Gas Utilities Corporation | | | 661,253 | 6,520,777 |
| SEMCO Energy Gas Company | | | 1,183,542 | 9,306,736 |
| Upper Peninsula Power Company | 2,760,297 | 16,617,883 | | |
| We Energies | 740,144 | 4,420,379 | | |
| Wisconsin Public Service Corporation | 586,229 | 2,818,809 | 29,277 | 249,419 |
| XCEL Energy | 513,474 | 3,459,864 | 29,262 | 269,172 |
| **EU Residential Overall** | **15,436,476** | **85,219,050** | **1,903,333** | **16,346,105** |

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

**Table 3. Efficiency United Verified Gross Savings, C&I**

| Utility | Verified Gross kWh | | Verified Gross ccf | |
|---|---|---|---|---|
| | Annual | Lifetime | Annual | Lifetime |
| Alpena Power Company | 1,136,074 | 12,989,185 | | |
| Bayfield Electric Cooperative | | | | |
| Daggett Electric Company | 9,463 | 114,010 | | |
| Edison Sault Electric Company | 3,023,163 | 25,901,109 | | |
| Indiana Michigan Power Company | 11,295,206 | 132,031,277 | | |
| Michigan Gas Utilities Corporation | | | 176,203 | 2,269,416 |
| SEMCO Energy Gas Company | | | 1,047,320 | 10,850,852 |
| Upper Peninsula Power Company | 4,144,521 | 51,783,023 | | |
| We Energies | 1,136,225 | 15,228,024 | | |
| Wisconsin Public Service Corporation | 1,587,883 | 18,338,121 | 24,442 | 355,708 |
| XCEL Energy | 529,601 | 4,762,915 | 7,158 | 85,883 |
| **EU C&I Overall** | **22,862,137** | **261,147,664** | **1,255,123** | **13,561,859** |

Table 4 shows the overall verified gross savings by utility for the 2011 Efficiency United programs studied in this evaluation.

**Table 4. Efficiency United Verified Gross Savings by Utility**

| Utility | Verified Gross kWh | | Verified Gross ccf | |
|---|---|---|---|---|
| | Annual | Lifetime | Annual | Lifetime |
| Alpena Power Company | 1,653,907 | 14,717,913 | | |
| Bayfield Electric Cooperative | 1,101 | 5,504 | | |
| Daggett Electric Company | 15,284 | 158,839 | | |
| Edison Sault Electric Company | 4,596,613 | 32,454,673 | | |
| Indiana Michigan Power Company | 20,033,333 | 181,600,767 | | |
| Michigan Gas Utilities Corporation | | | 837,456 | 8,790,193 |
| SEMCO Energy Gas Company | | | 2,230,862 | 20,157,588 |
| Upper Peninsula Power Company | 6,904,819 | 68,400,906 | | |
| We Energies | 1,876,369 | 19,648,403 | | |
| Wisconsin Public Service Corporation | 2,174,113 | 21,156,930 | 53,719 | 605,127 |
| XCEL Energy | 1,043,076 | 8,222,779 | 36,420 | 355,055 |
| **EU Overall** | **38,298,613** | **346,366,715** | **3,158,456** | **29,907,964** |

Overall, Efficiency United realized 346,366,715 lifetime kWh savings and 29,907,964 lifetime ccf savings resulting from programs implemented in 2011. In terms of annual savings, the program realized 38,298,613 kWh/yr and 3,158,456 ccf/yr savings from programs implemented in 2011.

# 3. Conclusions and Recommendations

## 3.1 Conclusions

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

### 3.1.1 Documentation Verification

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 Audit, 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. KEMA was able to download the sample of application forms directly from the program's document repository on December 2, 2011.

KEMA struggled to complete the documentation review effectively, as many of the measures represented by the downloaded documentation were entered in the 2010 data instead of the 2011 data, even when it appeared on the same application form as a 2011 measure. It is unclear why this is the case.

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

- ENERGY STAR: KEMA found one CFL, one smart strip, and one dishwasher that were not entered into the database.
- HVAC: KEMA found one application with a furnace and programmable thermostat on it; the thermostat was not entered in the database.
- Onsite Audit: KEMA found a number of differences between the quantities installed according to the Onsite Audit documentation and the quantities listed in the database for CFL, thermostat, pipe wrap, showerhead, and faucet aerator measures. We also found one wall insulation measure that had the wrong square footage multiplier entered in the database.
- New Construction: KEMA did not find any errors.
- C&I: KEMA found differences between the quantity listed on the application and the one in the database for five applications.
- Multifamily: KEMA did not find any errors.

### 3.1.2 Tracking Verification

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 tracking database improved immensely in 2011. The current database has a sound structure and tracks all of the data required for impact evaluations in an effective manner. We made the following adjustments where necessary as a result of our review:

- Corrected the per-unit savings assignments
- Corrected the multiplier entries (such as square footage of insulation installed, or kBtu of furnace capacity)
- Adjusted calculations to include only one multiplier, rather than two
- Assigned the correct water heater fuel
- Corrected the multiplier units (such as square footage of conditioned space instead of linear feet of rim joist insulation installed)
- Made per-unit savings consistent across programs
- Reviewed the magnitude of C&I savings estimates used that were not in the MEMD to confirm that they were reasonable.

### 3.1.3 Installation Rates

Installation rates for the across the HVAC, C&I and Low Income, Onsite Audit, New Construction and Multifamily programs ranged from 89 percent to 100 percent. Together these six programs represent 75 percent of the portfolio savings KEMA evaluated.

The only statistically significant program level changes in installation rate from the 2009-2010 program year to the 2011 program year were declines for the ENERGY STAR program in both kWh and ccf and a decline in Low Income program kWh. In the case of ENERGY STAR, the introduction of energy kits, which customers often purchase with one or two of the technologies in mind, is the likely driver of the decline. For the Low Income program, the decline from 99 percent to 97 percent is related to a less than 100 percent installation rate for refrigerators in addition to an increase in CFL removals.

Across programs, the installation rate for less expensive kit measures (faucet aerators, pipe wrap, and showerheads) was 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.

### 3.1.4 Verified Gross Savings

Table 5 shows the verified gross energy savings for every evaluated program in the Efficiency United and Energy Optimization portfolio. Table 5 and Table 6 show the verified gross energy savings for the EU portfolio and EO portfolio respectively.

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 adjustment factors. The gross savings adjustments for C&I include the installation rate, documentation review and in depth engineering reviews KEMA conducted using project documentation and on site verification surveys.

Overall KEMA verified 94 percent of the kWh and 84 percent of the ccf claimed by the program. The C&I program drove these rates: 63 percent of tracked kWh savings and 56 percent of tracked ccf savings came from the C&I program in 2011.

**Table 5. Verified Gross Energy Savings, Portfolio**

| Program | 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 |
| ENERGY STAR | 6,572,899 | 75% | 4,526,895 | 38,987,772 | 98,516 | 67% | 61,197 | 629,074 |
| Appliance Recycling | 3,635,698 | 77% | 2,818,906 | 13,468,272 | | | | |
| HVAC | 582,480 | 95% | 560,788 | 7,996,955 | 648,661 | 100% | 651,478 | 9,290,244 |
| Low Income | 2,094,648 | 97% | 1,977,369 | 22,748,158 | 156,519 | 99% | 152,555 | 1,911,382 |
| Online Audit | 1,588,234 | 50% | 827,513 | 8,091,126 | 59,721 | 60% | 36,615 | 374,308 |
| Onsite Audit | 2,074,578 | 87% | 1,794,811 | 17,675,184 | 250,468 | 90% | 225,336 | 2,490,245 |
| New Construction | 3,300 | 100% | 3,300 | 59,402 | 7,831 | 100% | 7,831 | 140,967 |
| C&I | 29,372,976 | 123% | 30,745,800 | 351,132,516 | 1,651,308 | 87% | 1,255,123 | 13,561,859 |
| Multifamily | 558,424 | 100% | 558,131 | 5,378,527 | 78,443 | 99% | 78,070 | 819,634 |
| **Overall** | **46,483,237** | | **43,813,513** | **465,537,912** | **2,951,467** | | **2,468,205** | **29,217,713** |

**Table 6. Verified Gross Energy Savings, EU Portfolio**

| Program | 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 |
| ENERGY STAR | 3,956,593 | 75% | 2,652,942 | 23,160,885 | 98,516 | 67% | 61,197 | 629,074 |
| Appliance Recycling | 1,408,198 | 77% | 1,092,472 | 5,224,515 | | | | |
| HVAC | 259,548 | 95% | 259,548 | 3,892,592 | 648,661 | 100% | 651,478 | 9,290,244 |
| Low Income | 1,617,652 | 97% | 1,520,960 | 17,254,142 | 156,519 | 99% | 152,555 | 1,911,382 |
| Online Audit | 1,116,661 | 50% | 588,113 | 5,793,327 | 59,721 | 60% | 36,615 | 374,308 |
| Onsite Audit | 2,047,900 | 87% | 1,772,090 | 17,466,740 | 250,468 | 90% | 225,336 | 2,490,245 |
| New Construction | 3,300 | 100% | 3,300 | 59,402 | 7,831 | 100% | 7,831 | 140,967 |
| C&I | 22,029,835 | 123% | 22,862,137 | 261,147,664 | 1,651,308 | 87% | 1,255,123 | 13,561,859 |
| Multifamily | 558,424 | 100% | 558,131 | 5,378,527 | 78,443 | 100% | 78,070 | 819,634 |
| **EU Overall** | **32,998,111** | | **31,309,693** | **339,377,794** | **2,951,467** | | **2,468,205** | **29,217,713** |

**Table 7. Verified Gross Energy Savings, EO Portfolio**

| Program | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| ENERGY STAR | 2,616,306 | 75% | 1,873,953 | 15,826,886 |
| Appliance Recycling | 2,227,500 | 77% | 1,726,434 | 8,243,757 |
| HVAC | 322,932 | 95% | 301,240 | 4,104,364 |
| Low Income | 476,996 | 97% | 456,410 | 5,494,017 |
| Online Audit | 471,573 | 50% | 239,400 | 2,297,799 |
| Onsite Audit | 26,678 | 87% | 22,720 | 208,444 |
| C&I | 7,343,141 | 123% | 7,883,663 | 89,984,851 |
| **Overall** | **13,485,126** | | **12,503,820** | **126,160,118** |

### 3.1.5 Attribution Adjustment Factor

Table 8 shows the attribution adjustment factor calculated in this round of evaluation for every evaluated program in the Efficiency United and Energy Optimization portfolio.

The attribution adjustment factors are relatively low based on 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, KEMA evaluated projects installed through August of 2011. New program initiatives such as a large increase in Onsite Audit participation were implemented after the evaluation period. These changes may have had a different free ridership rate than previous months.

The only statistically significant program level changes in attribution from the 2009-2010 program year to the 2011 program year were improvements for the ENERGY STAR program in both kWh and ccf and a large jump in C&I 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. In the case of ENERGY STAR, the introduction of energy kits, which customers often purchase with one or two of the technologies in mind (making the other technologies attributable to the program), is the likely driver of the increase.

**Table 8. Attribution Adjustment Factors, Portfolio**

| | kWh | | | | ccf | | | |
|---|---|---|---|---|---|---|---|---|
| | Attribution | 90% Confidence Interval | | | Attribution | 90% Confidence Interval | | |
| Program | Adjustment Factor | +/- | Lower Bound | Upper Bound | Adjustment Factor | +/- | Lower Bound | Upper Bound |
| ENERGY STAR | 32% | 3% | 29% | 35% | 25% | 12% | 13% | 37% |
| Appliance Recycling | 58% | 4% | 54% | 61% | - | - | - | - |
| HVAC | 18% | 5% | 12% | 23% | 16% | 3% | 13% | 18% |
| Low Income | N/A | | | | | | | |
| Online Audit | 53% | 7% | 46% | 60% | 43% | <0.1% | 43% | 43% |
| Onsite Audit | 78% | 5% | 72% | 83% | 63% | 7% | 55% | 70% |
| New Construction | N/A | | | | | | | |
| C&I | 40% | 3% | 37% | 43% | 33% | 18% | 16% | 51% |
| Multifamily | N/A | | | | | | | |

## 3.2 Recommendations

This section summarizes 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 faucet aerators and low flow showerheads distributed in energy kits, such as installation instructions within the kit or follow-up mailings.
- **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 some measures that show poor attribution.
- **Database:**
  - **Improve nonresidential tracking:** The current database does not track needed information for nonresidential participants. 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).
- **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.
- **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. Two refrigerators were not installed. One was removed by the program and the other was refused. In both cases it is likely that program staff were aware of the issues, but the information did not make it into the database.
- **Online Audit:**
  - Take steps to increase the installation of low flow showerheads and faucet aerators.
- **Onsite Audit:**
  - 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.
- **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.
  - Set qualification rules to maximize verified savings. For example, when rebating pool covers, set qualification rules that require the end-use system affected (i.e. the pool heater) to use electricity or natural gas in order to qualify for a rebate.
  - Establish a deemed calculation for variable frequency drives instead of a single deemed savings value.
  - 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.
  - Require staff to upload clear scans of program documentation. For many 2011 projects, the program documentation was difficult to read due to the scan quality.
  - Do not use a coincident factor (CF) when calculating tracking kWh savings. CF is used to estimate peak period savings and is not appropriate for determining annual kWh savings.

# A. Overview of Evaluation

## A.1 Introduction

This report presents the results of KEMA's evaluation of the Efficiency United (EU) programs administered by the Michigan Community Action Agency Association (MCAAA) and the Energy Optimization (EO) programs administered by the Michigan Electric Cooperative Association (MECA) Collaborative and the MECA Upper Peninsula (MECA UP) Collaborative.

## A.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). Eleven utilities chose to contract with the state plan administrator; of these, seven offer electric service only, two offer natural gas service only, and two offer both electric and gas service. Table 9 lists the participating utilities and their service options.

**Table 9. Utilities Participating in Efficiency United (MCAAA)[2]**

| Participating Utility or Cooperative | Electric Service | Gas Service |
|---|---|---|
| Alpena Power Company | X | |
| Bayfield Electric Cooperative | X | |
| Daggett Electric Department | X | |
| Edison Sault Electric Company | X | |
| Indiana Michigan Power Company | X | |
| Michigan Gas Utilities Corporation | | X |
| SEMCO Energy Gas Company and SEMCO Energy Gas Company - Battle Creek Division | | X |
| Upper Peninsula Power Company | X | |
| We Energies | X | |
| Wisconsin Public Service Corporation | X | X |
| Xcel Energy | X | X |

Some members of MECA joined with the UP Municipal Collaborative in the hopes of significantly reducing the cost to implement and evaluate the EO programs. The programs that were designed and implemented are very similar (if not identical) to those of the state administered programs. There are eight participating cooperatives from MECA and all implement electric EO programs only.[3] Table 10 shows the participating MECA cooperatives.

**Table 10. MECA Participating Cooperatives**

| Participating Utility or Cooperative | Electric Service |
|---|---|
| Alger Delta Cooperative Electric Association | X |
| Cloverland Electric Cooperative | X |
| Great Lakes Energy Cooperative | X |
| HomeWorks Tri-County Electric Cooperative | X |
| Midwest Energy Cooperative | X |
| Ontonagon County Rural Electrification Association | X |
| Presque Isle Electric and Gas Co-op | X |
| Thumb Electric Cooperative | X |

The four participating municipal utilities from the UP Municipal Collaborative also implement electric EO programs only. Table 11 shows the participating UP municipal utilities.

[2] Edison Sault Electric Company was purchased by Cloverland Electric Cooperative, which is one of the MECA cooperatives.

[3] Presque Isle Electric and Gas Co-op also provides gas service but does not implement natural gas EO programs per the EO legislation.

**Table 11. UP Municipal Collaborative Utilities**

| Participating Utility or Cooperative | Electric Service |
|---|---|
| Marquette Board of Light and Power | X |
| Escanaba Electric Department | X |
| Newberry Water and Light Board | X |
| City of Stephenson | X |

## A.3 Overview of Implemented Programs

The MCAAA, MECA, and UP Municipal Collaborative have contracted with CLEAResult Consulting to implement the energy optimization programs. The programs implemented by the three groups are essentially identical with minor variations in some areas. CLEAResult, in turn, has contracted with Franklin Energy Services to implement the commercial and industrial programs and with JACO to implement the appliance recycling program. Not all programs are offered in all utility service territories. Table 12 shows the programs currently being implemented.

**Table 12. 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 in Bayfield or Daggett; for electric customers only. |
| Residential HVAC Program | Not offered in Bayfield or Daggett. |
| Residential Low Income Program | Implemented through previously existing assistance program. |
| Residential Online Audit Program | Not offered in Bayfield or Daggett. |
| Residential Onsite Audit Program | Customers must receive gas service from participating utility |
| Commercial and Industrial Programs | Implemented by Franklin Energy Services. |
| Residential New Construction Program | Very limited marketing in 2011. |
| Multifamily Program | Implemented in MCAAA. |
| Pilot Programs | MCAAA offered 3 pilot programs in 2011. |
| Education Programs | One of first programs to be implemented. |

Three of the programs (Residential Appliance Recycling Program, Residential HVAC Program, Residential Online Audit Program) are not being implemented in the Bayfield Electric Cooperative or Dagget Electric Department service territories.

Eight pilot programs were implemented in MCAAA territories in 2011.

- A Residential Plug Load Analysis (RPLA) program was implemented in EU electric utility territories for residential and small business customers.
- A Comfort System Analysis Program began implementation in December 2010. The program offers efficiency training for HVAC contractors and their employees.

- A Home Performance (HP) program was implemented in SEMCO and Michigan Gas Utility territories beginning the last quarter of 2010. The program provides home audit services and incentives toward installing recommended measures.
- A Home Energy Makeover program was implemented in Midwest Energy's territory.
- A Behavioral Study was implemented in EU utility territories for residential and customers who participate in the Online Audit program.
- An LED Lighting program was implemented in EU utility territories for residential customers.
- An agriculture program was implemented in the Thumb Electric utility territory.
- A Best Energy Pilot was implemented in EU utility territories for commercial and industrial customers.
- A Retro-commissioning pilot was implemented in EU utility territories for commercial and industrial customers.

Further detail on the programs being implemented, including the savings by utility, can be found in Appendix L.

## A.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 MECA/MCAAA portfolio. An impact evaluation and process evaluation were performed for each program.[4] 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

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

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 2011. 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.

## A.5 Description of Common Evaluation Tasks

KEMA's impact evaluation of most of the programs in the MECA/MCAAA portfolio followed a relatively standard path. Each program received a tracking system review. Most 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 included an in-depth attribution analysis. Table 13 summarizes the general impact evaluation activities for each program.

**Table 13. 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 |
| Appliance Recycling | X | | X | X | X | |
| HVAC | X | X | X | X | X | X |
| Low Income | X | | X | X | | |
| Online Audit | X | | X | X | X | X |
| Onsite Audit | X | X | X | X | X | X |
| New Construction | X | X | X | X | | |
| Multifamily | X | X | X | X | | |
| Commercial and Industrial | X | X | X | X | X | |

The following sections describe the general activities in more detail.

## A.5.1 Tracking Review

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 Q.

## A.5.2 Paper Documentation Review

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 R.

## A.5.3 Sample Design and Data Collection Process

The primary objective of the 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.

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. KEMA used a model based sampling approach for some designs and simple random sampling for others.

KEMA collected data from customers based on a randomized order within the stratum. When a given measure was up for completion, 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, 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, KEMA asked customers about all of the measures they installed regardless of where each fell within the call order. When 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.

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, 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 KEMA was unable to recruit one of those sites, that sample point would then be allocated to the furnace sample. In

that way KEMA was still able utilize the entire sample and target the optimal precision for the sample design.

### A.5.4 Participant Survey

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 KEMA staff for the Commercial and Industrial, New Construction, 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.

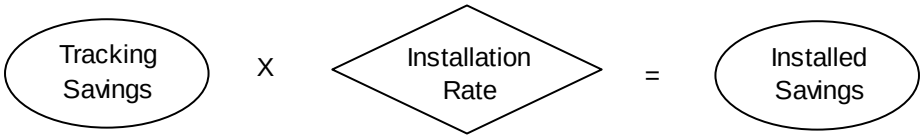
Most participant surveys also addressed program satisfaction and demographic questions. Those questions were primarily used for the process evaluation, and the results are presented in a separate report.

### A.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 appendices identify which analysis was used for each program.

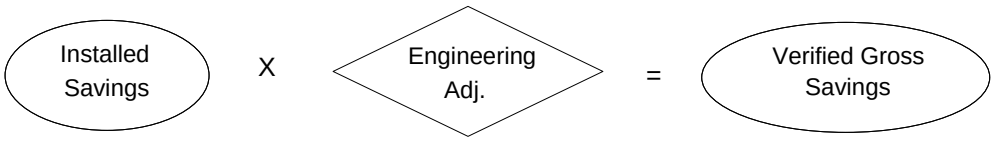
The installation rate was calculated for the each measure in the sample, and ratio estimation was used to determine the installation rate for the overall program. The overall installation rate was applied to the tracking savings to produce installed savings, as shown in Figure 1. Installed Savings Determination

**Figure 1. Installed Savings Determination**




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

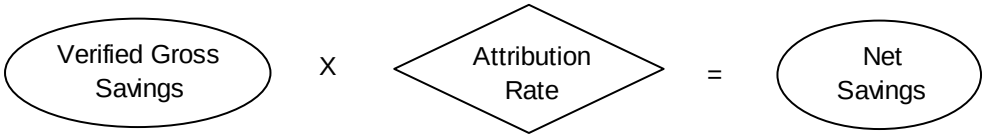
**Figure 3. Overall Verified Gross Savings Determination**


## A.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. 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 U.

**Figure 4. Net Savings Determination**




## A.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 LED Night Light kWh installation rate estimate in Table 16 is 93 percent and the 90 percent confidence interval is ± 6 percentage points (i.e., 93 percent ± 6 percent).[5] The Holiday Lights measure group accounted for 1 percent of the overall program tracking savings. The adjustment factors are calculated using a SAS® macro provided by SAS for ratio estimation by domains.

## A.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.

[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.

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.

## A.6 Overview of Report

The following appendices have program-specific evaluation results and methodology. Appendices B through J 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 Audits
- Residential Onsite Audits
- Residential New Construction
- Commercial and Industrial
- Multifamily

Appendix K reports the conclusions and recommendations for each program and the portfolio overall. Appendices L through S 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
- MEMD Savings Evidence
- Sample Design and Disposition

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

# B. Residential and Small Business ENERGY STAR Products Program

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

- Section B.1 provides a description of the program.
- Section B.2 gives an overview of the evaluation approach.
- Section B.3 presents the verified gross savings results and the overall adjustment factors.
- Section B.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.

## B.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. At this time, the ESP Program does not include point-of-sale rebates or upstream rebates to suppliers or manufacturers. The ESP Program is the second largest electric program in the MECA/MCAAA portfolio. Not all measures are offered in all utility service territories as shown in Table 14.

**Table 14. Measures Offered by Utility through ESP Program**

| Consortium | Utility | Measure | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CFL | Ceiling Fan | Smart Strip | Clothes Washer | Clothes Dryer | Faucet Aerator | Low Flow Showerhead | Pipe Insulation | Dishwasher | LED Night Light | Energy Kits |
| MECA Cooperatives | Alger Delta Cooperative Electric Association | X | X | X | X | X | X | X | X | X | X | X |
| | Cloverland Electric Cooperative | X | X | X | X | X | X | X | X | X | X | X |
| | Great Lakes Energy Cooperative | X | X | X | X | X | X | X | X | X | X | X |
| | HomeWorks Tri-County Electric Cooperative | X | X | X | X | X | X | X | X | X | X | X |
| | Midwest Energy Cooperative | X | X | X | X | X | X | X | X | X | X | X |
| | Ontonagon County Rural Electrification Association | X | X | X | X | X | X | X | X | X | X | X |
| | Presque Isle Electric and Gas Co-op | X | X | X | X | X | X | X | X | X | X | X |
| | Thumb Electric Cooperative | X | X | X | X | X | X | X | X | X | X | X |
| MECA UP | Marquette Board of Light and Power | X | | X | | | X | X | X | | X | X |
| | Escanaba Electric Department | X | | X | | | X | X | X | | X | X |
| | Newberry Water and Light Board | X | | X | | | X | X | X | | X | X |
| | City of Stephenson | X | | X | | | X | X | X | | X | X |
| MCAAA | Alpena Power Company | X | | X | X | | X | X | X | | X | X |
| | Bayfield Electric Cooperative | | | X | X | | X | X | X | | X | X |
| | Daggett Electric Department | | | X | X | | X | X | X | | X | X |
| | Edison Sault Electric Company | X | X | X | X | X | X | X | X | X | X | X |
| | Indiana Michigan Power Company | X | | X | X | | X | X | X | | X | X |
| | Michigan Gas Utilities Corporation | | | | X | | X | X | X | | | X |
| | SEMCO Energy Gas Company | | | | 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 |
| | Xcel Energy | X | | X | X | | X | X | X | | X | X |

Table 15 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 2011 program period.

**Table 15. Overview of ESP Program Accomplishments per Program Tracking**

| Metric | Evaluation Period Jan to Aug 2011 | Program Period Jan to Dec 2011 |
|---|---|---|
| Tracking kWh Savings | 1,164,584 | 6,572,899 |
| Tracking ccf Savings | 9,721 | 98,516 |
| # Measures | 5,068 | 23,126 |
| Incentives | $114,495.00 | $362,574.00 |

## B.2 General Approach

The impact evaluation of the ESP Program had the following objectives for the 2011 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 Q)
- Verify proper documentation with a sample of participating applications (Appendix R)
- 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 A.5 describes the steps used to complete these tasks in greater detail.

## B.3 Verified Gross Savings Results

### B.3.1 Installation Rate

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. As with the non-kit measures, we defined it as the number of units installed divided by the number of units in the tracking database description of the kit. Table 16 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 a marked difference in the installation rate between kit and non-kit measures. For non-kit measures, the installation rates are greater than 80 percent for all technologies except smart strips. For kit measures, the installation rates are much lower, in the 45 to 75 percent range. On the electric side, non-kit CFLs have an installation rate of 83 percent compared to 68 percent for kits. For faucet aerators, 100 percent of non-kit measures were installed compared to 48 percent of kit technologies. For LED night lights, 93 percent of non-kit measures were installed compared to 55 percent of kit technologies. For pipe wrap, 100 percent

of non-kit measures were installed compared to 58 percent of kit measures. All of these differences are statistically significant at the 90 percent confidence level. The only technology that has a comparable installation rate is smart strips, with 74 percent for non-kits and 73 percent for kits. The small difference in installation of smart strips is due in part to the fact that 72 percent of participants who got a smart strip in a kit said they likely would have bought one if it had not been part of the kit; in other words, the smart strip was a primary reason for purchasing the kit. There are similar differences on the natural gas side, though the non-kit sample sizes are so small as to prevent comparison.

For measures that are exclusively non-kit, only ceiling fans have an installation rate lower than 100 percent. However, ceiling fans are a very small percentage of the program savings and have very little effect on the overall results.

**Table 16. 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 | 146 | 83% | 4% | 79% | 87% | 19% | 0 | - | - | - | - | 0% |
| Ceiling Fan | 4 | 86% | 30% | 55% | 100% | 0% | 0 | - | - | - | - | 0% |
| Clothes Dryer | 30 | 100% | <0.1% | 100% | 100% | 2% | 0 | - | - | - | - | 0% |
| LED Night Light | 48 | 93% | 6% | 87% | 99% | 1% | 0 | - | - | - | - | 0% |
| Smart Strip | 285 | 74% | 3% | 71% | 78% | 18% | 0 | - | - | - | - | 0% |
| Washing Machine | 47 | 100% | <0.1% | 100% | 100% | 5% | 24 | 100% | <0.1% | 100% | 100% | 16% |
| Faucet Aerator | 146 | 100% | <0.1% | 100% | 100% | 4% | 1 | 100% | <0.1% | 100% | 100% | 1% |
| Showerhead | 0 | - | - | - | - | 0% | 2 | 100% | <0.1% | 100% | 100% | 2% |
| Pipe Wrap | 150 | 100% | <0.1% | 100% | 100% | 6% | 2 | 100% | <0.1% | 100% | 100% | 1% |
| Dishwasher | 9 | 100% | <0.1% | 100% | 100% | 0% | 0 | - | - | - | - | 0% |
| Kit - CFL | 76 | 68% | 7% | 61% | 75% | 6% | 0 | - | - | - | - | 0% |
| Kit - Faucet Aerator | 68 | 48% | 10% | 38% | 58% | 9% | 36 | 56% | 10% | 46% | 67% | 22% |
| Kit - LED Night Light | 52 | 55% | 9% | 46% | 63% | 1% | 0 | - | - | - | - | 0% |
| Kit - Pipe Wrap | 69 | 58% | 10% | 48% | 68% | 11% | 35 | 73% | 14% | 59% | 86% | 23% |
| Kit - Showerhead | 69 | 59% | 10% | 50% | 69% | 14% | 37 | 51% | 14% | 37% | 66% | 36% |
| Kit - Smart Strip | 81 | 73% | 7% | 66% | 79% | 3% | 0 | - | - | - | - | 0% |
| **ENERGY STAR Overall** | **1,280** | **75%** | **2%** | **72%** | **77%** | **100%** | **137** | **67%** | **8%** | **59%** | **75%** | **100%** |

## B.3.2 Verified Gross Savings

The installation rate was combined with the results of the documentation review to produce the gross savings adjustment factor, which is a single adjustment that can be applied to the tracking savings to determine verified gross savings. Table 17 shows the gross savings adjustment factors for ENERGY STAR Products.

The documentation review produced three adjustments to the gross savings. KEMA found one CFL, one smart strip, and one dishwasher that were not included in the tracking database. The adjustments for CFLs and smart strips were small enough that there was no noticeable change

between the installation rate and gross savings adjustment factor. For dishwashers, however, the gross savings adjustment factor is 120 percent compared to the 100 percent installation rate. Given the small portion of savings represented by dishwasher measures, however, the effect on the overall adjustment is less than a 1 percent increase.

**Table 17. 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 | 144 | 83% | 4% | 79% | 87% | 19% | 0 | - | - | - | - | 0% |
| Ceiling Fan | 4 | 86% | 30% | 55% | 116% | 0% | 0 | - | - | - | - | 0% |
| Clothes Dryer | 30 | 100% | <0.1% | 100% | 100% | 2% | 0 | - | - | - | - | 0% |
| LED Night Light | 44 | 93% | 6% | 87% | 99% | 1% | 0 | - | - | - | - | 0% |
| Smart Strip | 239 | 75% | 3% | 71% | 78% | 18% | 0 | - | - | - | - | 0% |
| Washing Machine | 47 | 100% | <0.1% | 100% | 100% | 5% | 24 | 100% | <0.1% | 100% | 100% | 16% |
| Faucet Aerator | 146 | 100% | <0.1% | 100% | 100% | 4% | 1 | 100% | <0.1% | 100% | 100% | 1% |
| Showerhead | 0 | - | - | - | - | 0% | 2 | 100% | <0.1% | 100% | 100% | 2% |
| Pipe Wrap | 150 | 100% | <0.1% | 100% | 100% | 6% | 2 | 100% | <0.1% | 100% | 100% | 1% |
| Dishwasher | 9 | 120% | <0.1% | 120% | 120% | 0% | 0 | - | - | - | - | 0% |
| Kit - CFL | 70 | 68% | 7% | 62% | 75% | 6% | 0 | - | - | - | - | 0% |
| Kit - Faucet Aerator | 36 | 48% | 10% | 38% | 58% | 9% | 26 | 56% | 11% | 45% | 67% | 22% |
| Kit - LED Night Light | 29 | 55% | 9% | 46% | 64% | 1% | 0 | - | - | - | - | 0% |
| Kit - Pipe Wrap | 41 | 58% | 10% | 48% | 69% | 11% | 26 | 73% | 14% | 59% | 87% | 23% |
| Kit - Showerhead | 38 | 59% | 10% | 50% | 69% | 14% | 21 | 51% | 15% | 37% | 66% | 36% |
| Kit - Smart Strip | 64 | 73% | 7% | 66% | 80% | 3% | 0 | - | - | - | - | 0% |
| **ENERGY STAR Overall** | **1,091** | **75%** | **2%** | **73%** | **77%** | **100%** | **102** | **67%** | **8%** | **59%** | **75%** | **100%** |

The gross savings adjustment factor was applied to the total savings reported for the ENERGY STAR Products Program in 2011 to produce the verified gross savings for the program. Table 18 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.[6]

[6] KEMA's study did not complete any surveys addressing electric savings for showerhead measures. To estimate verified gross savings, KEMA applied the gross savings adjustment factor found for showerhead therm savings.

### Table 18. Verified Gross Savings, ENERGY STAR, Overall

| 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 | 813,252 | 83% | 674,283 | 6,068,546 | | | | |
| Clothes Dryer | 22,032 | 100% | 22,032 | 308,448 | | | | |
| Dishwasher | 7,695 | 120% | 9,234 | 101,574 | | | | |
| LED Night Light | 59,378 | 93% | 55,287 | 884,598 | | | | |
| Showerhead | 81,844 | 100% | 81,844 | 818,440 | 8,019 | 100% | 8,019 | 80,190 |
| Smart Strip | 1,046,592 | 75% | 782,683 | 3,913,415 | | | | |
| Washing Machine | 90,740 | 100% | 90,740 | 998,140 | 3,247 | 100% | 3,247 | 35,721 |
| Ceiling Fan | 4,836 | 86% | 4,145 | 62,177 | | | | |
| Pipe Wrap | 45,900 | 100% | 45,900 | 596,700 | 146 | 100% | 146 | 1,602 |
| Faucet Aerator | 42,662 | 100% | 42,662 | 426,620 | 187 | 100% | 187 | 1,870 |
| Kit - CFL | 1,089,528 | 68% | 744,094 | 6,696,850 | | | | |
| Kit - Faucet Aerator | 592,952 | 48% | 285,435 | 2,854,354 | 20,502 | 56% | 11,495 | 114,951 |
| Kit - LED Night Light | 129,228 | 55% | 70,866 | 1,133,850 | | | | |
| Kit - Pipe Wrap | 546,516 | 58% | 317,986 | 4,133,818 | 18,814 | 73% | 13,711 | 150,821 |
| Kit - Showerhead | 1,176,896 | 59% | 698,345 | 6,983,451 | 47,601 | 51% | 24,392 | 243,919 |
| Kit - Smart Strip | 822,848 | 73% | 601,358 | 3,006,791 | | | | |
| **ENERGY STAR Overall** | **6,572,899** | **75%** | **4,526,895** | **38,987,772** | **98,516** | **67%** | **61,197** | **629,074** |

Table 19 and Table 20 show the verified gross lifetime savings for the Efficiency United and Energy Optimization programs, respectively.

### Table 19. Verified Gross Savings, ENERGY STAR, EU

| 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 | 351,648 | 83% | 291,558 | 2,624,023 | | | | |
| Clothes Dryer | 2,448 | 100% | 2,448 | 34,272 | | | | |
| Dishwasher | 810 | 120% | 972 | 10,692 | | | | |
| LED Night Light | 32,318 | 93% | 30,092 | 481,465 | | | | |
| Showerhead | 66,822 | 100% | 66,822 | 668,220 | 8,019 | 100% | 8,019 | 80,190 |
| Smart Strip | 367,448 | 75% | 274,792 | 1,373,961 | | | | |
| Washing Machine | 30,023 | 100% | 30,023 | 330,253 | 3,247 | 100% | 3,247 | 35,721 |
| Ceiling Fan | 156 | 86% | 134 | 2,006 | | | | |
| Pipe Wrap | | | | | 146 | 100% | 146 | 1,602 |
| Faucet Aerator | 830 | 100% | 830 | 8,300 | 187 | 100% | 187 | 1,870 |
| Kit - CFL | 851,136 | 68% | 581,284 | 5,231,559 | | | | |
| Kit - Faucet Aerator | 362,544 | 48% | 174,522 | 1,745,215 | 20,502 | 56% | 11,495 | 114,951 |
| Kit - LED Night Light | 115,654 | 55% | 63,422 | 1,014,751 | | | | |
| Kit - Pipe Wrap | 334,152 | 58% | 194,424 | 2,527,508 | 18,814 | 73% | 13,711 | 150,821 |
| Kit - Showerhead | 809,116 | 59% | 480,112 | 4,801,122 | 47,601 | 51% | 24,392 | 243,919 |
| Kit - Smart Strip | 631,488 | 73% | 461,507 | 2,307,537 | | | | |
| **ENERGY STAR EU Overall** | **3,956,593** | **75%** | **2,652,942** | **23,160,885** | **98,516** | **67%** | **61,197** | **629,074** |

**Table 20. Verified Gross Savings, ENERGY STAR, EO**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| CFL | 461,604 | 83% | 382,725 | 3,444,523 |
| Clothes Dryer | 19,584 | 100% | 19,584 | 274,176 |
| Dishwasher | 6,885 | 120% | 8,262 | 90,882 |
| LED Night Light | 27,060 | 93% | 25,196 | 403,133 |
| Showerhead | 15,022 | 100% | 15,022 | 150,220 |
| Smart Strip | 679,144 | 75% | 507,891 | 2,539,454 |
| Washing Machine | 60,717 | 100% | 60,717 | 667,887 |
| Ceiling Fan | 4,680 | 86% | 4,011 | 60,171 |
| Pipe Wrap | 45,900 | 100% | 45,900 | 596,700 |
| Faucet Aerator | 41,832 | 100% | 41,832 | 418,320 |
| Kit - CFL | 238,392 | 68% | 162,810 | 1,465,291 |
| Kit - Faucet Aerator | 230,408 | 48% | 110,914 | 1,109,139 |
| Kit - LED Night Light | 13,574 | 55% | 7,444 | 119,099 |
| Kit - Pipe Wrap | 212,364 | 58% | 123,562 | 1,606,310 |
| Kit - Showerhead | 367,780 | 59% | 218,233 | 2,182,328 |
| Kit - Smart Strip | 191,360 | 73% | 139,851 | 699,254 |
| **ENERGY STAR EO Overall** | **2,616,306** | **75%** | **1,873,953** | **15,826,886** |

## B.4 Attribution Results

The EO/EU programs were not required to report net or attributable savings for the 2011 program year. However, discussions within the State of Michigan suggest that net savings will be required in future program years. 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.

### B.4.1 Attribution Adjustment Factors

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.[7] Table 21 shows the results.

[7] Appendix U discusses the methodology used in the attribution analysis.

As with the installation rate, this table highlights the differences between kit and non-kit technologies. For the most part, kit measures have a higher attribution than non-kit measures; however, none of the differences are statistically significant. The two measures where non-kit measures have a higher attribution than kit measures are CFLs and smart strips. Non-kit CFLs have an attribution rate of 41 percent compared to 24 percent for kits. Non-kit smart strips have an attribution rate of 70 percent compared to 56 percent for kits. Both differences are statistically significant at the 90 percent confidence level. Measures that are not offered in kits show a very low attribution. Ceiling fans are the highest with an attribution of 19 percent. The other measures (clothes dryers, washing machines, dishwashers) all show attributions less than 10 percent.

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

**Table 21. 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 | 144 | 41% | 6% | 35% | 48% | 19% | 0 | - | - | - | - | 0% |
| Ceiling Fan | 4 | 19% | 29% | 0% | 48% | 0% | 0 | - | - | - | - | 0% |
| Clothes Dryer | 30 | 5% | 3% | 2% | 7% | 2% | 0 | - | - | - | - | 0% |
| LED Night Light | 44 | 63% | 15% | 48% | 78% | 1% | 0 | - | - | - | - | 0% |
| Smart Strip | 232 | 70% | 4% | 66% | 74% | 18% | 0 | - | - | - | - | 0% |
| Washing Machine | 47 | 5% | 3% | 2% | 8% | 5% | 24 | 6% | 4% | 1% | 10% | 16% |
| Faucet Aerator | 0 | - | - | - | - | 4% | 1 | 16% | <0.1% | 16% | 16% | 1% |
| Showerhead | 0 | - | - | - | - | 0% | 2 | 36% | 3% | 34% | 39% | 2% |
| Pipe Wrap | 0 | - | - | - | - | 6% | 2 | 7% | 27% | 0% | 35% | 1% |
| Dishwasher | 9 | 1% | 2% | 0% | 3% | 0% | 0 | - | - | - | - | 0% |
| Kit - CFL | 70 | 24% | 7% | 18% | 31% | 6% | 0 | - | - | - | - | 0% |
| Kit - Faucet Aerator | 30 | 60% | 13% | 47% | 74% | 9% | 20 | 62% | 14% | 48% | 75% | 22% |
| Kit - LED Night Light | 22 | 75% | 13% | 62% | 88% | 1% | 0 | - | - | - | - | 0% |
| Kit - Pipe Wrap | 29 | 38% | 11% | 27% | 50% | 11% | 24 | 55% | 19% | 36% | 74% | 23% |
| Kit - Showerhead | 29 | 53% | 13% | 40% | 66% | 14% | 14 | 37% | 13% | 23% | 50% | 36% |
| Kit - Smart Strip | 56 | 56% | 9% | 47% | 65% | 3% | 0 | - | - | - | - | 0% |
| **ENERGY STAR Overall** | **746** | **46%** | **3%** | **43%** | **49%** | **100%** | **87** | **38%** | **7%** | **30%** | **45%** | **100%** |

## B.4.2 Analysis of Survey Responses

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 U has greater detail on the attribution analysis methodology and the methods used to combine the three components into a single attribution value.(Table 22)

**Table 22. Attribution Question Sequence**

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

### B.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 23 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 23. Determining Acceleration Period, ENERGY STAR Overall**

| DAT1a. Without EO/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 | 201 | 19% | 55% | 0 |
| Earlier | N/A | 27 | 3% | 5% | 0 |
| Later | Months < 48 | 104 | 12% | 10% | Months / 48 |
| | Months >= 48 | 0 | 0% | 0% | 100% |
| | Don't Know/Refused | 65 | 9% | 5% | Average of DAT1b |
| Never | N/A | 187 | 23% | 20% | 100% |
| Not Applicable | N/A | 215 | 31% | 0% | Not Asked |
| Don't Know/Refused | N/A | 34 | 4% | 5% | Average of DAT1a |

The table shows that the many of the respondents would have installed the equipment at the same time regardless of program involvement, representing 19 percent of kWh and 55 percent of gas savings (ccf). One hundred eighty-seven respondents give the program full attribution credit, representing 23 percent of kWh savings and 20 percent of gas savings (ccf). One hundred and four respondents representing 12 percent of kWh savings and 10 percent of gas savings (ccf) said they would have installed the equipment within the next four years, which results in an accelerated measure. Two hundred fifteen measures were not asked the timing questions, either because they received 100 percent attribution based on their response to DAT0 (1 response), or they were went through the CFL attribution sequence (214 responses).

### B.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 24 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 24. Determining Efficiency Attribution, ENERGY STAR Overall**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 274 | 29% | 42% | 0% |
| Lower | Standard Efficiency | 0 | 0% | 0% | 100% |
| | Slightly > Standard | 1 | 0% | 1% | 70% |
| | Between Standard and High | 0 | 0% | 0% | 50% |
| | Slightly < High | 4 | 0% | 1% | 30% |
| | Don't Know/Refused | 1 | 0% | 0% | Average of DAT2b |
| | N/A | 137 | 18% | 9% | 100% |
| Higher | N/A | 7 | 1% | 0% | 0% |
| Not Applicable | N/A | 270 | 35% | 27% | Not Asked |
| Don't Know/Refused | N/A | 139 | 18% | 19% | Average of DAT2a |

The table shows that the majority of respondents would have installed the same efficiency level without the program, with 274 respondents representing 29 percent of program kWh savings and 42 percent of program gas savings (ccf). One hundred thirty-seven measures received 100 percent attribution because they answered lower to DAT2a and the only alternative efficiency level is standard. Four hundred forty 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.

### B.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” or “More” 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.

Table 25 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 25. Determining Quantity Attribution, Overall**

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 115 | 16% | 15% | 0% |
| Less | Value < 100% | 49 | 7% | 6% | Value < 50% |
| | Value >= 100% | 2 | 0% | 3% | Value > 50% |
| | Don't Know/Refused | 0 | 0% | 0% | Average of DAT3a |
| More | N/A | 26 | 3% | 9% | 0% |
| None | N/A | 132 | 18% | 19% | 100% |
| Not Applicable | N/A | 501 | 54% | 49% | Not Asked |
| Don't Know/Refused | N/A | 8 | 1% | 0% | Average of DAT3 |

The table shows that 115 respondents representing 16 percent of kWh savings and 15 percent of gas savings (ccf) would have installed equipment of the same size or quantity without the program. One hundred thirty-two respondents representing 18 percent of kWh savings and 19 percent of gas savings (ccf) would not have installed any equipment, resulting in 100 percent quantity attribution. Five hundred and one measures were not asked either quantity question,

either because they 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.

#### B.4.2.4 Overall Attribution

KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 26 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 116 responses representing 15 percent of kWh savings and three percent of gas savings (ccf) received all three types of attribution (or full attribution based on the overall likelihood question). 230 responses representing 25 percent of kWh savings and 28 percent of gas savings (ccf) did not receive any timing, efficiency, or quantity attribution.

**Table 26. Simplistic Representation of Overall Attribution, ENERGY STAR**

| Attribution | | | Responses | Percent kWh | Percent ccf |
|---|---|---|---|---|---|
| Timing | Efficiency | Quantity | | | |
| Yes | Yes | Yes | 116 | 15% | 3% |
| Yes | No | Yes | 16 | 2% | 0% |
| Yes | No | No | 125 | 15% | 15% |
| Yes | Yes | No | 18 | 3% | 2% |
| No | Yes | Yes | 148 | 20% | 8% |
| No | Yes | No | 111 | 14% | 18% |
| No | No | Yes | 69 | 6% | 25% |
| No | No | No | 230 | 25% | 28% |

## B.5 Comparison of 2009-10 and 2011 Program Results

KEMA compared the results of the 2009-2010 program evaluation to the results of the 2011 program evaluation.

### B.5.1 Overall Comparison

Table 27 shows the tracking savings, number of measures, and total incentives paid for the 2009-2010 and 2011 program periods. The final column shows the difference between the two, with a negative value representing a decrease from 2010 and a positive value representing an increase.

The table shows a significant reduction in savings for the ENERGY STAR Program from 2010 to 2011. Tracking kWh savings decreased by 80 percent, while natural gas savings, number of measures, and incentives all decreased by 71 percent.

One obvious reason for the difference is that the 2009-2010 program period covered a longer time period than the 2011 program year. Another possible reason is the elimination from the 2011 program of the CFL giveaways, which were a substantial part of the 2009-2010 program period kWh savings.

**Table 27. Comparison of 2010 and 2011 ENERGY STAR Program Results**

| Metric | Program Period Program Start to Dec 2010 | Program Period Jan to Dec 2011 | 2010 to 2011 Change |
|---|---|---|---|
| Tracking kWh Savings | 32,629,213 | 6,572,899 | -80% |
| Tracking ccf Savings | 338,521 | 98,516 | -71% |
| Total # Measures | 80,293 | 23,126 | -71% |
| Total Incentive | $1,233,272 | $362,574 | -71% |

## B.5.2 Adjustment Factors

Table 28 shows the 2009-2010 and 2011 installation rate, gross savings adjustment factor, and attribution adjustment factor for kWh and ccf. Highlighted cells show a statistically significant difference from the 2010 to 2011 program periods at the 90 percent confidence interval.

The table shows that all 6 comparisons were statistically significant. From 2010 to 2011, the program saw a decrease in installation rate and gross savings adjustment factor and an increase in the attribution adjustment factor for both electricity and natural gas. Since the installation rate is a factor of the gross savings adjustment factor, the real cause of the decrease in gross savings adjustment between the two years is in the installation rate.

**Table 28. Comparison of 2010 and 2011 ENERGY STAR Adjustment Factors**

| Adjustment Factor | kWh | | ccf | |
|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 |
| Installation Rate | 83% | 75% | 92% | 67% |
| Gross Savings Adjustment Factor | 82% | 75% | 95% | 67% |
| Attribution Adjustment Factor | 32% | 46% | 25% | 38% |

There appear to be two reasons for the installation rate decrease from 2010 to 2011.

- Smart Strips: The installation rate for smart strips went from 80 percent in 2010 to 74 percent in 2011. More importantly, smart strips went from 1 percent of program savings

in 2010 to 18 percent in the 2011 sample frame, which increased their effect on the overall program ratio.

- Energy Kits: Energy kits were not a part of the 2010 program. The kits made up 42 percent of 2011 program kWh savings and 81 percent of 2011 program ccf savings, with installation rates of 57 percent, 76 percent, and 59 percent for electric savings for kits with CFLs, electric savings for kits without CFLs, and ccf kit savings, respectively.

The same reasons appear to apply to the attribution rate, as well. Smart strips purchased outside of kits increased in attribution from 42 percent in 2010 to 70 percent in 2011 while also contributing more to program savings. Energy kits show 2011 attribution rates of 70 and 54 percent for kWh and 69 percent for ccf.

# C. Residential Appliance Recycling Program

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

- Section C.1 provides a description of the program.
- Section C.2 gives an overview of the evaluation approach.
- Section C.3 presents the verified gross savings results and the overall adjustment factors.
- Section C.4 shows the attribution analysis results.

## C.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 second largest residential program in the MECA/MCAAA portfolio (considering electric savings only) and the third largest overall. Not all measures are offered in all utility service territories as shown in Table 29.

**Table 29. Measures Offered by Utility through Appliance Recycling Program**

| Consortium | Utility | Measure | |
|---|---|---|---|
| | | Refrigerator | Freezer |
| MECA Cooperatives | Alger Delta Cooperative Electric Association | X | X |
| | Cloverland Electric Cooperative | X | X |
| | Great Lakes Energy Cooperative | X | X |
| | HomeWorks Tri-County Electric Cooperative | X | X |
| | Midwest Energy Cooperative | X | X |
| | Ontonagon County Rural Electrification Association | X | X |
| | Presque Isle Electric and Gas Co-op | X | X |
| | Thumb Electric Cooperative | X | X |
| MECA UP | Marquette Board of Light and Power | X | X |
| | Escanaba Electric Department | X | X |
| | Newberry Water and Light Board | X | X |
| | City of Stephenson | X | X |
| MCAAA | Alpena Power Company | X | X |
| | Bayfield Electric Cooperative | | |
| | Daggett Electric Department | | |
| | Edison Sault Electric Company | X | X |
| | Indiana Michigan Power Company | X | X |
| | Michigan Gas Utilities Corporation | | |
| | SEMCO Energy Gas Company | | |
| | Upper Peninsula Power Company | X | X |
| | We Energies | X | X |
| | Wisconsin Public Service Corporation | X | |
| | Xcel Energy | 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 30 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 2011 program period. The table shows data for the program as a whole and by equipment type.

**Table 30. Overview of AR Program Accomplishments per Program Tracking**

| Metric | Evaluation Period Jan to Aug 2011 | 2011 Program Period Jan to Dec 2011 |
|---|---|---|
| Tracking kWh Savings | 2,110,405 | 3,635,698 |
| Refrigerator kWh | 1,621,840 | 2,745,424 |
| Freezer kWh | 488,565 | 890,274 |
| Total # Measures | 1,285 | 2,216 |
| # Refrigerators Recycled | 970 | 1,642 |
| # Freezers Recycled | 315 | 574 |
| # Participants | 1,211 | 2,100 |
| Total Incentive paid to Implementer | $192,750.00 | $332,400.00 |
| Refrigerator | $145,500.00 | $246,300.00 |
| Freezer | $47,250.00 | $86,100.00 |

## C.2 General Approach

The impact evaluation of the AR program had the following objectives for the 2011 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 Q)
- Verify proper documentation with a sample of participating applications (Appendix R)
- 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 A.5 describes the steps used to complete these tasks in greater detail.

### C.2.1.1 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.

#### C.2.1.2 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.

#### C.2.1.3 Non-participant Survey

In addition to the participant survey, 1,444 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 694 respondents. The second group was from a general population survey of Michigan residential customers. There were 750 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.

## C.3 Verified Gross Savings Results

### C.3.1 Removal Rate

When a unit is removed, the program confirms that it was installed and operational in accordance with program assumptions. KEMA found that 100 percent of the participants

reported having units removed by the program. This resulted in a removal rate of 100 percent. Table 31 shows the results of the survey data analysis.

**Table 31. Removal Rate, Appliance Recycling**

| Measure Group | kWh | | | | | |
|---|---|---|---|---|---|---|
| | | | 90% Confidence Interval | | | % |
| | n | Removal Rate | +/- | Lower Bound | Upper Bound | Program Savings |
| Refrigerators | 316 | 100% | <0.1% | 100% | 100% | 76% |
| Freezers | 118 | 100% | <0.1% | 100% | 100% | 24% |
| **Overall Appliance Recycling** | **434** | **100%** | **<0.1%** | **100%** | **100%** | **100%** |

## C.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). 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 80 percent for refrigerators and 70 percent for freezers. In other words, on average, the refrigerators recycled by the program operated for 80 percent of the year rather than 24/365 operation.

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, the survey responses indicate that the usage was significantly below 24/365 operation for secondary and freezer units. 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 77 percent of the year, which is reflected in Table 32.

**Table 32. Engineering Adjustment Factor, Appliance Recycling**

| Measure Group | kWh | | | | | |
|---|---|---|---|---|---|---|
| | n | Engineering Adjustment Factor | 90% Confidence Interval +/- | Lower Bound | Upper Bound | % Program Savings |
| Refrigerators | 316 | 80% | 3% | 77% | 83% | 76% |
| Freezers | 118 | 70% | 6% | 65% | 76% | 24% |
| **Overall Appliance Recycling** | **434** | **77%** | **3%** | **75%** | **80%** | **100%** |

## C.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 33 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 33. Gross Savings Adjustment Factor, Appliance Recycling**

| Measure Group | kWh | | | | | |
|---|---|---|---|---|---|---|
| | min n | Gross Savings Adjustment Factor | 90% Confidence Interval +/- | Lower Bound | Upper Bound | % Program Savings |
| Refrigerators | 316 | 80% | 3% | 77% | 83% | 76% |
| Freezers | 118 | 70% | 5% | 66% | 76% | 24% |
| **Overall Appliance Recycling** | **434** | **77%** | **3%** | **75%** | **80%** | **100%** |

The gross savings adjustment factor was applied to the total savings reported for the Appliance Recycling Program in 2011 to produce the verified gross savings for the program. Table 34 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 34. Verified Gross Savings, Appliance Recycling, Overall**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| Refrigerators | 2,745,424 | 80% | 2,192,647 | 10,963,233 |
| Freezers | 890,274 | 70% | 626,260 | 2,505,039 |
| **Appliance Recycling Overall** | **3,635,698** | **77%** | **2,818,906** | **13,468,272** |

Table 35 and Table 36 show the verified gross lifetime savings for the Efficiency United and Energy Optimization programs, respectively.

**Table 35. Verified Gross Savings, Appliance Recycling, EU**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| Refrigerators | 1,070,080 | 80% | 854,625 | 4,273,124 |
| Freezers | 338,118 | 70% | 237,848 | 951,391 |
| **Appliance Recycling EU Overall** | **1,408,198** | **77%** | **1,092,472** | **5,224,515** |

**Table 36. Verified Gross Savings, Appliance Recycling, EO**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| Refrigerators | 1,675,344 | 80% | 1,338,022 | 6,690,109 |
| Freezers | 552,156 | 70% | 388,412 | 1,553,648 |
| **Appliance Recycling EO Overall** | **2,227,500** | **77%** | **1,726,434** | **8,243,757** |

## C.4 Attribution Results

The MPSC does not require the EO/EU programs to determine and report net savings for the 2011 program year. However, recent discussions indicate that such reporting may be required in the future. KEMA collected data to allow for attribution (net-to-gross) analysis to give the 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 2011 program year.

### C.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 vs. gross savings. To determine this, our sample of program participants were 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. At this stage units are either destroyed or transferred to the second hand market.

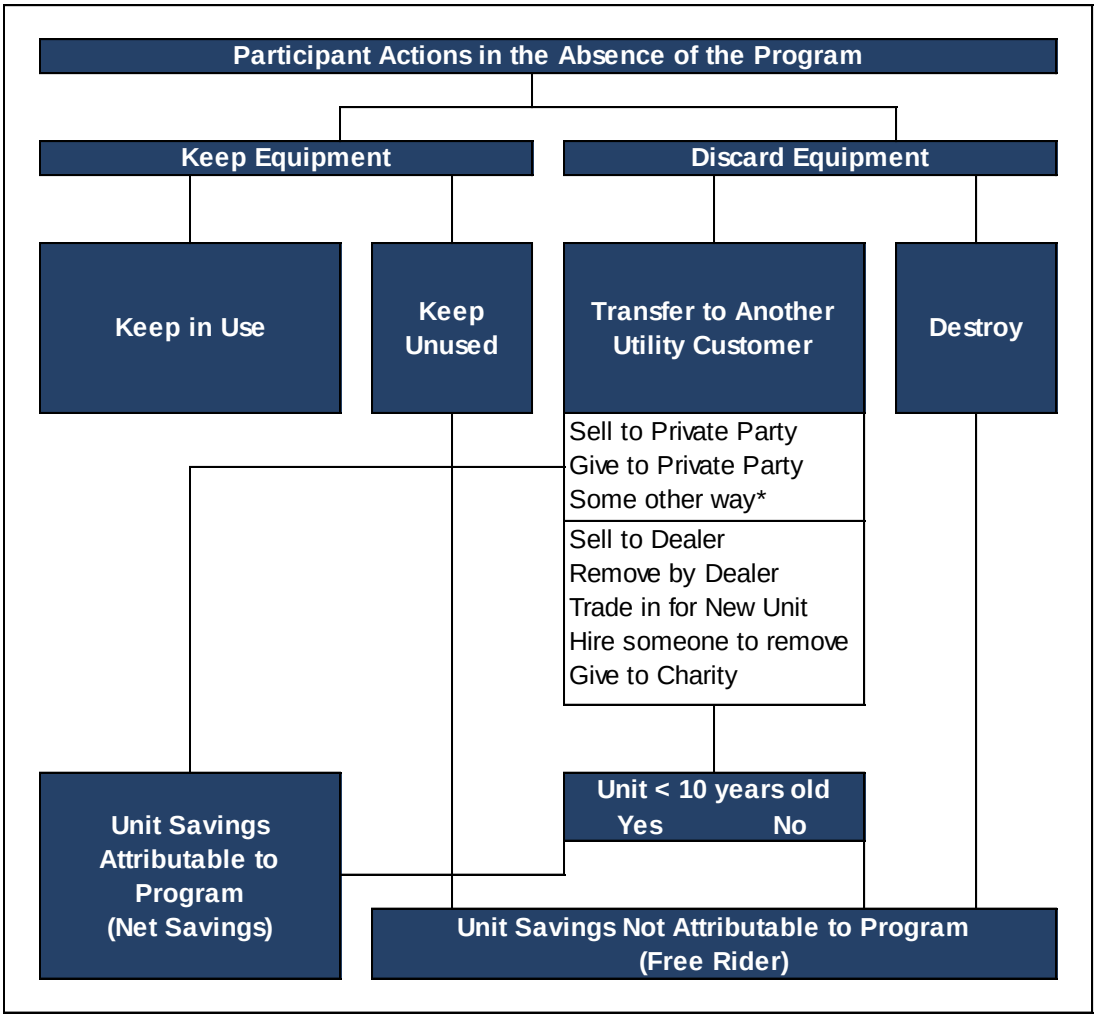
Units that would have been hauled to a dump or recycling center were considered to be units that would have been destroyed. Units that would have been given or sold to private parties were considered to be units that would have been transferred to the secondary market.

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[8] 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

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

saleable and recycled by the dealers. 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**




* All verbal responses to "Some Other Way" w ould result in the transfer of the unit.

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, KEMA surveyed a group of non-participants who had disposed of a refrigerator or freezer in

the past five 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**

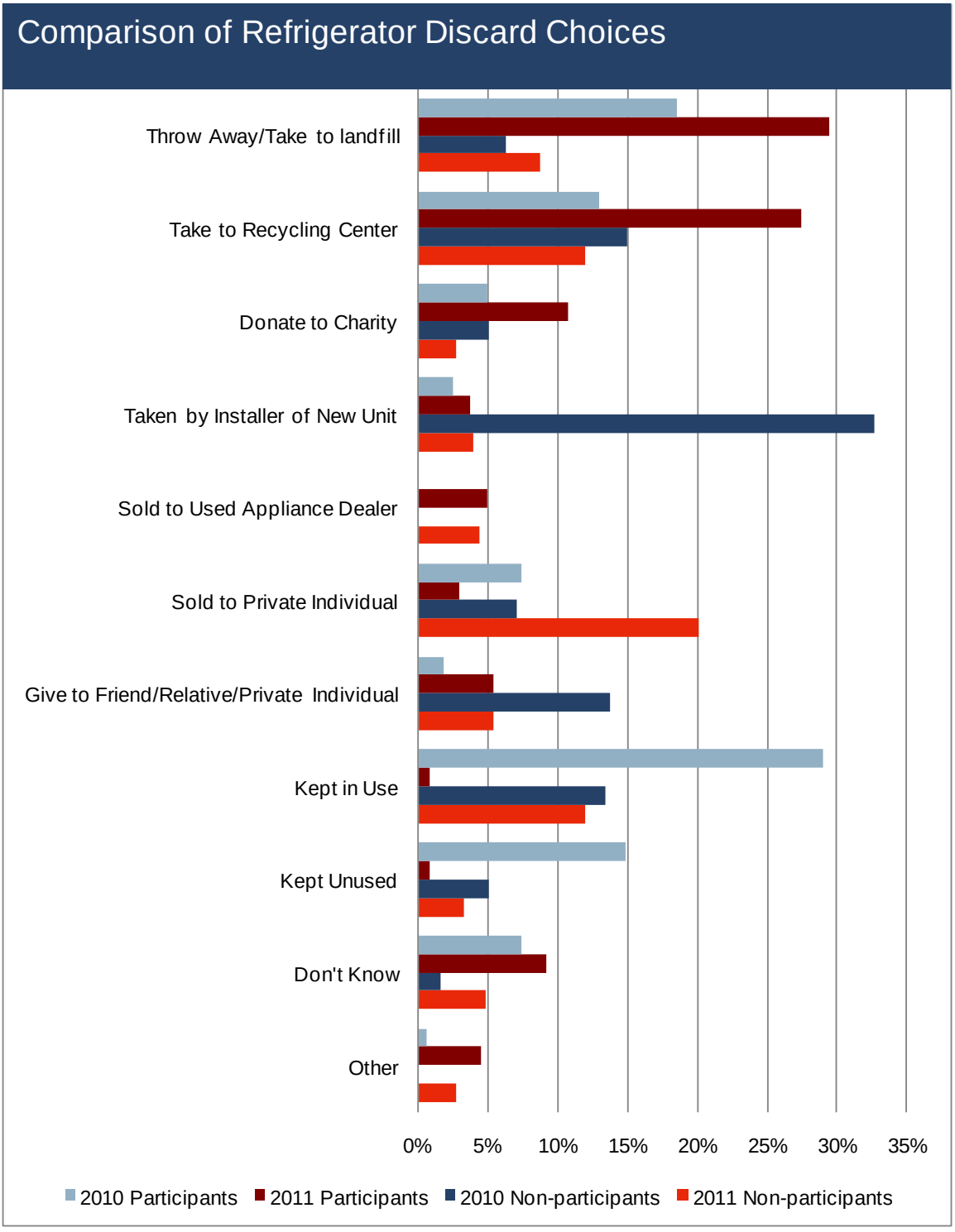
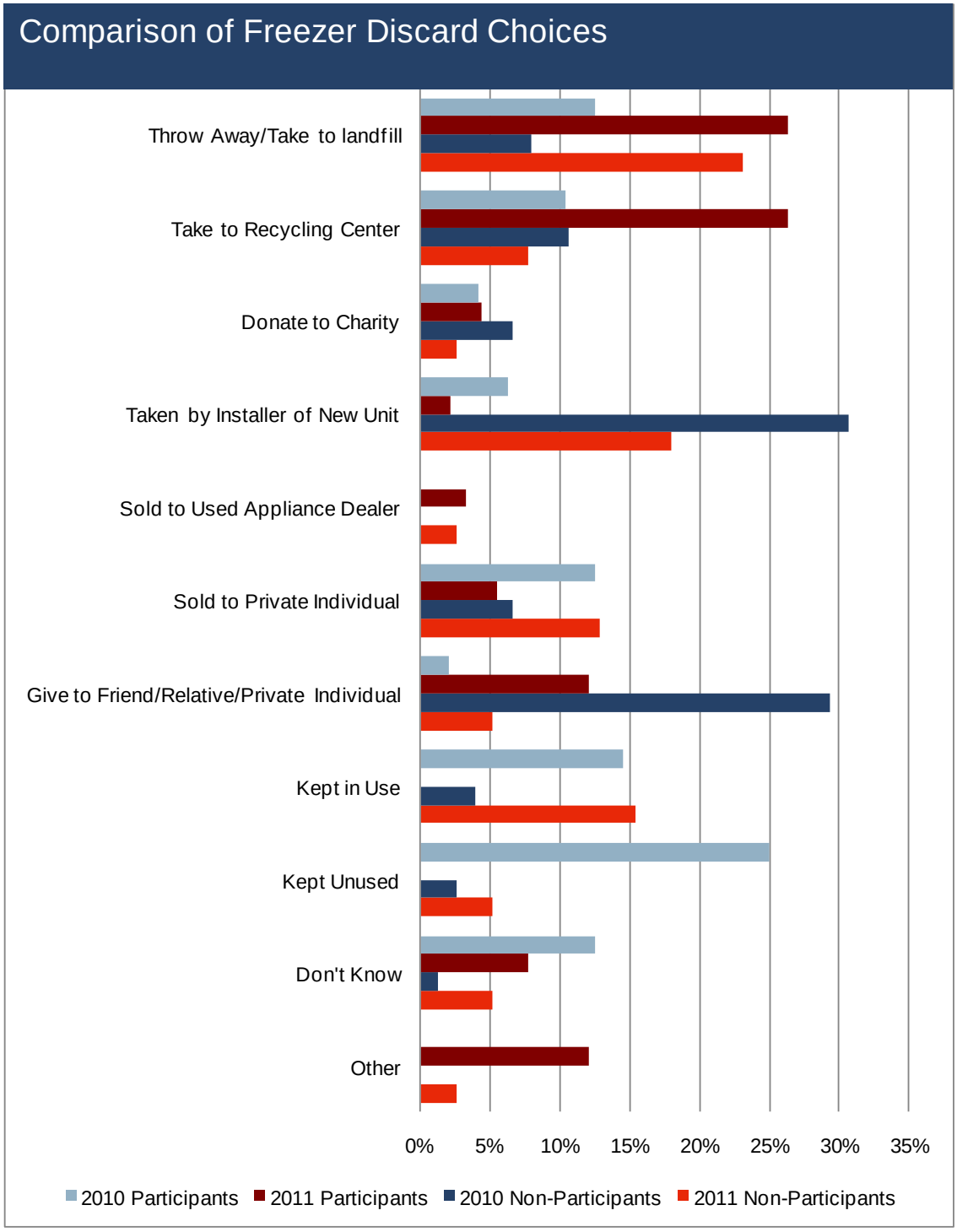


**Figure 7. Comparison of Freezer Discard Choices**



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 expect to keep the equipment. We also found that disposal patterns changed by the equipment type, with refrigerators more likely to be transferred while freezers are more likely to be destroyed. 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 C.3.2 above; the attribution rate, which incorporates free ridership; and acceleration, the savings credited to the program for early removal of units. Table 37 shows these various factors based on participant responses.

**Table 37. Attribution Parameters**

| Equipment | Mean Attribution | Aggregate Mean Attribution | Acceleration Rate (Annual %) | Energy from Acceleration Period (kWh) |
|---|---|---|---|---|
| **Refrigerators** | | | | |
| Particpants | 35% | 35% | 11% | 133 |
| Non-Participants | 35% | | | |
| **Freezers** | | | | |
| Particpants | 40% | 37% | 9% | 86 |
| Non-Participants | 28% | | | |

## C.4.2 Attribution Adjustment Factors

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 38 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 more than 75 percent and therefore dominated the overall attribution result, which was 42 percent.

**Table 38. Attribution Adjustment Factor, Appliance Recycling**

| Measure Group | kWh | | | | | |
|---|---|---|---|---|---|---|
| | n | Attribution Adjustment Factor | 90% Confidence Interval | | | % Program Savings |
| | | | +/- | Lower Bound | Upper Bound | |
| Refrigerators | 316 | 43% | 3% | 40% | 45% | 76% |
| Freezers | 118 | 40% | 3% | 37% | 42% | 24% |
| **Overall Appliance Recycling** | **434** | **42%** | **2%** | **40%** | **44%** | **100%** |

# C.5 Comparison of 2009-10 and 2011 Program Results

## C.5.1 Overall Comparison

Comparing results from last program cycle to this cycle provides some insight into program trends. As shown in Table 39, in general the program contracted during the 2011 program cycle, although the number of freezers recycled did increase. It is possible that this is in some part due to the fact that the 2010 "program cycle" included portions of 2009 as the programs first were implemented. Other potential causes of the changes found could be the general state of the economy (purchases of new equipment drop in favor of continued used of older equipment) and the fact that, as the programs get established, the pent up demand for program services is lowered.

**Table 39. Comparison of 2010 and 2011 Appliance Recycling Program Results**

| Metric | Program Period Program Start to Dec 2010 | Program Period January to December 2011 | 2010-2011 Change |
|---|---|---|---|
| Tracking kWh Savings | 4,399,373 | 3,635,698 | -17% |
| Refrigerator kWh | 3,675,056 | 2,745,424 | -25% |
| Freezer kWh | 724,317 | 890,274 | 23% |
| Total # Measures | 2,665 | 2,216 | -17% |
| # Refrigerators Recycled | 2,198 | 1,642 | -25% |
| # Freezers Recycled | 467 | 574 | 23% |
| # Participants | 2,495 | 2,100 | -16% |
| Total Incentive paid to Implementer | $399,750.00 | $332,400.00 | -17% |
| Refrigerator | $329,700.00 | $246,300.00 | -25% |
| Freezer | $70,050.00 | $86,100.00 | 23% |

## C.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 2010 and 2011. In the last program cycle, both refrigerators and freezers reported being plugged in and operational approximately 75 percent of the time. In this program

cycle, refrigerators were operational 80 percent of the time compared to 70 percent for freezers. This change is due to a program shift towards more primary refrigerators being recycled. In 2010, 31 percent of recycled refrigerators were primary refrigerators, while in 2011 49 percent were primary refrigerators. As primary refrigerators have a higher usage (secondary refrigerators are not necessarily plugged in and running full time), even though the reported usage of secondary units in 2011 decreased, this shift towards primary refrigerators increased the average usage for the refrigerator category as a whole. Usage of freezers declined by approximately 5 percent, consistent with the decline in usage of secondary refrigerators, possibly due to pressure from the difficult economy encouraging people to reduce optional use of these extra units. As discussed in Section C.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 2010 to 2011 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 40)

**Table 40. Gross Savings Adjustment by Equipment Type**

| Measure Group | Gross Savings Adj. | |
|---|---|---|
| | 2010 | 2011 |
| Refrigerators | 75% | 80% |
| Freezers | 75% | 70% |
| **Overall Appliance Recycling** | **75%** | **77%** |

## C.5.3 Program Attribution

The evaluation team found that program attribution declined between the 2010 and 2011 program years by approximately 25 percent. The largest factor driving the reduction in attribution was the number of participants who responded that they would have kept and used the equipment in the absence of the program. In the 2010 program year, almost 30 percent of participants reported that they would have kept and used their refrigerator or freezer if it had not been removed by the program, while in 2011 that percentage dropped to approximately 1 percent. A unit that would have stayed in use in the participant's home in the absence of the program receives 100 percent attribution, while a transferred unit has a greater chance of being destroyed, lowering the average attribution for units leaving the home. (Table 41) Highlighted cells show a statistically significant difference from the 2010 to 2011 program periods at the 90 percent confidence interval. Refrigerators, freezers and the program overall all showed a statistically significant decline in attribution.

**Table 41. Change in Attribution from 2010 to 2011**

| Measure Group | Attribution | |
|---|---|---|
| | 2010 | 2011 |
| Refrigerators | 60% | 43% |
| Freezers | 51% | 40% |
| **Overall Appliance Recycling** | **58%** | **42%** |

# D. Residential HVAC Program

This section reports on the methodology and overall results of KEMA's evaluation of the 2011 Residential HVAC Program.

- Section D.1 provides a description of the program.
- Section D.2 gives an overview of the evaluation approach.
- Section D.3 presents the verified gross savings results and the overall adjustment factors.
- Section D.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.

## D.1 Program Description

The Residential HVAC Program 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 program applies to existing homes installing new equipment and new homes only when they do not qualify for the Residential New Construction Program incentives. The HVAC Program is the largest residential natural gas program in the MECA/MCAAA portfolio and is offered in all utility service territories except Bayfield Electric Cooperative and Daggett Electric Department. Not all measures are offered in all utility service territories as shown in Table 42.

**Table 42. Measures Offered by Utility through HVAC Program**

| Consortium | Utility | Measure | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ECM Drive | Pipe Insulation | Electric Water Heater | Gas Water Heater | Programmable Thermostat | Water Heater kit | Furnace; Furnace Tune-Up | Central Air Conditioner | Boiler | Heat Pump |
| MECA Cooperatives | Alger Delta Cooperative Electric Association | X | X | X | | X | X | | X | | X |
| | Cloverland Electric Cooperative | X | X | X | | X | X | | X | | X |
| | Great Lakes Energy Cooperative | X | X | X | | X | X | | X | | X |
| | HomeWorks Tri-County Electric Cooperative | X | X | X | | X | X | | X | | X |
| | Midwest Energy Cooperative | X | X | X | | X | X | | X | | X |
| | Ontonagon County Rural Electrification Association | X | X | X | | X | X | | X | | X |
| | Presque Isle Electric and Gas Co-op | X | X | X | | X | X | | X | | X |
| | Thumb Electric Cooperative | X | X | X | | X | X | | X | | X |
| MECA UP | Marquette Board of Light and Power | X | | | | | | | | | |
| | Escanaba Electric Department | X | | | | | | | | | |
| | Newberry Water and Light Board | X | | | | | | | | | |
| | City of Stephenson | X | | | | | | | | | |
| MCAAA | Alpena Power Company | X | | | | | | | X | | X |
| | Bayfield Electric Cooperative | | | | | | | | | | |
| | Daggett Electric Department | | | | | | | | | | |
| | Edison Sault Electric Company | X | X | X | | | X | | X | | X |
| | Indiana Michigan Power Company | X | | | | | | | X | | X |
| | Michigan Gas Utilities Corporation | | | | X | X | | X | | X | |
| | SEMCO Energy Gas Company | | | | X | X | | X | | X | |
| | Upper Peninsula Power Company | X | | | | | | | 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 43 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 2011 program period.

**Table 43. Overview of HVAC Program Accomplishments per Program Tracking**

| Metric | Evaluation Period Jan to Aug 2011 | Program Period Jan to Dec 2011 |
|---|---|---|
| Tracking kWh Savings | 209,196 | 582,480 |
| Tracking ccf Savings | 283,781 | 648,661 |
| # Measures | 1,653 | 4,560 |
| Incentives | $217,890.00 | $630,426.00 |

## D.2 General Approach

The impact evaluation of the HVAC Program had the following objectives for the 2011 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 Q)
- Verify proper documentation with a sample of participating applications (Appendix R)
- 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 A.5 describes the steps used to complete these tasks in greater detail.

## D.3 Verified Gross Savings Results

### D.3.1 Installation Rate

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 44 shows the results.

The table shows that the majority of measure groups had 100 percent installation rate for both electric and gas, with the exception of water heater kits, which had an installation rate of 68 percent. Since water heater kits make up only 16 percent of program kWh savings, the overall installation rate for electric measures is still high at 95 percent.

**Table 44. 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% | 9 | 100% | <0.1% | 100% | 100% | 14% |
| CAC | 11 | 100% | <0.1% | 100% | 100% | 9% | 0 | - | - | - | - | 0% |
| ECM | 33 | 100% | <0.1% | 100% | 100% | 54% | 0 | - | - | - | - | 0% |
| Furnace | 0 | - | - | - | - | 0% | 253 | 100% | <0.1% | 100% | 100% | 79% |
| Heat Pump | 2 | 100% | <0.1% | 100% | 100% | 12% | 0 | - | - | - | - | 0% |
| Water Heater Kit | 2 | 68% | 164% | 0% | 100% | 16% | 0 | - | - | - | - | 0% |
| Pipe Wrap | 8 | 100% | <0.1% | 100% | 100% | 6% | 0 | - | - | - | - | 0% |
| Thermostat | 3 | 100% | <0.1% | 100% | 100% | 1% | 107 | 100% | <0.1% | 100% | 100% | 8% |
| Water Heaters | 9 | 100% | <0.1% | 100% | 100% | 3% | 7 | 100% | <0.1% | 100% | 100% | 0% |
| **HVAC Overall** | **68** | **95%** | **7%** | **88%** | **100%** | **100%** | **376** | **100%** | **<0.1%** | **100%** | **100%** | **100%** |

## D.3.2 Verified Gross Savings

KEMA combined the installation rate and the effects of the documentation review (Appendix R) 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. Table 45 shows the gross savings adjustment factor for HVAC.

The only change between the installation rate and gross savings adjustment factor was in the furnace measure group. In the documentation review, KEMA found one furnace measure that also had a programmable thermostat installed but was not entered in the database. We applied an adjustment factor to furnaces (because the two measures were linked) to account for the oversight.

**Table 45. 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 min n | ccf Gross Savings Adjustment Factor | ccf 90% Confidence Interval +/- | ccf Lower Bound | ccf Upper Bound | ccf % Program Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler | 0 | - | - | - | - | 0% | 9 | 100% | <0.1% | 100% | 100% | 14% |
| CAC | 11 | 100% | <0.1% | 100% | 100% | 9% | 0 | - | - | - | - | 0% |
| ECM | 33 | 100% | <0.1% | 100% | 100% | 54% | 0 | - | - | - | - | 0% |
| Furnace | 0 | - | - | - | - | 0% | 253 | 101% | <0.1% | 101% | 101% | 79% |
| Heat Pump | 2 | 100% | <0.1% | 100% | 100% | 12% | 0 | - | - | - | - | 0% |
| Water Heater Kit | 2 | 68% | 164% | -96% | 233% | 16% | 0 | - | - | - | - | 0% |
| Pipe Wrap | 8 | 100% | <0.1% | 100% | 100% | 6% | 0 | - | - | - | - | 0% |
| Thermostat | 3 | 100% | <0.1% | 100% | 100% | 1% | 107 | 100% | <0.1% | 100% | 100% | 8% |
| Water Heaters | 9 | 100% | <0.1% | 100% | 100% | 3% | 7 | 100% | <0.1% | 100% | 100% | 0% |
| **HVAC Overall** | **68** | **95%** | **7%** | **88%** | **103%** | **100%** | **376** | **100%** | **<0.1%** | **100%** | **100%** | **100%** |

The gross savings adjustment factor was applied to the total savings reported for the HVAC Program in 2011 to produce the verified gross savings for the program. Table 46 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.[9]

**Table 46. Verified Gross Savings, HVAC, Overall**

| 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 |
| ECM | 264,260 | 100% | 264,260 | 3,963,900 | | | | |
| CAC | 39,234 | 100% | 39,234 | 588,505 | | | | |
| Heat Pump | 95,237 | 100% | 95,237 | 1,428,555 | | | | |
| Pipe Wrap | 67,320 | 100% | 67,320 | 875,160 | | | | |
| Thermostat | 12,834 | 100% | 12,834 | 141,174 | 69,662 | 100% | 69,662 | 766,285 |
| Water Heaters | 44,588 | 100% | 44,588 | 579,644 | 1,280 | 100% | 1,280 | 14,080 |
| Kit - Faucet Aerator | 16,949 | 50% | 8,474 | 84,744 | | | | |
| Kit - Pipe Wrap | 15,623 | 100% | 15,623 | 203,097 | | | | |
| Kit - Showerhead | 26,435 | 50% | 13,218 | 132,177 | | | | |
| Boiler | | | | | 48,219 | 100% | 48,219 | 964,374 |
| Furnace | | | | | 485,576 | 101% | 488,392 | 7,325,882 |
| Furnace Tune-up | | | | | 43,925 | 100% | 43,925 | 219,623 |
| **HVAC Overall** | **582,480** | **95%** | **560,788** | **7,996,955** | **648,661** | **100%** | **651,478** | **9,290,244** |

Table 47 and Table 48 show the verified gross lifetime savings for the Efficiency United and Energy Optimization programs, respectively.

**Table 47. Verified Gross Savings, HVAC, EU**

| 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 |
| Water Heaters | 314 | 100% | 314 | 4,082 | 1,280 | 100% | 1,280 | 14,080 |
| CAC | 33,727 | 100% | 33,727 | 505,912 | | | | |
| ECM | 174,470 | 100% | 174,470 | 2,617,050 | | | | |
| Heat Pump | 51,037 | 100% | 51,036 | 765,547 | | | | |
| Boiler | | | | | 48,219 | 100% | 48,219 | 964,374 |
| Thermostat | | | | | 69,662 | 100% | 69,662 | 766,285 |
| Furnace | | | | | 485,576 | 101% | 488,392 | 7,325,882 |
| Furnace Tune-up | | | | | 43,925 | 100% | 43,925 | 219,623 |
| **HVAC EU Overall** | **259,548** | **95%** | **259,548** | **3,892,592** | **648,661** | **100%** | **651,478** | **9,290,244** |

[9] KEMA's study did not complete any surveys addressing HVAC program furnace tune-ups. To estimate verified gross savings, KEMA applied the gross savings adjustment factor found for Low Income program furnace tune-ups.

**Table 48. Verified Gross Savings, HVAC, EO**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| ECM | 89,790 | 100% | 89,790 | 1,346,850 |
| CAC | 5,506 | 100% | 5,506 | 82,593 |
| Heat Pump | 44,201 | 100% | 44,200 | 663,007 |
| Pipe Wrap | 67,320 | 100% | 67,320 | 875,160 |
| Thermostat | 12,834 | 100% | 12,834 | 141,174 |
| Water Heaters | 44,274 | 100% | 44,274 | 575,562 |
| Kit - Faucet Aerator | 16,949 | 50% | 8,474 | 84,744 |
| Kit - Pipe Wrap | 15,623 | 100% | 15,623 | 203,097 |
| Kit - Showerhead | 26,435 | 50% | 13,218 | 132,177 |
| **HVAC EO Overall** | **322,932** | **95%** | **301,240** | **4,104,364** |

## D.4 Attribution Results

The EO/EU programs were not required to report net or attributable savings for the 2011 program year. However, discussions within the State of Michigan suggest that net savings will be required in future program years. 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.

### D.4.1 Attribution Adjustment Factors

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.[10] Table 49 shows the results.

Attribution results were below 20 percent for all measure groups except pipe wrap (65%) and electric water heaters (27%). Both measures are a small portion of overall program kWh savings. On the electric side, ECMs (10% attribution, 54% of program savings), heat pumps (0%, 12%), and water heater kits (1%, 16%) had the greatest effect on the overall result. For

[10] Appendix U discusses the methodology used in the attribution analysis.

natural gas, furnaces and boilers account for 93 percent of program savings with attribution rates of 14 percent and 7 percent respectively.

**Table 49. 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% | 9 | 7% | 10% | 0% | 17% | 14% |
| CAC | 11 | 9% | 11% | 0% | 20% | 9% | 0 | - | - | - | - | 0% |
| ECM | 33 | 10% | 8% | 2% | 18% | 54% | 0 | - | - | - | - | 0% |
| Furnace | 0 | - | - | - | - | 0% | 253 | 14% | 3% | 11% | 16% | 79% |
| Heat Pump | 2 | 0% | <0.1% | 0% | 0% | 12% | 0 | - | - | - | - | 0% |
| Water Heater Kit | 2 | 1% | 0% | 1% | 2% | 16% | 0 | - | - | - | - | 0% |
| Pipe Wrap | 8 | 65% | 29% | 36% | 94% | 6% | 0 | - | - | - | - | 0% |
| Thermostat | 2 | 0% | <0.1% | 0% | 0% | 1% | 107 | 15% | 5% | 10% | 20% | 8% |
| Water Heaters | 8 | 27% | 27% | 0% | 54% | 3% | 7 | 2% | 3% | 0% | 5% | 0% |
| **HVAC Overall** | **66** | **13%** | **6%** | **8%** | **19%** | **100%** | **376** | **13%** | **2%** | **11%** | **15%** | **100%** |

## D.4.2 Analysis of Survey Responses

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 U has greater detail on the attribution analysis methodology and the methods used to combine the three components into a single attribution value.

**Table 50. Attribution Question Sequence**

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

### D.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 51 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 51. Determining Acceleration Period, HVAC Overall**

| DAT1a. Without EO/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 | 315 | 63% | 71% | 0 |
| Earlier | N/A | 11 | 2% | 2% | 0 |
| Later | Months < 48 | 51 | 17% | 12% | Months / 48 |
| | Months >= 48 | 2 | 1% | 0% | 100% |
| | Don't Know/Refused | 24 | 8% | 5% | Average of DAT1b |
| Never | N/A | 27 | 3% | 5% | 100% |
| Not Applicable | N/A | 1 | 5% | 0% | Not Asked |
| Don't Know/Refused | N/A | 13 | 1% | 3% | 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 63 percent of kWh and 71 percent of gas savings (ccf). Twenty-nine respondents give the program full attribution credit, representing 4 percent of kWh savings and 5 percent of gas savings (ccf). Eighty-eight

respondents representing 26 percent of kWh savings and 20 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.

Table 52 shows the DAT1a and DAT1b responses for furnaces, which is by far the largest measure group in the HVAC Program. Sixty-nine percent of ccf savings were represented by Same Time responses, which do not receive attribution. Twelve respondents answered Never or More than 48 months, which receives full timing attribution.

**Table 52. Determining Acceleration Period, Furnace**

| DAT1a. Without EO/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 | 173 | 0% | 69% | 0 |
| Earlier | N/A | 7 | 0% | 2% | 0 |
| Later | Months < 48 | 35 | 0% | 14% | Months / 48 |
| | Months >= 48 | 1 | 0% | 0% | 100% |
| | Don't Know/Refused | 18 | 0% | 7% | Average of DAT1b |
| Never | N/A | 11 | 0% | 5% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 8 | 0% | 3% | Average of DAT1a |

### D.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 53 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 53. Determining Efficiency Attribution, HVAC Overall**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 239 | 67% | 65% | 0% |
| Lower | Standard Efficiency | 10 | 3% | 3% | 100% |
| | Slightly > Standard | 7 | 0% | 3% | 70% |
| | Between Standard and High | 4 | 0% | 1% | 50% |
| | Slightly < High | 9 | 1% | 2% | 30% |
| | Don't Know/Refused | 1 | 0% | 0% | Average of DAT2b |
| Higher | N/A | 27 | 6% | 7% | 0% |
| Not Applicable | N/A | 120 | 20% | 11% | Not Asked |
| Don't Know/Refused | N/A | 27 | 3% | 8% | Average of DAT2a |

The table shows that the majority of respondents would have installed the same efficiency level without the program, with 239 respondents representing 67 percent of program kWh savings and 65 percent of program gas savings (ccf). Fifty-eight respondents representing 7 percent of program kWh savings and 17 percent of program gas savings (ccf) will receive some form of efficiency attribution by answering “Lower” or “Don’t know/Refused” to DAT2a. Three percent of both kWh and 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 54 shows the DAT2a and DAT2b responses for furnaces. Furnaces represent the majority of the responses in Table 53 that received attribution.

**Table 54. Determining Efficiency Attribution, Furnace**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 183 | 0% | 71% | 0% |
| Lower | Standard Efficiency | 8 | 0% | 3% | 100% |
| | Slightly > Standard | 6 | 0% | 2% | 70% |
| | Between Standard and High | 3 | 0% | 1% | 50% |
| | Slightly < High | 7 | 0% | 3% | 30% |
| | Don't Know/Refused | 1 | 0% | 1% | Average of DAT2b |
| Higher | N/A | 21 | 0% | 9% | 0% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 24 | 0% | 10% | Average of DAT2a |

### D.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 EO/EU 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 55 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 55. Determining Quantity Attribution, Overall**

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of Focus? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 383 | 78% | 90% | 0% |
| Less | Value < 100% | 4 | 2% | 1% | Value < 50% |
| | Value >= 100% | 2 | 0% | 1% | Value > 50% |
| | Don't Know/Refused | 5 | 0% | 1% | Average of DAT3a |
| More | Value < 100% | 2 | 0% | 1% | Value < 100% |
| | Value >= 100% | 0 | 0% | 0% | Value = 100% |
| | Don't Know/Refused | 0 | 0% | 0% | Average of DAT3a |
| None | N/A | 20 | 8% | 2% | 100% |
| Not Applicable | N/A | 2 | 8% | 0% | Not Asked |
| Don't Know/Refused | N/A | 26 | 4% | 5% | Average of DAT3 |

The table shows that 383 respondents representing 78 percent of kWh savings and 90 percent of gas savings (ccf) would have installed equipment of the same size or quantity without the program. Twenty respondents representing 8 percent of kWh savings and 2 percent of gas savings (ccf) would not have installed any equipment, resulting in 100 percent quantity attribution.

### D.4.2.4 Overall Attribution

KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 56 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 11 responses representing 9 percent of kWh savings and 2 percent of gas savings (ccf) received all three types of attribution (or full attribution based on the overall likelihood question). In total, 194 responses representing 55 percent of kWh savings and 54

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.

**Table 56. Simplistic Representation of Overall Attribution, HVAC**

| Attribution | | | Responses | Percent kWh | Percent ccf |
|---|---|---|---|---|---|
| Timing | Efficiency | Quantity | | | |
| Yes | Yes | Yes | 11 | 9% | 2% |
| Yes | No | Yes | 5 | 3% | 1% |
| Yes | No | No | 58 | 16% | 14% |
| Yes | Yes | No | 15 | 2% | 5% |
| No | Yes | Yes | 16 | 3% | 4% |
| No | Yes | No | 24 | 2% | 7% |
| No | No | Yes | 121 | 9% | 13% |
| No | No | No | 194 | 55% | 54% |

## D.5 Comparison of 2009-10 and 2011 Program Results

KEMA compared the results of the 2009-2010 program evaluation to the results of the 2011 program evaluation.

### D.5.1 Overall Comparison

Table 57 shows the tracking savings, number of measures, and total incentives paid for the 2009-2010 and 2011 program periods. The final column shows the difference between the two, with a negative value representing a decrease from 2010 and a positive value representing an increase.

The table shows a 50 percent increase in kWh savings from the 2009-2010 program period to the 2011 program period and a slight (7%) increase in incentives. The number of measures and tracked natural gas savings decreased slightly; approximately 5 percent. The increase in electric savings are likely due in part to the addition of water heater kits, offered by the MECA coops. Other than the kits, the distribution of savings across the different electric measure groups is relatively consistent from 2010 to 2011, suggesting that any other effects are simply a result of program expansion, likely by the self-implemented coops.

**Table 57. Comparison of 2010 and 2011 HVAC Program Results**

| Metric | Program Period Program Start to Dec 2010 | Program Period Jan to Dec 2011 | 2010 to 2011 Change |
|---|---|---|---|
| Tracking kWh Savings | 384,466 | 582,480 | 52% |
| Tracking ccf Savings | 685,958 | 648,661 | -5% |
| Total # Measures | 4,761 | 4,560 | -4% |
| Total Incentive | $587,914 | $630,426 | 7% |

## D.5.2 Adjustment Factors

Table 58 shows the 2009-2010 and 2011 installation rate, gross savings adjustment factor, and attribution adjustment factor for kWh and ccf. Highlighted cells show a statistically significant difference from the 2010 to 2011 program periods at the 90 percent confidence interval.

The table shows a statistically significant increase in gross savings adjustment factor for kWh from 2010 to 2011. Since the installation rate didn't change, this is an effect caused by differences in the documentation review or tracking adjustment factor from 2010 to 2011. A review of the 2010 report shows that the tracking review had a greater effect on the gross savings adjustment factor than the documentation review; therefore, the difference in gross savings adjustment factors from Table 58 are a result of the change in analysis method. This round, KEMA conducted our tracking review BEFORE the program savings were finalized which means that the effects of the tracking review are not included in the adjustment factors.

The table also shows relatively consistent attribution rates from 2010 to 2011, with no statistically significant differences..

**Table 58. Comparison of 2010 and 2011 HVAC Adjustment Factors**

| Adjustment Factor | kWh | | ccf | |
|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 |
| Installation Rate | 94% | 95% | 100% | 100% |
| Gross Savings Adjustment Factor | 84% | 95% | 105% | 105% |
| Attribution Adjustment Factor | 18% | 17% | 16% | 20% |

# E. Residential Low Income Program

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

- Section E.1 provides a description of the program.
- Section E.2 gives an overview of the evaluation approach.
- Section E.3 presents the verified gross savings results and the overall adjustment factors.

## E.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, high efficiency water heaters, thermostats, boilers, furnaces, and tune-ups. Low flow showerheads, pipe wrap, and faucet aerators may also be installed. The MECA/MCAAA portion of the program began implementation in November 2009. The program is available in all utility service territories. The LI program is the third largest program in the MECA/MCAAA portfolio.

Table 59 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 2011 program period.

**Table 59. Overview of LI Program Accomplishments per Program Tracking**

| Metric | Evaluation Period Jan to Aug 2011 | Program Period Jan to Dec 2011 |
|---|---|---|
| Tracking kWh Savings | 830,698 | 2,094,648 |
| Tracking ccf Savings | 44,992 | 156,519 |
| # Measures | 1,752 | 5,268 |
| Incentives | $547,779.00 | $832,195.00 |

## E.2 General Approach

The impact evaluation of the 2011 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 Q)
- Conduct CATI surveys with a sample of participants
- Complete verified gross savings analysis.

There was no net savings analysis for this program. Section A.5 describes the steps used to complete these tasks in greater detail.

## E.3 Verified Gross Savings Results

### E.3.1 Installation Rate

KEMA calculated the installation rate for each measure group in the Low Income Program. We defined the installation rate for CFLs and refrigerators 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 furnaces and furnace tune-ups, it is the capacity of the furnace. Table 60 shows the results.

The installation rate for all measure groups is above 90 percent. CFLs had the lowest rate at 91 percent, which is a result of bulbs that were installed by the program representative but subsequently removed by the homeowner. The insulation and air-sealing measures have an installation rate of less than 100 percent because one respondent indicated that their gas service was provided by a non-participating utility. Finally, the refrigerator installation rate is less than 100 percent because one respondent reported that the program removed their newly installed refrigerator and another reported that they had refused the refrigerator.

**Table 60. Installation Rate, Low Income**

| 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 | 102 | 91% | 4% | 87% | 95% | 20% | 0 | - | - | - | - | 0% |
| Furnace | 0 | - | - | - | - | 0% | 33 | 100% | <0.1% | 100% | 100% | 52% |
| Furnace Tune-up | 0 | - | - | - | - | 0% | 26 | 100% | <0.1% | 100% | 100% | 4% |
| Insulation | 0 | - | - | - | - | 0% | 78 | 98% | 3% | 95% | 100% | 34% |
| Thermostat | 0 | - | - | - | - | 0% | 13 | 100% | <0.1% | 100% | 100% | 4% |
| Refrigerator | 142 | 99% | 1% | 97% | 100% | 80% | 0 | - | - | - | - | 0% |
| Air Sealing | 0 | - | - | - | - | 0% | 36 | 99% | 2% | 97% | 100% | 6% |
| **Low Income Overall** | **244** | **97%** | **1%** | **96%** | **98%** | **100%** | **186** | **99%** | **1%** | **98%** | **100%** | **100%** |

## E.3.2 Verified Gross Savings

KEMA did not conduct a documentation review for the Low Income Program; therefore, the gross savings adjustment factor is equal to the installation rate. Table 61 shows the gross savings adjustment factor for Low Income.

**Table 61. Gross Savings Adjustment Factor, Low Income**

| Measure Group | kWh min n | kWh Gross Savings Adjustment Factor | kWh 90% Confidence Interval +/- | kWh Lower Bound | kWh Upper Bound | kWh % Program Savings | ccf min n | ccf Gross Savings Adjustment Factor | ccf 90% Confidence Interval +/- | ccf Lower Bound | ccf Upper Bound | ccf % Program Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CFL | 102 | 91% | 4% | 87% | 95% | 20% | 0 | - | - | - | - | 0% |
| Furnace | 0 | - | - | - | - | 0% | 33 | 100% | <0.1% | 100% | 100% | 52% |
| Furnace Tune-up | 0 | - | - | - | - | 0% | 26 | 100% | <0.1% | 100% | 100% | 4% |
| Insulation | 0 | - | - | - | - | 0% | 78 | 98% | 3% | 95% | 101% | 34% |
| Thermostat | 0 | - | - | - | - | 0% | 13 | 100% | <0.1% | 100% | 100% | 4% |
| Refrigerator | 142 | 99% | 1% | 97% | 100% | 80% | 0 | - | - | - | - | 0% |
| Air Sealing | 0 | - | - | - | - | 0% | 36 | 99% | 2% | 97% | 101% | 6% |
| **Low Income Overall** | **244** | **97%** | **1%** | **96%** | **98%** | **100%** | **186** | **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 62 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.[11]

[11] KEMA's study did not complete any surveys addressing thermostats that saved electricity, ECMs, faucet aerators, pipe wrap, showerheads, or boilers. To estimate verified gross savings, KEMA applied

### Table 62. Verified Gross Savings, Low Income, Overall

| 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 | 973,984 | 91% | 888,716 | 7,998,440 | | | | |
| Refrigerator | 952,500 | 99% | 939,010 | 13,146,141 | | | | |
| Thermostat | 9,240 | 100% | 9,240 | 101,640 | 21,085 | 100% | 21,085 | 231,931 |
| ECM | 1,460 | 100% | 1,460 | 21,900 | | | | |
| Faucet Aerator | 46,480 | 84% | 38,943 | 389,427 | 20,383 | 89% | 18,174 | 181,744 |
| Pipe Wrap | 31,212 | 97% | 30,200 | 392,606 | 1,388 | 95% | 1,320 | 14,521 |
| Showerhead | 79,772 | 87% | 69,800 | 698,005 | 33,399 | 96% | 32,200 | 321,999 |
| Air Sealing | | | | | 5,851 | 99% | 5,788 | 63,673 |
| Furnace | | | | | 36,869 | 100% | 36,869 | 553,037 |
| Furnace Tune-up | | | | | 13,193 | 100% | 13,193 | 65,964 |
| Insulation | | | | | 23,106 | 98% | 22,680 | 453,608 |
| Boiler | | | | | 1,245 | 100% | 1,245 | 24,906 |
| **Low Income Overall** | **2,094,648** | **97%** | **1,977,369** | **22,748,158** | **156,519** | **99%** | **152,555** | **1,911,382** |

Table 63 and Table 64 show the verified gross lifetime savings for the Efficiency United and Energy Optimization programs, respectively.

### Table 63. Verified Gross Savings, Low Income, EU

| 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 | 783,728 | 91% | 715,116 | 6,436,041 | | | | |
| ECM | 1,460 | 100% | 1,460 | 21,900 | | | | |
| Faucet Aerator | 46,480 | 84% | 38,943 | 389,427 | 20,383 | 89% | 18,174 | 181,744 |
| Pipe Wrap | 31,212 | 97% | 30,200 | 392,606 | 1,388 | 95% | 1,320 | 14,521 |
| Refrigerator | 675,000 | 99% | 665,440 | 9,316,163 | | | | |
| Showerhead | 79,772 | 87% | 69,800 | 698,005 | 33,399 | 96% | 32,200 | 321,999 |
| Air Sealing | | | | | 5,851 | 99% | 5,788 | 63,673 |
| Furnace | | | | | 36,869 | 100% | 36,869 | 553,037 |
| Furnace Tune-up | | | | | 13,193 | 100% | 13,193 | 65,964 |
| Insulation | | | | | 23,106 | 98% | 22,680 | 453,608 |
| Thermostat | | | | | 21,085 | 100% | 21,085 | 231,931 |
| Boiler | | | | | 1,245 | 100% | 1,245 | 24,906 |
| **Low Income EU Overall** | **1,617,652** | **97%** | **1,520,960** | **17,254,142** | **156,519** | **99%** | **152,555** | **1,911,382** |

the gross savings adjustment factor found for the most similar program and measure group that was available. For thermostats, KEMA applied the ratio for therm savings to the electric savings. For faucet aerators, pipe wrap and showerheads, the corresponding ratios from the Onsite Audit program were applied. For boilers, we applied the boiler ratio from the HVAC program.

**Table 64. Verified Gross Savings, Low Income, EO**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| CFL | 190,256 | 91% | 173,600 | 1,562,399 |
| Refrigerator | 277,500 | 99% | 273,570 | 3,829,978 |
| Thermostat | 9,240 | 100% | 9,240 | 101,640 |
| **Low Income EO Overall** | **476,996** | **97%** | **456,410** | **5,494,017** |

## E.4 Comparison of 2009-10 and 2011 Program Results

KEMA compared the results of the 2009-2010 program evaluation to the results of the 2011 program evaluation.

### E.4.1 Overall Comparison

Table 65 shows the tracking savings, number of measures, and total incentives paid for the 2009-2010 and 2011 program periods. The final column shows the difference between the two, with a negative value representing a decrease from 2010 and a positive value representing an increase.

The Low Income Program shows a decrease in all four metrics: kWh savings, ccf savings, number of measures, and incentives. The number of measures shows the greatest decrease, with an 85 percent decrease from the 2009-2010 period to 2011. Natural gas savings decreased by 57 percent and electric savings decreased by 15 percent. Again, the most obvious reason for the difference is the longer program period in 2009-2010.

The program also shows a change in measure mix, with a lesser portion of ccf savings going to building shell measures in 2011 (40% of savings) than in 2010 (68%).

**Table 65. Comparison of 2010 and 2011 Low Income Program Results**

| Metric | Program Period Program Start to Dec 2010 | Program Period Jan to Dec 2011 | 2010 to 2011 Change |
|---|---|---|---|
| Tracking kWh Savings | 2,478,352 | 2,094,648 | -15% |
| Tracking ccf Savings | 367,235 | 156,519 | -57% |
| Total # Measures | 34,954 | 5,268 | -85% |
| Total Incentive | $892,749 | $832,195 | -7% |

## E.4.2 Adjustment Factors

Table 66 shows the 2009-2010 and 2011 installation rate, gross savings adjustment factor, and attribution adjustment factor for kWh and ccf. Highlighted cells show a statistically significant difference from the 2010 to 2011 program periods at the 90 percent confidence interval.

The table shows a statistically significant increase in gross savings adjustment factor for natural gas from 2010 to 2011. Since the installation rate didn't change, this effect is caused by differences in the documentation review or tracking adjustment factor from 2010 to 2011. A review of the 2010 report shows that the tracking review had a greater effect on the gross savings adjustment factor than the documentation review; therefore, the difference in gross savings adjustment factors from Table 66 is a result in the change in analysis method. This round, KEMA conducted our tracking review BEFORE the program savings were finalized, which means that the effects of the tracking review are not included in the adjustment factors.

The table also shows a statistically significant (though small) decrease in the installation rate from 2010 to 2011. The only installation rate adjustment in 2010 was due to CFLs that were removed by the homeowners. The same phenomenon was observed in 2011; however, KEMA also found two instances where refrigerators were not currently installed.

**Table 66. Comparison of 2010 and 2011 Low Income Adjustment Factors**

| Adjustment Factor | kWh | | ccf | |
|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 |
| Installation Rate | 99% | 97% | 100% | 99% |
| Gross Savings Adjustment Factor | 98% | 97% | 88% | 99% |

# F. Residential Online Audit Program

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

- Section F.1 provides a description of the program.
- Section F.2 gives an overview of the evaluation approach.
- Section  presents the verified gross savings results and the overall adjustment factors.
- Section F.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.

## F.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 small part of the MECA/MCAAA portfolio.

Table 67 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 2011 program period.

**Table 67. Overview of OA Program Accomplishments per Program Tracking**

| Metric | Program Period Program Start to Dec 2010 | Program Period Jan to Dec 2011 |
|---|---|---|
| Tracking kWh Savings | 1,758,466 | 1,588,234 |
| Tracking ccf Savings | 5,496 | 59,721 |
| Total # Measures | 2,864 | 3,514 |
| Total Incentive | $55,643 | $114,306 |

## F.2 General Approach

The impact evaluation of the OA program had the following objectives for the 2011 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 Q)
- Verify proper documentation with a sample of participating applications (Appendix R)
- 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 A.5 describes the steps used to complete these tasks in greater detail.

# F.3 Verified Gross Savings Results

## F.3.1 Installation Rate

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 68 shows the results.

On the electric side, CFLs and LED night lights had the highest installation rates at approximately 65 percent but accounted for only 30 percent of the savings. The overall electric installation rate was 50 percent. On the natural gas side, showerheads also had a high installation rate at 78 percent, accounting for 42 percent of savings. The natural gas overall installation rate was 60 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. However, our participant survey also found a number of respondents (13%) who reported that they had not received their energy kit, causing a lower installation rate than was expected.

**Table 68. 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 | 164 | 66% | 4% | 61% | 70% | 29% | 0 | - | - | - | - | 0% |
| Kit - Door Strip | 0 | - | - | - | - | 0% | 13 | 38% | 22% | 16% | 59% | 5% |
| Kit - Faucet Aerator | 114 | 43% | 6% | 37% | 49% | 28% | 10 | 49% | 24% | 25% | 72% | 27% |
| Kit - LED Night Light | 17 | 65% | 14% | 51% | 79% | 1% | 0 | - | - | - | - | 0% |
| Kit - Pipe Wrap | 0 | - | - | - | - | 0% | 10 | 49% | 26% | 23% | 75% | 27% |
| Kit - Showerhead | 114 | 45% | 7% | 38% | 52% | 43% | 9 | 78% | 23% | 56% | 100% | 42% |
| **Online Audit Overall** | **409** | **50%** | **5%** | **45%** | **54%** | **100%** | **42** | **60%** | **16%** | **44%** | **76%** | **100%** |

## F.3.2 Verified Gross Savings

The Online Audit Program does not have a paper application; therefore, KEMA did not do a documentation review for this program. As a result, the gross savings adjustment factor is equal to the installation rate. Table 69 shows the gross savings adjustment factor for Online Audit.

**Table 69. 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 min n | ccf Gross Savings Adjustment Factor | ccf 90% Confidence Interval +/- | ccf Lower Bound | ccf Upper Bound | ccf % Program Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kit - CFL | 164 | 66% | 5% | 61% | 70% | 29% | 0 | - | - | - | - | 0% |
| Kit - Door Strip | 0 | - | - | - | - | 0% | 13 | 38% | 26% | 12% | 64% | 5% |
| Kit - Faucet Aerator | 114 | 43% | 6% | 36% | 49% | 28% | 10 | 49% | 26% | 23% | 75% | 27% |
| Kit - LED Night Light | 17 | 65% | 14% | 51% | 79% | 1% | 0 | - | - | - | - | 0% |
| Kit - Pipe Wrap | 0 | - | - | - | - | 0% | 10 | 49% | 31% | 18% | 79% | 27% |
| Kit - Showerhead | 114 | 45% | 7% | 38% | 52% | 43% | 9 | 78% | 24% | 54% | 102% | 42% |
| **Online Audit Overall** | **409** | **50%** | **5%** | **45%** | **54%** | **100%** | **42** | **60%** | **16%** | **44%** | **76%** | **100%** |

The gross savings adjustment factor was applied to the total savings reported for the Online Audit Program in 2011 to produce the verified gross savings for the program. Table 70 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 70. Verified Gross Savings, Online Audit, Overall**

| 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 | 545,454 | 66% | 359,337 | 3,234,029 | | | | |
| Kit - Faucet Aerator | 389,768 | 43% | 166,356 | 1,663,564 | 16,422 | 49% | 8,011 | 80,107 |
| Kit - Showerhead | 608,132 | 45% | 272,597 | 2,725,970 | 26,082 | 78% | 20,443 | 204,426 |
| Kit - LED Night Light | 44,880 | 65% | 29,223 | 467,563 | | | | |
| Kit - Door Strip | | | | | 2,147 | 38% | 810 | 8,913 |
| Kit - Pipe Wrap | | | | | 15,070 | 49% | 7,351 | 80,861 |
| **Online Audit Overall** | **1,588,234** | **50%** | **827,513** | **8,091,126** | **59,721** | **60%** | **36,615** | **374,308** |

Table 71 and Table 72 show the verified gross lifetime savings for the Efficiency United and Energy Optimization programs, respectively.

**Table 71. Verified Gross Savings, Online Audit, EU**

| 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 | 399,431 | 66% | 263,139 | 2,368,250 | | | | |
| Faucet Aerator | 262,612 | 43% | 112,085 | 1,120,851 | 16,422 | 49% | 8,011 | 80,107 |
| Showerhead | 409,738 | 45% | 183,666 | 1,836,663 | 26,082 | 78% | 20,443 | 204,426 |
| LED Night Light | 44,880 | 65% | 29,223 | 467,563 | | | | |
| Pipe Wrap | | | | | 15,070 | 49% | 7,351 | 80,861 |
| Door Strip | | | | | 2,147 | 38% | 810 | 8,913 |
| **Online Audit EU Overall** | **1,116,661** | **50%** | **588,113** | **5,793,327** | **59,721** | **60%** | **36,615** | **374,308** |

**Table 72. Verified Gross Savings, Online Audit, EO**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| CFL | 146,023 | 66% | 96,198 | 865,779 |
| Faucet Aerator | 127,156 | 43% | 54,271 | 542,713 |
| Showerhead | 198,394 | 45% | 88,931 | 889,307 |
| **Online Audit EO Overall** | **471,573** | **50%** | **239,400** | **2,297,799** |

## F.4 Attribution Results

The EO/EU programs were not required to report net or attributable savings for the 2011 program year. However, discussions within the State of Michigan suggest that net savings will be required in future program years. 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.

## F.4.1 Attribution Adjustment Factors

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.[12] Table 73 shows the results.

CFLs had the lowest electric attribution rate at 35 percent. On the gas side, door strips showed the lowest rate at 23 percent. Faucet aerators and showerheads showed relatively high attribution for both natural gas and electric, with installation rates near or above 50 percent. Overall, the electric attribution adjustment factor was 46 percent and gas was 49 percent.

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

**Table 73. Attribution Adjustment Factor, Online Audit**

| | 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 |
| Kit - CFL | 136 | 35% | 6% | 29% | 40% | 29% | 0 | - | - | - | - | 0% |
| Kit - Door Strip | 0 | - | - | - | - | 0% | 5 | 23% | 33% | 0% | 56% | 5% |
| Kit - Faucet Aerator | 60 | 59% | 9% | 50% | 69% | 28% | 6 | 53% | 37% | 16% | 89% | 27% |
| Kit - LED Night Light | 14 | 53% | 19% | 34% | 73% | 1% | 0 | - | - | - | - | 0% |
| Kit - Pipe Wrap | 0 | - | - | - | - | 0% | 5 | 27% | 32% | 0% | 59% | 27% |
| Kit - Showerhead | 52 | 46% | 10% | 36% | 56% | 43% | 7 | 59% | 32% | 27% | 91% | 42% |
| **Online Audit Overall** | **262** | **46%** | **6%** | **40%** | **51%** | **100%** | **23** | **49%** | **19%** | **30%** | **68%** | **100%** |

## F.4.2 Analysis of Survey Responses

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 U has greater detail on the attribution analysis methodology.

For Online Audits, 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. KEMA wanted to get information at a

[12] Appendix U discusses the methodology used in the attribution analysis.

disaggregated level to judge the relative attribution of each technology in the kit, not the kit overall.

### F.4.2.1 Overall Likelihood

For the energy kits, 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, KEMA skipped them through the rest of the attribution sequence and assigned them an attribution rate of 100% for that technology.

Table 74 shows the results for the Online Audit Program. Forty-five of the respondents, representing 17 percent of kWh and 26 percent of ccf, said they would not have purchased the technology and received full attribution credit. Respondents representing 66 percent of kWh and 62 percent of ccf savings said they would or were likely to have purchased it, while those representing 15 percent of kWh and 12 percent of ccf savings said they were not likely.

**Table 74. Likelihood of Purchase, Online Audit**

| DAT0. If they had not been part of the kit would you have bought <technology>? | | | |
|---|---|---|---|
| Response | Responses | Percent kWh | Percent ccf |
| Yes | 142 | 47% | 33% |
| Probably yes | 54 | 19% | 29% |
| Probably not | 40 | 15% | 12% |
| No | 45 | 17% | 26% |
| Not Applicable | 0 | 0% | 0% |
| Don't Know/Refused | 4 | 2% | 0% |

### F.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 75 shows the responses to the DAT1a and DAT1b questions for Online Audit. 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 of 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 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 75. Determining Acceleration Period, Online Audit Overall**

| DAT1a. Without EO/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 | 17 | 7% | 1% | 0 |
| Earlier | N/A | 15 | 6% | 13% | 0 |
| Later | Months < 48 | 45 | 17% | 53% | Months / 48 |
| | Months >= 48 | 0 | 0% | 0% | 100% |
| | Don't Know/Refused | 18 | 9% | 0% | Average of DAT1b |
| Never | N/A | 14 | 6% | 7% | 100% |
| Not Applicable | N/A | 172 | 53% | 26% | Not Asked |
| Don't Know/Refused | N/A | 4 | 3% | 0% | 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 26 percent of total kWh and 53 percent of total gas savings (ccf). Only 32 responses representing 13 percent of kWh and 14 percent of ccf would have installed the equipment earlier or at the same time, which

received no timing attribution. Respondents representing 6 percent of kWh and 7 percent of ccf would never have purchased the equipment without the program.

#### F.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 76 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 is 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, 25 respondents representing 10 percent of kWh and 14 percent of ccf would have installed equipment of a lower efficiency.

**Table 76. Determining Efficiency Attribution, Online Audit Overall**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | |
|---|---|---|---|
| Response | Responses | Percent kWh | Percent ccf |
| Same | 69 | 31% | 41% |
| Lower | 25 | 10% | 14% |
| Higher | 0 | 0% | 0% |
| Not Applicable | 180 | 53% | 44% |
| Don't Know/Refused | 11 | 5% | 0% |

### F.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” or “more” 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.

Table 77 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 77. Determining Quantity Attribution, Online Audit Overall**

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 30 | 9% | 14% | 0% |
| Less | Value < 100% | 13 | 4% | 5% | Value < 50% |
| | Value >= 100% | 0 | 0% | 0% | Value > 50% |
| | Don't Know/Refused | 1 | 0% | 0% | Average of DAT3a |
| More | N/A | 9 | 1% | 14% | 0% |
| None | N/A | 7 | 3% | 0% | 100% |
| Not Applicable | N/A | 222 | 82% | 67% | Not Asked |
| Don't Know/Refused | N/A | 3 | 1% | 0% | Average of DAT3 |

The table shows that only 24 respondents representing 8 percent of kWh savings and 5 percent of ccf savings received quantity attribution: 14 respondents who would have installed less, 7 who would have installed none, and 3 who answered “don’t know.” KEMA reviewed the measure level data and found that 19 of those responses were for faucet aerators, and five were for LED night lights.

### F.4.2.5 Overall Attribution

KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 78 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 84 respondents representing 29 percent of kWh and 42 percent of ccf received all three kinds of attribution (or full attribution based on the overall likelihood question). Seventy-six respondents representing 25 percent of kWh savings and 13 percent of natural gas savings did not receive any attribution. The Timing attribution was the most represented, with 153 respondents representing 57 percent of kWh savings and 78 percent of ccf savings.

**Table 78. Simplistic Representation of Overall Attribution, Online Audit**

| Attribution | | | | | |
|---|---|---|---|---|---|
| Timing | Efficiency | Quantity | Responses | Percent kWh | Percent ccf |
| Yes | Yes | Yes | 84 | 29% | 42% |
| Yes | No | Yes | 11 | 4% | 9% |
| Yes | No | No | 54 | 23% | 27% |
| Yes | Yes | No | 4 | 1% | 0% |
| No | Yes | Yes | 6 | 2% | 0% |
| No | Yes | No | 43 | 14% | 7% |
| No | No | Yes | 7 | 2% | 1% |
| No | No | No | 76 | 25% | 13% |

# F.5 Comparison of 2009-10 and 2011 Program Results

KEMA compared the results of the 2009-2010 program evaluation to the results of the 2011 program evaluation.

## F.5.1 Overall Comparison

Table 79 shows the tracking savings, number of measures, and total incentives paid for the 2009-2010 and 2011 program periods. The final column shows the difference between the two, with a negative value representing a decrease from 2010 and a positive value representing an increase.

The dominant change from 2010 to 2011 is a large increase in natural gas savings, with 10 times more ccf in 2011 than in 2010. The program also experienced a relatively small decrease in kWh savings (11 percent) and a 23 percent increase in the number of measures. For the Online Audit Program, the 2011 program period was longer than the 2010 period because the program didn't officially launch until March 2010. The program tracking data only had four kits with gas savings from January to August 2010. The sharp increase in gas savings from 2010 to 2011 can be explained by the longer implementation period for gas kits.

**Table 79. Comparison of 2010 and 2011 Online Audit Program Results**

| Metric | Program Period Program Start to Dec 2010 | Program Period Jan to Dec 2011 | 2010 to 2011 Change |
|---|---|---|---|
| Tracking kWh Savings | 1,758,466 | 1,588,234 | -10% |
| Tracking ccf Savings | 5,496 | 59,721 | 987% |
| Total # Measures | 2,864 | 3,514 | 23% |
| Total Incentive | $55,643 | $114,306 | 105% |

## F.5.2 Adjustment Factors

Table 80 shows the 2009-2010 and 2011 installation rate, gross savings adjustment factor, and attribution adjustment factor for kWh and ccf. None of the differences between the two years were statistically significant at the 90 percent confidence interval. The natural gas differences look large, but the 2010 period only had one observation, limiting the possibility of statistically significant differences.

**Table 80. Comparison of 2010 and 2011 Online Audit Adjustment Factors**

| Adjustment Factor | kWh | | ccf | |
|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 |
| Installation Rate | 44% | 50% | 72% | 60% |
| Gross Savings Adjustment Factor | 47% | 50% | 73% | 60% |
| Attribution Adjustment Factor | 53% | 46% | 43% | 49% |

# G. Onsite Audit

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

- Section G.1 provides a description of the program.
- Section G.2 gives an overview of the evaluation approach.
- Section  presents the verified gross savings results and the overall adjustment factors.
- Section G.4 shows the overall attribution analysis results, including an analysis of the survey responses to the attribution questions.

## G.1 Program Description

The Residential Onsite Audit (AW) Program, which is part of the Audit and Weatherization Programs, was launched in late 2010. The program offered a free in-person audit for residential natural gas customers with buildings of four units or less. The participants may also receive direct install measures, including CFLs, faucet aerators, low flow showerheads, pipe wrap, and programmable thermostats. Savings from weatherization measures that are installed as a result of the audit are also reported in this program. The AW Program is the third-largest residential natural gas program in the MECA/MCAAA portfolio. Not all measures are offered in all utility service territories as shown in Table 81.

**Table 81. Measures Offered by Utility through Onsite Audit Program**

| Consortium | Utility | Measure | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CFL | Faucet Aerator | Low Flow Showerhead | Pipe Insulation | Programmable Thermostat | Insulation | Window Replacement | Air Sealing |
| MCAAA | Alpena Power Company | | | | | | | | |
| | Bayfield Electric Cooperative | | | | | | | | |
| | Daggett Electric Department | | | | | | | | |
| | Edison Sault Electric Company | | | | | | | | |
| | Indiana Michigan Power Company | X | X | X | X | | | | |
| | Michigan Gas Utilities Corporation | | X | X | X | X | X | X | X |
| | SEMCO Energy Gas Company | | X | X | X | 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 | | | | |
| | Xcel Energy | X | X | X | X | X | X | X | X |

Table 82 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 2011 program period.

**Table 82. Overview of AW Program Accomplishments per Program Tracking**

| Metric | Evaluation Period Jan to Aug 2011 | Program Period Jan to Dec 2011 |
|---|---|---|
| Tracking kWh Savings | 105,402 | 2,074,578 |
| Tracking ccf Savings | 29,370 | 250,468 |
| # Measures | 1,680 | 17,422 |
| Incentives | $44,299.00 | $366,267.00 |

## G.2 General Approach

The impact evaluation of the AW Program had the following objectives for the 2011 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 Q)
- Verify proper documentation with a sample of participating applications (Appendix R)
- 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 A.5 describes the steps used to complete these tasks in greater detail.

## G.3 Verified Gross Savings Results

### G.3.1 Installation Rate

KEMA calculated the installation rate for each measure group in the Onsite Audit 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 83 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 faucet aerators and showerheads, the most common reason for removal was that the water pressure was too low. For thermostats, a few respondents reported a different square footage than that recorded in the database, while others indicated removing their thermostat after encountering difficulties using it.

**Table 83. Installation Rate, Onsite 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CFL | 40 | 88% | 6% | 82% | 94% | 49% | 0 | - | - | - | - | 0% |
| Faucet Aerator | 20 | 84% | 10% | 73% | 94% | 14% | 49 | 89% | 6% | 84% | 95% | 10% |
| Insulation | 0 | - | - | - | - | 0% | 7 | 100% | <0.1% | 100% | 100% | 16% |
| Pipe Wrap | 18 | 100% | <0.1% | 100% | 100% | 16% | 46 | 97% | 3% | 95% | 100% | 11% |
| Thermostat | 0 | - | - | - | - | 0% | 48 | 87% | 7% | 80% | 94% | 46% |
| Showerhead | 16 | 88% | 12% | 76% | 99% | 20% | 40 | 97% | 4% | 93% | 100% | 14% |
| **Onsite Audit Overall** | **94** | **89%** | **4%** | **85%** | **93%** | **100%** | **190** | **91%** | **4%** | **88%** | **95%** | **100%** |

## G.3.2 Verified Gross Savings

KEMA combined the installation rate and the effects of the documentation review (Appendix R) 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. Table 84 shows the gross savings adjustment factor for Onsite Audit.

KEMA's documentation review found a number of errors for the Onsite Audit Program. Most were data entry errors, where the information on the application sheet did not match what was entered in the database.

- For CFLs, auditors would occasionally install a number of bulbs (nine, for example) and leave the remaining allowable bulbs (three; total allowable is 12) for the homeowner to put in storage. In some cases, the data was entered to reflect the number installed, which was correct, but in other cases the data reflected the total number of bulbs left at the house.
- For pipe wrap, the documentation indicated that a certain number of feet were installed (such as four) but the database showed one unit installed, with one unit equaling six feet of pipe wrap. KEMA adjusted savings to reflect the actual number of feet installed.
- For programmable thermostats, KEMA found some houses that refused new thermostats or already had them. The data for some of these homes indicated that thermostats had been installed.
- Finally, there was one wall insulation measure that had the square footage entered from the application incorrectly.

The overall effect of these adjustments reduced the kWh gross savings adjustment factor by 2 percent (from the installation rate) and the natural gas gross savings adjustment factor by 1 percent.

### Table 84. Gross Savings Adjustment Factor, Onsite Audit

| | 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 | 39 | 85% | 6% | 79% | 91% | 49% | 0 | - | - | - | - | 0% |
| Faucet Aerator | 18 | 84% | 10% | 73% | 94% | 14% | 46 | 89% | 6% | 84% | 95% | 10% |
| Insulation | 0 | - | - | - | - | 0% | 7 | 100% | 0% | 99% | 100% | 16% |
| Pipe Wrap | 18 | 97% | 0% | 96% | 97% | 16% | 46 | 95% | 3% | 92% | 98% | 11% |
| Thermostat | 0 | - | - | - | - | 0% | 43 | 86% | 7% | 79% | 93% | 46% |
| Showerhead | 14 | 88% | 12% | 76% | 99% | 20% | 39 | 96% | 4% | 92% | 101% | 14% |
| **Onsite Audit Overall** | **89** | **87%** | **4%** | **83%** | **91%** | **100%** | **181** | **90%** | **4%** | **87%** | **94%** | **100%** |

The gross savings adjustment factor was applied to the total savings reported for the Onsite Audit Program in 2011 to produce the verified gross savings for the program. Table 85 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.[13]

### Table 85. Verified Gross Savings, Onsite Audit, Overall

| | 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 | 1,064,140 | 85% | 902,707 | 8,124,362 | | | | |
| Faucet Aerator | 304,610 | 84% | 255,214 | 2,552,138 | 32,232 | 89% | 28,739 | 287,395 |
| Pipe Wrap | 217,872 | 97% | 209,928 | 2,729,069 | 26,816 | 95% | 25,496 | 280,461 |
| Showerhead | 487,956 | 88% | 426,962 | 4,269,615 | 50,949 | 96% | 49,109 | 491,089 |
| Air Sealing | | | | | 133 | 99% | 131 | 2,623 |
| Insulation | | | | | 7,530 | 100% | 7,510 | 150,208 |
| Thermostat | | | | | 130,509 | 86% | 112,058 | 1,232,642 |
| Window Replacement | | | | | 2,300 | 100% | 2,291 | 45,827 |
| **Onsite Audit Overall** | **2,074,578** | **87%** | **1,794,811** | **17,675,184** | **250,468** | **90%** | **225,336** | **2,490,245** |

Table 86 and Table 87 show the verified gross lifetime savings for the Efficiency United and Energy Optimization programs, respectively.

[13] KEMA's study did not complete any surveys addressing air sealing or window replacement. To estimate verified gross savings, KEMA applied the gross savings adjustment factor found for the most similar program and measure group that was available. For air sealing, KEMA applied the corresponding ratio from the Low Income program. For window replacement, we applied the insulation ratio from the Onsite Audit program.

**Table 86. Verified Gross Savings, Onsite Audit, EU**

| 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 | 1,039,940 | 85% | 882,178 | 7,939,603 | | | | |
| Faucet Aerator | 303,780 | 84% | 254,518 | 2,545,184 | 32,232 | 89% | 28,739 | 287,395 |
| Pipe Wrap | 217,260 | 97% | 209,339 | 2,721,403 | 26,816 | 95% | 25,496 | 280,461 |
| Showerhead | 486,920 | 88% | 426,055 | 4,260,550 | 50,949 | 96% | 49,109 | 491,089 |
| Air Sealing | | | | | 133 | 99% | 131 | 2,623 |
| Insulation | | | | | 7,530 | 100% | 7,510 | 150,208 |
| Thermostat | | | | | 130,509 | 86% | 112,058 | 1,232,642 |
| Window Replacement | | | | | 2,300 | 100% | 2,291 | 45,827 |
| **Onsite Audit EU Overall** | **2,047,900** | **87%** | **1,772,090** | **17,466,740** | **250,468** | **90%** | **225,336** | **2,490,245** |

**Table 87. Verified Gross Savings, Onsite Audit, EO**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| CFL | 24,200 | 85% | 20,529 | 184,759 |
| Faucet Aerator | 830 | 84% | 695 | 6,954 |
| Pipe Wrap | 612 | 97% | 590 | 7,666 |
| Showerhead | 1,036 | 88% | 907 | 9,065 |
| **Onsite Audit EO Overall** | **26,678** | **87%** | **22,720** | **208,444** |

## G.4 Attribution Results

The EO/EU programs were not required to report net or attributable savings for the 2011 program year. However, discussions within the State of Michigan suggest that net savings will be required in future program years. 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.

### G.4.1 Attribution Adjustment Factors

KEMA calculated the attribution adjustment factor for each measure group in Onsite Audit. 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 88 shows the results.

The Onsite Audit 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 78 percent attribution for electric measures and 63 percent for natural gas measures. The lower attribution for gas measures is driven primarily by the low attribution for thermostats.

**Table 88. Attribution Adjustment Factor, Onsite Audit**

| | 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 | 39 | 73% | 8% | 64% | 81% | 49% | 0 | - | - | - | - | 0% |
| Faucet Aerator | 16 | 87% | 12% | 75% | 99% | 14% | 46 | 68% | 11% | 57% | 79% | 10% |
| Insulation | 0 | - | - | - | - | 0% | 7 | 60% | 57% | 3% | 117% | 16% |
| Pipe Wrap | 16 | 78% | 13% | 65% | 92% | 16% | 45 | 85% | 7% | 78% | 93% | 11% |
| Thermostat | 0 | - | - | - | - | 0% | 43 | 51% | 10% | 42% | 61% | 46% |
| Showerhead | 14 | 84% | 13% | 71% | 96% | 20% | 38 | 78% | 10% | 68% | 88% | 14% |
| **Onsite Audit Overall** | **85** | **78%** | **5%** | **72%** | **83%** | **100%** | **179** | **63%** | **7%** | **55%** | **70%** | **100%** |

## G.4.2 Analysis of Survey Responses

KEMA reviewed the responses to the attribution question sequence used in the Onsite Audit 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 U has greater detail on the attribution analysis methodology and the methods used to combine the three components into a single attribution value.

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

**Table 89. Attribution Question Sequence**

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

### G.4.2.1 Overall Likelihood

For non-CFL measures directly installed as part of the Onsite Audit program, 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, KEMA skipped them through the rest of the attribution sequence and assigned them an attribution rate of 100 percent for that technology.

Table 90 shows the results for the Onsite Audit Program. One hundred twenty of the respondents, representing 24 percent of kWh and 46 percent of ccf, said they would not have purchased the technology and received full attribution credit. Respondents representing 12 percent of kWh and 40 percent of ccf savings said they would or were likely to have purchased it, while those representing 7 percent of kWh and 11 percent of ccf savings said they were not likely.

**Table 90. Likelihood of Purchase, Online Audit**

| DAT0. If the <technology> had not been installed as part of the audit, what is the likelihood? | | | |
|---|---|---|---|
| Response | Responses | Percent kWh | Percent ccf |
| Yes | 29 | 3% | 15% |
| Probably yes | 42 | 9% | 25% |
| Probably not | 30 | 7% | 11% |
| No | 120 | 24% | 46% |
| Not Applicable | 40 | 58% | 1% |
| Don't Know/Refused | 3 | 0% | 2% |

### G.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 91 shows the responses to the DAT1a and DAT1b questions for Onsite Audit. 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 91. Determining Acceleration Period, Onsite Audit Overall**

| DAT1a. Without EO/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 | 15 | 3% | 8% | 0 |
| Earlier | N/A | 3 | 0% | 1% | 0 |
| Later | Months < 48 | 37 | 5% | 26% | Months / 48 |
| | Months >= 48 | 0 | 0% | 0% | 100% |
| | Don't Know/Refused | 20 | 4% | 9% | Average of DAT1b |
| Never | N/A | 17 | 5% | 4% | 100% |
| Not Applicable | N/A | 160 | 82% | 48% | Not Asked |
| Don't Know/Refused | N/A | 12 | 1% | 4% | Average of DAT1a |

The table shows that the 15 of the respondents would have installed the equipment at the same time regardless of program involvement, representing 3 percent of kWh and 8 percent of gas savings (ccf). Seventeen respondents give the program full attribution credit, representing 5 percent of kWh savings and 4 percent of gas savings (ccf). Sixty-nine respondents representing 10 percent of kWh savings and 39 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.

### G.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. 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 92. Determining Efficiency Attribution, Onsite Audit Overall**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 29 | 5% | 11% | 0% |
| Lower | Standard Efficiency | 0 | 0% | 0% | 100% |
| | Slightly > Standard | 0 | 0% | 0% | 70% |
| | Between Standard and High | 3 | 0% | 3% | 50% |
| | Slightly < High | 0 | 0% | 0% | 30% |
| | Don't Know/Refused | 0 | 0% | 0% | Average of DAT2b |
| | N/A | 17 | 4% | 5% | 100% |
| Higher | N/A | 0 | 0% | 0% | 0% |
| Not Applicable | N/A | 204 | 86% | 79% | Not Asked |
| Don't Know/Refused | N/A | 11 | 5% | 3% | Average of DAT2a |

The table shows that the majority of respondents would have installed the same efficiency level without the program, with 29 respondents representing 5 percent of program kWh savings and 11 percent of program gas savings (ccf). Four percent of kWh savings and five 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.

### G.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” or “more” 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.

Table 93 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 93. Determining Quantity Attribution, Onsite Audit Overall**

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 21 | 5% | 6% | 0% |
| Less | Value < 100% | 1 | 0% | 0% | Value < 50% |
| | Value >= 100% | 3 | 0% | 3% | Value > 50% |
| | Don't Know/Refused | 0 | 0% | 0% | Average of DAT3a |
| More | N/A | 6 | 1% | 1% | 0% |
| None | N/A | 10 | 1% | 3% | 100% |
| Not Applicable | N/A | 218 | 92% | 86% | Not Asked |
| Don't Know/Refused | N/A | 5 | 1% | 1% | Average of DAT3 |

The table shows that 27 respondents representing 6 percent of kWh savings and 7 percent of gas savings (ccf) would have installed equipment of the same or greater size or quantity without the program. Nineteen respondents representing 2 percent of kWh savings and 7 percent of gas savings (ccf) received some quantity attribution.

### G.4.2.5 Overall Attribution

KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 94 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 170 responses representing 44 percent of kWh savings and 79 percent of gas savings (ccf) received all three types of attribution (or full attribution based on the overall likelihood question). In total, only 16 measures representing 6 percent of kWh savings and 8 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 90 percent of the savings reported by the program.

**Table 94. Simplistic Representation of Overall Attribution, Onsite Audit**

| Attribution | | | Responses | Percent kWh | Percent ccf |
|---|---|---|---|---|---|
| Timing | Efficiency | Quantity | | | |
| Yes | Yes | Yes | 170 | 44% | 79% |
| Yes | No | Yes | 3 | 0% | 1% |
| Yes | No | No | 24 | 6% | 6% |
| Yes | Yes | No | 5 | 2% | 1% |
| No | Yes | Yes | 7 | 3% | 1% |
| No | Yes | No | 26 | 35% | 1% |
| No | No | Yes | 13 | 3% | 3% |
| No | No | No | 16 | 6% | 8% |

## G.5 Comparison of 2009-10 and 2011 Program Results

This is the first year of evaluation for the Onsite Audit Program.

# H. Residential New Construction Program

This section reports on the methodology and overall results of KEMA's evaluation of the Residential New Construction (NC) Program.

- Section H.1 provides a description of the program.
- Section H.2 gives an overview of the evaluation approach.
- Section H.3 looks at survey results and determines verified gross savings.

## H.1 Program Description

The Residential New Construction Program began implementation in late 2010. The program paid incentives to residential builders who constructed homes to ENERGY STAR standards. The NC program offered incentives for natural gas savings to customers with natural gas service from SEMCO or MGU. Of these customers, those with electric service from IMP received incentives for electric savings as well. CLEAResult did not market the NC program extensively and paid only 35 incentives during 2011.

Under the NC program, participants received rebates based on the aboveground conditioned square footage of the home. SEMCO and MGU natural gas customers received $1 for every 10 square feet of conditioned aboveground building space. Those SEMCO or MGU customers with electric service from IMP received an additional $1 per 10 square feet. For example, a 2,000 $ft^2$ home with both gas and electric service would receive (2,000 $ft^2$ / 10) x $2 = $400 rebate. The program capped rebates at $350 for gas service and $350 for electric service, for a maximum total rebate of $700.

Table 95 shows the tracking savings, number of projects rebated, and incentives paid for the NC program based on the program tracking data. The New Construction Program is a very small portion of the Efficiency United portfolio.

**Table 95. Overview of NC Program Accomplishments per Program Tracking**

| Metric | Sample Frame | Program Year |
|---|---|---|
| Projects | 33 | 35 |
| kWh | 2,579 | 3,300 |
| ccf | 6,998 | 7,831 |
| Incentives | $7,275 | $8,076 |

## H.2 General Approach

The evaluation work plan set one objective for the 2011 NC program impact evaluation: determine program lifetime verified gross savings. To meet this objective, KEMA completed the following tasks:

- Verify proper tracking assignments (Appendix Q)
- Verify proper documentation with a sample of participating applications (Appendix R)
- Conduct CATI surveys with a sample of participants
- Conduct verified gross savings analysis

Section A.5 describes the steps used to complete these tasks in greater detail.

KEMA did not attempt to determine attribution for this program. The sample design and disposition for this program are found in Appendix T. The results of the documentation and tracking reviews are found in Appendices Q and R.

## H.3 Survey Results and Verified Gross Savings

KEMA verified the ENERGY STAR rating of homes rebated under the NC program in 2011 through a survey completed with 17 of the 33 homeowners in the sample frame. In addition to verifying the ENERGY STAR rating, KEMA asked the customers to verify the home's conditioned square footage, which is the metric used to determine energy savings.

All of the survey respondents verified the ENERGY STAR rating tracked by the program, resulting in an installation rate of 100 percent. The respondents also verified the conditioned square footage.

KEMA also conducted a documentation review of the 35 applications from the New Construction 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. Coupled with the square footage adjustment and the installation rate, this resulted in a gross savings adjustment factor of 100 percent.

The gross savings adjustment factor was applied to the total savings reported for the New Construction Program in 2011 to produce the verified gross savings for the program. Table 96 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.

**Table 96. Verified Gross Savings, New Construction, EU**

| Result | kWh | ccf |
|---|---|---|
| Tracking Gross Savings | 3,300 | 7,831 |
| Gross Savings Adjustment Factor | 100% | 100% |
| Verified Gross Annual Savings | 3,300 | 7,831 |
| Verified Gross Lifetime Savings | 59,402 | 140,967 |

# I. Commercial and Industrial Program

The Commercial and Industrial (C&I) Program encompasses many components under a single umbrella, including a prescriptive rebate program, a custom rebate program, an RFP (request for proposal) program, and a new construction program. The 2011 C&I program saw participation in the prescriptive and custom programs and no activity in the new construction or RFP 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
- Motion sensors
- HVAC equipment
- Motors/fans/pumps/drives
- Water heaters
- Refrigeration
- Food service equipment
- Lighting controls
- Thermostat controls
- Boiler tune-ups
- LED exit signs.

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 2011 for MCAAA and MECA cooperative utilities and for MECA UP municipals. The C&I programs are implemented by Franklin Energy (under contract to CLEAResult) in the MCAAA, MECA and MECA UP member utilities. The program is offered in all service territories except Bayfield Electric Cooperative. The C&I program is the largest program in the MECA/MCAAA portfolio.

Table 97 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 2011 program period.

**Table 97. Overview of C&I Program Accomplishments per Program Tracking**

| Metric | Evaluation Period Jan to Aug 2011 | Program Period Jan to Dec 2011 |
|---|---|---|
| Tracking kWh Savings | 8,335,579 | 29,372,976 |
| Tracking ccf Savings | 181,245 | 1,651,308 |
| # Measures | 329 | 1,149 |
| Incentives | $543,803.00 | $1,695,556.00 |

# I.1 General Approach

## I.1.1 Evaluation Objectives

The impact evaluation of the C&I Program had the following objectives for the 2011 program:

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

The evaluation addressed both prescriptive and custom measures. For the evaluation, the prescriptive measures were divided into two categories based on information from the MEMD. Those measures with a defined savings per unit[15] were considered the equivalent of deemed measures. Most lighting measures fall into this category, as well as electric motor replacements, controls for lights, vending machine controls, boiler tune-ups, and pool covers. The remaining prescriptive measures were considered non-deemed prescriptive measures for the purpose of this evaluation.

[15] This refers to measures that were defined at the time of the data collection. All measures (except those in the Custom program) have since been defined with savings per unit.

The evaluation tasks were organized according to the type of incentive offered. The sample of program customers who implemented any custom or prescriptive non-deemed measures were grouped together, and the sample of the remaining customers who only implemented deemed measures were evaluated as a separate group. Some adjustments were made as to how deemed and non-deemed measures were defined to increase the likelihood of conducting the targeted number of on-site visits. The goal was to conduct approximately 80 on-site visits. KEMA attempted an on-site visit to all customers in the non-deemed group. To increase the sample size for site visits, several of the projects in the deemed group were moved to the non-deemed group. These projects were selected by project size, in kWh savings, where the largest projects in the deemed group were moved to the non-deemed group. If a customer had multiple projects, all projects were moved to the non-deemed group. All of the customers in the evaluation frame were included in the sample. The following tasks apply to these groups:

- Prescriptive, deemed measures:
  - On-site verification with a sub-sample of completed installations
  - CATI surveys with a sample of participants.
- Prescriptive, non-deemed measures and custom measures:
  - On-site verification with a sample of completed installations
  - Expert interviews with a sample of participants
  - Engineering reviews of a sample of completed measures.
- Combined:
  - Verify proper tracking assignments (Appendix Q)
  - Verify proper documentation with a sample of participating applications (Appendix R)
  - 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.

## I.1.2 Overview of Approach

Section A.5 describes the steps used to complete the tracking and documentation verification in greater detail. The following sections provide more detail on the rest of the evaluation tasks.

### I.1.2.1 On-site Verification

KEMA performed on-site inspections of prescriptive and custom measures. All customers who implemented any prescriptive, non-deemed or custom measures were included in the sample.

Additionally, four customers with deemed measures received site visits. A total of 231 projects at 79 customer sites 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 was identified prior to entering the field 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 operates 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.

#### I.1.2.2 Survey Data Collection

Two types of surveys were conducted to collect data to inform the impact evaluation. The customers who were in the prescriptive, deemed measures group received a CATI survey and those who were in the non-deemed and custom measures received an expert interview delivered by a KEMA engineer.

**CATI survey data collection**

A CATI survey was conducted for a sample of prescriptive program participants. All of the customers with only prescriptive, deemed measures were included in this sample. 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.

**Expert interview data collection**

Expert interviews were conducted for the custom and prescriptive, non-deemed program participants. We attempted to complete a survey with all of the customers in this category; a total of 75 surveys were completed. Only three customers refused to participate, but we were not able to contact or arrange a survey for 12 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.

### I.1.2.3 Engineering Review

All custom and prescriptive participants that completed an expert interview received an on-site visit and an engineering review analysis. During the engineering review, a 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 non-deemed prescriptive participants, the engineering review determined whether the prescriptive savings were properly calculated according to the program. Savings estimates also included operating characteristics, particularly hours of operation. For example, one industrial facility operates their lights 24 hours a day, five days a week, resulting in more savings than estimated using the prescriptive approach.

### I.1.2.4 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 the other programs, KEMA used a “binary” installation rate for the C&I program. This method asks customers whether the energy efficiency project or something like it was installed. Those that answer yes receive a 100 percent installation rate. Those that answer no receive a zero percent installation rate. If 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 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.

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

#### I.1.2.5 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. 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.

## I.2 Verified Gross Savings Results

### I.2.1 Prescriptive Project Review

KEMA completed engineering evaluations for 53 customer projects in the prescriptive program. Eleven of these customers had both custom and prescriptive measures.

The application paperwork did not specify a calculation approach. For most measures, the MEMD database provided the calculation approach. Where the MEMD was unclear, such as for de-lamping measures, the calculation method was not available to the evaluation engineer. This was further complicated when measure savings were combined by project such that the savings value for a specific measure could not be determined. Further, a number of inconsistencies were found between the expected measure approach and the tracking savings.

KEMA contacted customers regarding the measures that were installed at the site. For each measure, the engineer verified that the measure was installed as described in Section □o. 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 90 percent of the electrical savings. 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 the verified gross savings compared to program savings. Lighting calculations followed the fixture wattages provided in the MEMD and the site specific operating hours, where available. In many cases, the tracking savings calculations included a coincidence factor, which was incorrectly applied. Coincidence factors apply to peak demand, and do not apply to the non-peak savings. This is a minor correction.

VFD installations were observed at four sites, including schools, reflecting a range of conditions. The program approach to VFDs was to assign standard values based only on whether the VFD was a fan or a pump. In many cases the process pump VFD value in the MEMD database was used. When data was sufficient to calculate a more accurate number, the verified numbers reflect these calculations. KEMA developed a calculator tool for VFDs for this project. The tool considered a number of factors in the calculation, including the equipment type (pump or fan) and the baseline control strategy (bypass, cycling, discharge dampers, etc), and it required the user to specify a flow profile based on measurement or discussions with the site contact. Where the flow profile could be estimated, this provided a reasonable estimate for the VFD installations. In one case, KEMA collected metered data and found that the VFD allowed the HVAC fan to run at a significantly lower speed for a large portion of the operating time. The savings were significantly higher than the deemed value. At two other sites, operating conditions reported during the site visit resulted in significantly lower savings than the deemed values.

Boiler tune-ups were the most significant gas measures. Given the small savings per measure, boiler tune-ups were included in the prescriptive, deemed portion of the sample, resulting in savings close to the tracking results. Two furnace replacements and two infrared heater measures were included in the sample. Furnace calculations used site-specific data and the calculation methodology developed for the Focus on Energy Deemed Savings Manual.[16] Two programmable thermostat measures were included in the sample and evaluated based on the operating conditions at the site.

[16] KEMA, Inc. Business Programs: Deemed Savings Manual V1.0. Prepared for Wisconsin Public Utility Commission. March, 2010.

Five refrigeration measures were included in the sample. One measure used the wrong deemed savings value, resulting in verified savings greater than the tracking savings. Anti-sweat heater control measures were adjusted for the actual heater wattage found onsite.

### I.2.2 Custom Project Review

Thirty-six customers participated in the custom portion of the C&I program in the evaluation sample. Thirty-three of the 36 customers participated in the evaluation, some with more than one project. A little over half of the projects in the initial population and final sample were lighting and approximately one third were HVAC. Table 98 shows all of the custom projects as well as their distribution.

**Table 98. Custom Project Distribution**

| Measure Description | Evaluated Projects | Total Projects |
|---|---|---|
| Custom lighting | 22 | 24 |
| Install energy recovery wheel | 1 | 1 |
| Install variable frequency drive, VFD | 3 | 4 |
| Installed oxygen trim combustion controls on boiler | 1 | 1 |
| Recover waste heat from boiler for process heating | 1 | 1 |
| Refrigerator replacement | 1 | 1 |
| Replace injection molding machine | 1 | 1 |
| Irrigation pump system improvements | 1 | 1 |
| DHW, system replacement and improvements | 1 | 1 |
| Generation system improvements | 1 | 1 |
| Replace air compressor with VFD air compressor | 1 | 1 |
| Replace air compressor desiccant dryer with refrigeration dryer | 1 | 1 |
| **Total** | **35** | **38** |

In general, the paperwork for the custom projects was clear, and sufficient information was provided to interpret how the savings were calculated. However, there were a number of projects where the quality of the scanned documentation was poor and illegible. Also, 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, KEMA used the same or similar savings calculation methodology as the tracking savings. The major difference between the tracked savings and the verified savings was that site-specific values were used instead of assumptions from secondary sources.

The lighting projects were similar to the prescribed 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
- Tracking savings calculations use a coincident factor, CF, when determining kWh savings; however, this is not appropriate as CF should be used for peak savings, not kWh savings
- KEMA used manufacturer specifications to determine fixture wattages
- A different number of fixtures was found to be installed or removed
- Unable to identify the source of tracking savings, assumed data entry error.

Tracked savings for the refrigerator replacement, generation system improvements, and irrigation system improvement projects were verified and reasonable. Therefore, no adjustments were made to these savings values.

The VFD projects have different verified gross savings than tracking savings due to different operating hours and load profiles. For many cases, the values assumed in tracking estimates differed considerably from what was found during the site visits. In several cases the equipment loading was unknown to facility staff; KEMA performed electrical spot metering to assess the load. Monitoring data revealed that the VFDs were operating at a higher frequency than assumed in tracking calculations. One project had two motors that cycled between each other. The overall operating hours were determined to be much lower than the tracking savings assumed, because only one motor operated at a time. These discrepancies in operating hours and load profiles result in a much lower savings.

### I.2.3 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 that 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 99 shows the results.

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

**Table 99. Installation Rate, C&I**

| 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 | 13 | 100% | <0.1% | 100% | 100% | 3% | 0 | - | - | - | - | 0% |
| Lighting | 139 | 100% | 0% | 99% | 100% | 57% | 0 | - | - | - | - | 0% |
| Boiler Tune-Up | 0 | - | - | - | - | 0% | 16 | 100% | 0% | 100% | 100% | 11% |
| Custom | 31 | 100% | <0.1% | 100% | 100% | 21% | 4 | 100% | <0.1% | 100% | 100% | 67% |
| Heating | 0 | - | - | - | - | 0% | 3 | 100% | <0.1% | 100% | 100% | 22% |
| Motors | 11 | 100% | <0.1% | 100% | 100% | 15% | 0 | - | - | - | - | 0% |
| Other | 3 | 100% | <0.1% | 100% | 100% | 1% | 2 | 100% | <0.1% | 100% | 100% | 1% |
| Occupancy Sensors | 17 | 96% | 5% | 91% | 100% | 3% | 0 | - | - | - | - | 0% |
| **C&I Overall** | **214** | **100%** | **0%** | **99%** | **100%** | **100%** | **25** | **100%** | **<0.1%** | **100%** | **100%** | **100%** |

## I.2.4 Engineering Adjustment Factor

KEMA pooled the adjustments from the documentation verification and tracking verification into the engineering adjustment factor. The changes resulting from the tracking review are discussed in Appendix Q. From the documentation review, KEMA made adjustments to account for the following errors, discussed in Appendix R.

- One application had the incorrect company name entered into the database.
- There were two sets of paperwork for the same application.
- Quantities of installed equipment were incorrect in 5 instances.

Table 100 shows the engineering adjustment factors. These factors take into account differences between the observed quantities of equipment installed versus tracking quantities, as well as any adjustments 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 longer than those assumed in the calculation. As discussed in Section I.2.2, the custom VFD savings were adjusted down because of lower operating hours and higher frequency load profiles. Overall, the program achieved an engineering adjustment factor of 122 percent for electricity and 92 percent for natural gas.

**Table 100. Engineering Adjustment Factor by Measure Group, 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 | 13 | 89% | 16% | 72% | 105% | 3% | 0 | - | - | - | - | 0% |
| Lighting | 135 | 142% | 28% | 114% | 169% | 57% | 0 | - | - | - | - | 0% |
| Boiler Tune-Up | 0 | - | - | - | - | 0% | 15 | 96% | 2% | 95% | 98% | 11% |
| Custom | 31 | 95% | 7% | 88% | 102% | 21% | 4 | 80% | <0.1% | 80% | 80% | 67% |
| Heating | 0 | - | - | - | - | 0% | 3 | 103% | 8% | 95% | 112% | 22% |
| Motors | 11 | 72% | 74% | -2% | 146% | 15% | 0 | - | - | - | - | 0% |
| Other | 3 | 82% | 4% | 78% | 85% | 1% | 2 | 23% | <0.1% | 23% | 23% | 1% |
| Occupancy Sensors | 16 | 80% | 24% | 57% | 104% | 3% | 0 | - | - | - | - | 0% |
| **C&I Overall** | **209** | **123%** | **23%** | **100%** | **147%** | **100%** | **24** | **88%** | **2%** | **85%** | **90%** | **100%** |

## I.2.5 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 101 shows the gross savings adjustment factor for the C&I program.

**Table 101. Gross Savings Adjustment Factor by Measure Group, C&I**

| | kWh | | | | | | ccf | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | Gross Savings | 90% Confidence Interval | | | % | min | Gross Savings | 90% Confidence Interval | | | % |
| Measure Group | n | Adjustment Factor | +/- | Lower Bound | Upper Bound | Program Savings | n | Adjustment Factor | +/- | Lower Bound | Upper Bound | Program Savings |
| CFL | 13 | 89% | 16% | 72% | 105% | 3% | 0 | - | - | - | - | 0% |
| Lighting | 139 | 141% | 28% | 114% | 169% | 57% | 0 | - | - | - | - | 0% |
| Boiler Tune-Up | 0 | - | - | - | - | 0% | 16 | 96% | 2% | 94% | 98% | 11% |
| Custom | 31 | 95% | 7% | 88% | 102% | 21% | 4 | 80% | <0.1% | 80% | 80% | 67% |
| Heating | 0 | - | - | - | - | 0% | 3 | 103% | 8% | 95% | 112% | 22% |
| Motors | 11 | 72% | 74% | -2% | 146% | 15% | 0 | - | - | - | - | 0% |
| Other | 3 | 82% | 4% | 78% | 85% | 1% | 2 | 23% | <0.1% | 23% | 23% | 1% |
| Occupancy Sensors | 17 | 77% | 23% | 54% | 101% | 3% | 0 | - | - | - | - | 0% |
| **C&I Overall** | **214** | **123%** | **23%** | **100%** | **146%** | **100%** | **25** | **87%** | **2%** | **85%** | **90%** | **100%** |

The gross savings adjustment factor was applied to the total savings reported for the Commercial and Industrial Program in 2011 to produce the verified gross savings for the program. Table 102 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. Boilers were in the final program population, but were not present in the sample used for the evaluation. For boilers, the gross savings adjustment from the “heating” measure group (103%) was used to estimate verified gross savings.

**Table 102. Verified Gross Savings, C&I, Overall**

| 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 |
| Custom | 12,860,753 | 95% | 12,239,133 | 146,869,600 | 1,043,058 | 80% | 832,765 | 9,993,180 |
| CFL | 3,231,411 | 89% | 2,860,831 | 11,443,323 | | | | |
| Lighting | 8,683,945 | 141% | 12,215,924 | 145,426,411 | | | | |
| Occupancy Sensors | 1,118,544 | 77% | 866,114 | 8,661,140 | | | | |
| Motors | 2,803,422 | 72% | 2,007,657 | 32,122,508 | 872 | 72% | 624 | 9,988 |
| Other | 674,901 | 82% | 556,141 | 6,609,534 | 237,089 | 23% | 53,616 | 563,954 |
| Boiler | | | | | 108,865 | 103% | 112,646 | 2,027,691 |
| Boiler Tune-Up | | | | | 208,696 | 96% | 200,913 | 200,913 |
| Heating | | | | | 52,727 | 103% | 54,559 | 766,133 |
| **C&I Overall** | **29,372,976** | **123%** | **30,745,800** | **351,132,516** | **1,651,308** | **87%** | **1,255,123** | **13,561,859** |

**Table 103. Verified Gross Savings, C&I, EU**

| 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 | 2,291,838 | 89% | 2,029,009 | 8,116,034 | | | | |
| Custom | 10,290,676 | 95% | 9,793,280 | 117,519,365 | 1,043,058 | 80% | 832,765 | 9,993,180 |
| Lighting | 6,028,993 | 141% | 8,481,137 | 100,321,580 | | | | |
| Occupancy Sensors | 952,105 | 77% | 737,236 | 7,372,365 | | | | |
| Other | 512,585 | 82% | 422,387 | 5,432,912 | 237,089 | 23% | 53,616 | 563,954 |
| Motors | 1,953,638 | 72% | 1,399,088 | 22,385,409 | 872 | 72% | 624 | 9,988 |
| Boiler | | | | | 108,865 | 103% | 112,646 | 2,027,691 |
| Boiler Tune-Up | | | | | 208,696 | 96% | 200,913 | 200,913 |
| Heating | | | | | 52,727 | 103% | 54,559 | 766,133 |
| **C&I EU Overall** | **22,029,835** | **123%** | **22,862,137** | **261,147,664** | **1,651,308** | **87%** | **1,255,123** | **13,561,859** |

**Table 104. Verified Gross Savings, C&I, EO**

| Measure Group | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| CFL | 939,573 | 89% | 831,822 | 3,327,289 |
| Lighting | 2,654,952 | 141% | 3,734,788 | 45,104,831 |
| Occupancy Sensors | 166,439 | 77% | 128,877 | 1,288,775 |
| Motors | 849,784 | 72% | 608,569 | 9,737,099 |
| Other | 162,317 | 82% | 133,754 | 1,176,622 |
| Custom | 2,570,077 | 95% | 2,445,853 | 29,350,235 |
| **C&I EO Overall** | **7,343,141** | **123%** | **7,883,663** | **89,984,851** |

## I.3 Attribution Results

The EO/EU programs were not required to report net or attributable savings for the 2011 program year. However, discussions within the State of Michigan suggest that net savings will

be required in future program years. 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.

## I.3.1 Attribution Adjustment Factors

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.[17] Table 105 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. Overall, the attribution adjustment factor for electricity was 62 percent and for natural gas was 12 percent. There is more discussion about attribution results in Appendix U and the following section.

**Table 105. Attribution Adjustment Factor by Measure Group, 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 | 11 | 74% | 35% | 39% | 109% | 3% | 0 | - | - | - | - | 0% |
| Lighting | 129 | 71% | 18% | 54% | 89% | 57% | 0 | - | - | - | - | 0% |
| Boiler Tune-Up | 0 | - | - | - | - | 0% | 15 | 12% | 19% | 0% | 31% | 11% |
| Custom | 30 | 30% | 10% | 20% | 39% | 21% | 3 | 11% | <0.1% | 11% | 11% | 67% |
| Heating | 0 | - | - | - | - | 0% | 2 | 44% | 51% | 0% | 95% | 22% |
| Motors | 11 | 4% | 6% | 0% | 10% | 15% | 0 | - | - | - | - | 0% |
| Other | 3 | 43% | 6% | 37% | 48% | 1% | 1 | 0% | <0.1% | 0% | 0% | 1% |
| Occupancy Sensors | 14 | 33% | 13% | 20% | 45% | 3% | 0 | - | - | - | - | 0% |
| **C&I Overall** | **198** | **62%** | **18%** | **44%** | **79%** | **100%** | **21** | **12%** | **3%** | **9%** | **16%** | **100%** |

## I.3.2 Analysis of Survey Responses

KEMA reviewed the 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 U has greater detail on the attribution analysis methodology and the methods used to combine the three components into a single attribution value.

[17] Appendix U discusses the methodology used in the attribution analysis.

**Table 106. Attribution Question Sequence**

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

### I.3.2.1 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 107 shows the responses to the DAT1a and DAT1b questions for C&I. 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 107. Determining Acceleration Period, C&I Overall**

| DAT1a. Without EO/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 | 100 | 38% | 77% | 0 |
| Earlier | N/A | 3 | 1% | 0% | 0 |
| Later | Months < 48 | 69 | 32% | 9% | Months / 48 |
| | Months >= 48 | 3 | 1% | 0% | 100% |
| | Don't Know/Refused | 14 | 5% | 13% | Average of DAT1b |
| Never | N/A | 27 | 21% | 0% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 6 | 1% | 0% | Average of DAT1a |

The table shows that the majority of the respondents would have installed the equipment at the same time, with 100 responses representing 38 percent of kWh and 77 percent of gas savings (ccf). Eighty-six respondents indicate that they would have installed the equipment later without the program, representing 38 percent of kWh savings and 22 percent of gas savings (ccf). Twenty-seven respondents representing 21 percent of kWh savings said they would never have installed the equipment without the program, which receives 100 percent attribution.

Table 108 through Table 113 show the DAT1a and DAT1b responses by measure category for measures with more than five responses. The boiler measure group appears to be the least likely to be accelerated, with 13 respondents representing 88 percent of the boiler group savings indicating that they would have installed the boiler measures at the same time. The lighting measure groups were the most likely to be accelerated. The custom measure group had 18 out of 33 projects that would have been installed later or never, representing 53 percent of the group kWh savings and 43 percent of the gas savings (ccf).

**Table 108. Determining Acceleration Period, Boiler Tune-Up**

| DAT1a. Without EO/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% | 88% | 0 |
| Earlier | N/A | 0 | 0% | 0% | 0 |
| Later | Months < 48 | 2 | 0% | 12% | Months / 48 |
| | Months >= 48 | 0 | 0% | 0% | 100% |
| | Don't Know/Refused | 0 | 0% | 0% | Average of DAT1b |
| Never | 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 DAT1a |

### Table 109. Determining Acceleration Period, CFL

| DAT1a. Without EO/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 | 6 | 71% | 0% | 0 |
| Earlier | N/A | 0 | 0% | 0% | 0 |
| Later | Months < 48 | 4 | 29% | 0% | Months / 48 |
| | Months >= 48 | 0 | 0% | 0% | 100% |
| | Don't Know/Refused | 1 | 0% | 0% | 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 | 0 | 0% | 0% | Average of DAT1a |

### Table 110. Determining Acceleration Period, Custom

| DAT1a. Without EO/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 | 46% | 57% | 0 |
| Earlier | N/A | 1 | 0% | 0% | 0 |
| Later | Months < 48 | 13 | 43% | 0% | Months / 48 |
| | Months >= 48 | 0 | 0% | 0% | 100% |
| | Don't Know/Refused | 4 | 9% | 43% | Average of DAT1b |
| Never | N/A | 1 | 1% | 0% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 1 | 1% | 0% | Average of DAT1a |

### Table 111. Determining Acceleration Period, Lighting

| DAT1a. Without EO/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 | 55 | 30% | 0% | 0 |
| Earlier | N/A | 1 | 0% | 0% | 0 |
| Later | Months < 48 | 36 | 29% | 0% | Months / 48 |
| | Months >= 48 | 3 | 2% | 0% | 100% |
| | Don't Know/Refused | 7 | 5% | 0% | Average of DAT1b |
| Never | N/A | 24 | 32% | 0% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 4 | 1% | 0% | Average of DAT1a |

**Table 112. Determining Acceleration Period, Motors**

| DAT1a. Without EO/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 | 77% | 0% | 0 |
| Earlier | N/A | 1 | 21% | 0% | 0 |
| Later | Months < 48 | 2 | 2% | 0% | Months / 48 |
| | Months >= 48 | 0 | 0% | 0% | 100% |
| | Don't Know/Refused | 0 | 0% | 0% | Average of DAT1b |
| Never | 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 DAT1a |

**Table 113. Determining Acceleration Period, Occupancy Sensors**

| DAT1a. Without EO/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 | 3 | 27% | 0% | 0 |
| Earlier | N/A | 0 | 0% | 0% | 0 |
| Later | Months < 48 | 7 | 56% | 0% | Months / 48 |
| | Months >= 48 | 0 | 0% | 0% | 100% |
| | Don't Know/Refused | 2 | 11% | 0% | Average of DAT1b |
| Never | N/A | 1 | 1% | 0% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 1 | 5% | 0% | Average of DAT1a |

### I.3.2.2 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 114 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. Boiler tune-ups went through a similar, but different attribution sequence and are also included in the Not Applicable category below.

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 114. Determining Efficiency Attribution, C&I Overall**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 134 | 46% | 65% | 0% |
| Lower | Standard Efficiency | 12 | 17% | 0% | 100% |
| | Slightly > Standard | 0 | 0% | 0% | 70% |
| | Between Standard and High | 2 | 0% | 0% | 50% |
| | Slightly < High | 4 | 3% | 0% | 30% |
| | Don't Know/Refused | 6 | 15% | 4% | Average of DAT2b |
| Higher | N/A | 3 | 1% | 0% | 0% |
| Not Applicable | N/A | 14 | 0% | 18% | Not Asked |
| Don't Know/Refused | N/A | 47 | 17% | 13% | Average of DAT2a |

The table shows that the majority of respondents stated they would have installed the same efficiency level without the program, with 134 respondents representing 46 percent of program kWh savings and 65 percent of program gas savings (ccf). Seventy-one respondents representing 52 percent of program kWh savings and 17 percent of program gas savings (ccf) will receive some form of efficiency attribution by answering “Lower” or “Don’t know/Refused” to DAT2a. Seventeen percent of kWh savings will receive 100 percent efficiency attribution.

Table 115 through Table 118 show the DAT2a and DAT2b responses by measure category for measures with more than five responses. Heating, motors. and Other had too few respondents to be included. CFL lighting had the greatest portion of its group receiving 100 percent attribution at 68 percent of electricity savings. Custom measures receive at least some

attribution for 48 percent of the electricity and 54 percent of the gas savings. Similarly, 51 percent of lighting savings will receive some attribution.

**Table 115. Determining Efficiency Attribution, CFL**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 9 | 28% | 0% | 0% |
| Lower | Standard Efficiency | 2 | 68% | 0% | 100% |
| | Slightly > Standard | 0 | 0% | 0% | 70% |
| | Between Standard and High | 0 | 0% | 0% | 50% |
| | Slightly < High | 0 | 0% | 0% | 30% |
| | Don't Know/Refused | 0 | 0% | 0% | Average of DAT2b |
| Higher | N/A | 0 | 0% | 0% | 0% |
| Not Applicable | N/A | 0 | 0% | 0% | - |
| Don't Know/Refused | N/A | 1 | 5% | 0% | Average of DAT2a |

**Table 116. Determining Efficiency Attribution, Custom**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 23 | 61% | 45% | 0% |
| Lower | Standard Efficiency | 1 | 8% | 0% | 100% |
| | Slightly > Standard | 0 | 0% | 0% | 70% |
| | Between Standard and High | 0 | 0% | 0% | 50% |
| | Slightly < High | 2 | 16% | 0% | 30% |
| | Don't Know/Refused | 1 | 0% | 11% | Average of DAT2b |
| Higher | N/A | 0 | 0% | 0% | 0% |
| Not Applicable | N/A | 0 | 0% | 0% | - |
| Don't Know/Refused | N/A | 6 | 15% | 20% | Average of DAT2a |

**Table 117. Determining Efficiency Attribution, Lighting**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 85 | 46% | 0% | 0% |
| Lower | Standard Efficiency | 9 | 15% | 0% | 100% |
| | Slightly > Standard | 0 | 0% | 0% | 70% |
| | Between Standard and High | 2 | 0% | 0% | 50% |
| | Slightly < High | 2 | 0% | 0% | 30% |
| | Don't Know/Refused | 3 | 24% | 0% | Average of DAT2b |
| Higher | N/A | 3 | 2% | 0% | 0% |
| Not Applicable | N/A | 0 | 0% | 0% | - |
| Don't Know/Refused | N/A | 26 | 13% | 0% | Average of DAT2a |

**Table 118. Determining Efficiency Attribution, Occupancy Sensors**

| DAT2a. Without EO/EU, would you have installed the same, higher, or lower efficiency? | | | | | |
|---|---|---|---|---|---|
| DAT2b. Without EO/EU, what efficiency would you have installed? | | | | | |
| DAT2a Response | DAT2b Response | Responses | Percent kWh | Percent ccf | Efficiency Attribution |
| Same | N/A | 5 | 57% | 0% | 0% |
| Lower | Standard Efficiency | 0 | 0% | 0% | 100% |
| | Slightly > Standard | 0 | 0% | 0% | 70% |
| | Between Standard and High | 0 | 0% | 0% | 50% |
| | Slightly < High | 0 | 0% | 0% | 30% |
| | Don't Know/Refused | 1 | 4% | 0% | Average of DAT2b |
| Higher | N/A | 0 | 0% | 0% | 0% |
| Not Applicable | N/A | 0 | 0% | 0% | - |
| Don't Know/Refused | N/A | 8 | 39% | 0% | Average of DAT2a |

### I.3.2.3 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 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 EO/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 119 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 119. Determining Quantity Attribution, C&I Overall**

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 125 | 54% | 91% | 0% |
| Less | Value < 100% | 28 | 5% | 6% | Value < 50% |
| | Value >= 100% | 4 | 1% | 0% | Value > 50% |
| | Don't Know/Refused | 19 | 6% | 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 | 42 | 34% | 0% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 4 | 1% | 4% | Average of DAT3 |

The table shows that 125 respondents representing 54 percent of kWh savings and 91 percent of gas savings (ccf) would have installed equipment of the same size or quantity without the program. Forty-two respondents representing 34 percent of kWh savings and zero percent of gas savings (ccf) would not have installed any equipment, resulting in 100 percent quantity attribution.

Table 120 through Table 125 show the DAT3 and DAT3a responses by measure category for measures with more than five responses. Four of the seven measure groups had at least one respondent who said they would not have installed any project without the program. Lighting responses indicated the strongest program attribution, with 50 percent of the lighting savings with 100 percent quantity attribution, and 13 percent of the lighting savings with some attribution. Motors, boiler tune-ups, and CFLs had the lowest attribution, with just 2 percent, 8 percent, and 7 percent of the savings, respectively, with some attribution. Custom projects were somewhat better, with 17 percent of electric savings and 11 percent of gas savings receiving at least some attribution. Occupancy sensors received some attribution for 40 percent of the savings. Some attribution in the "Other" category is reflected for 89 percent, but solely based on "Don't know/refused" responses.

**Table 120. Determining Quantity Attribution, Boiler Tune-Up**

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 14 | 0% | 92% | 0% |
| Less | Value < 100% | 1 | 0% | 8% | 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 121. Determining Quantity Attribution, CFL

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 7 | 93% | 0% | 0% |
| Less | Value < 100% | 3 | 2% | 0% | Value < 50% |
| | Value >= 100% | 1 | 5% | 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 | 1 | 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 122. Determining Quantity Attribution, Custom

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 22 | 83% | 89% | 0% |
| Less | Value < 100% | 0 | 0% | 0% | Value < 50% |
| | Value >= 100% | 0 | 0% | 0% | Value > 50% |
| | Don't Know/Refused | 6 | 8% | 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 | 9% | 0% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 1 | 0% | 11% | Average of DAT3 |

### Table 123. Determining Quantity Attribution, Lighting

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 62 | 37% | 0% | 0% |
| Less | Value < 100% | 20 | 6% | 0% | Value < 50% |
| | Value >= 100% | 3 | 0% | 0% | Value > 50% |
| | Don't Know/Refused | 7 | 5% | 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 | 35 | 50% | 0% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 3 | 2% | 0% | Average of DAT3 |

### Table 124. Determining Quantity Attribution, Motors

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 9 | 98% | 0% | 0% |
| Less | Value < 100% | 0 | 0% | 0% | Value < 50% |
| | Value >= 100% | 0 | 0% | 0% | Value > 50% |
| | Don't Know/Refused | 2 | 2% | 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 125. Determining Quantity Attribution, Occupancy Sensors**

| DAT3. Without EO/EU, how different would the quantity/size have been? | | | | | |
|---|---|---|---|---|---|
| DAT3a. By what percentage did you change the amount installed because of EO/EU? | | | | | |
| DAT3 Response | DAT3a Response | Responses | Percent kWh | Percent ccf | Quantity Attribution |
| Same Amount | N/A | 6 | 60% | 0% | 0% |
| Less | Value < 100% | 4 | 22% | 0% | Value < 50% |
| | Value >= 100% | 0 | 0% | 0% | Value > 50% |
| | Don't Know/Refused | 2 | 12% | 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 | 6% | 0% | 100% |
| Not Applicable | N/A | 0 | 0% | 0% | Not Asked |
| Don't Know/Refused | N/A | 0 | 0% | 0% | Average of DAT3 |

### I.3.2.4 Overall Attribution

KEMA put all three attribution components together in one table to show where overlap between quantity, efficiency, and timing attribution occurred. Table 126 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 19 responses representing 15 percent of kWh savings and zero percent of gas savings (ccf) received all three types of attribution. Seventy-seven responses representing 28 percent of kWh savings and 73 percent of gas savings (ccf) did not receive any timing, efficiency, or quantity attribution.

**Table 126. Simplistic Representation of Overall Attribution, C&I**

| Attribution | | | Responses | Percent kWh | Percent ccf |
|---|---|---|---|---|---|
| Timing | Efficiency | Quantity | | | |
| Yes | Yes | Yes | 19 | 15% | 0% |
| Yes | No | Yes | 34 | 8% | 6% |
| Yes | No | No | 27 | 11% | 0% |
| Yes | Yes | No | 9 | 5% | 17% |
| No | Yes | Yes | 18 | 17% | 4% |
| No | Yes | No | 12 | 9% | 1% |
| No | No | Yes | 26 | 7% | 0% |
| No | No | No | 77 | 28% | 73% |

## I.4 Comparison of 2009-2010 and 2011 Program Results

KEMA compared the results of the 2009-2010 program evaluation to the results of the 2011 program evaluation.

## I.5 Overall Comparison

Table 127 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 2010 and a positive value representing an increase.

Overall, the table shows a significant decrease in the incentives paid (20%) and the number of measures (23%). However, the decrease in energy savings was less than the decrease in incentives, reflecting an increase in the value of savings per incentive. Electric savings decreased by 9 percent, and gas savings decreased by 12 percent.

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

- Shorter program period (2009-2010 compared to 2011)
- Increase in custom measures, which are tracked as one measure regardless of the components of the custom project.

The increase in savings relative to the number of measures is likely similarly related to the increase in custom projects in 2011, where 36 projects were installed compared to 9 in 2009-2010. Custom projects typically have more savings per measure, because they may be a larger non-standard measure, and because of the artifact of tracking all components of a custom project as one measure.

**Table 127. Comparison of 2010 and 2011 C&I Program Results**

| Metric | Program Period Program Start to Dec 2010 | Program Period Jan to Dec 2011 | 2010 to 2011 Change |
|---|---|---|---|
| Tracking kWh Savings | 32,300,685 | 29,372,976 | -9% |
| Tracking ccf Savings | 1,875,385 | 1,651,308 | -12% |
| Total # Measures | 1,490 | 1,149 | -23% |
| Total Incentive | $2,126,181 | $1,695,556 | -20% |

## I.6 Adjustment Factors

Table 128 shows the 2009-2010 and 2011 installation rate, gross savings adjustment factor, and attribution adjustment factor. Highlighted cells show a statistically significant difference from the 2010 to 2011 program periods at the 90 percent confidence interval.

The only statistically significant adjustment was for attribution for electricity savings, which reflects the stronger attribution for lighting in 2011 compared to 2010. Attribution for gas measures is based on a fairly small number of measures, and more likely to vary from year to year.

**Table 128. Comparison of 2010 and 2011 C&I Adjustment Factors**

| Adjustment Factor | kWh | | ccf | |
|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 |
| Installation Rate | 98% | 100% | 100% | 100% |
| Gross Savings Adjustment Factor | 95% | 121% | 90% | 92% |
| Attribution Adjustment Factor | 40% | 67% | 33% | 10% |

# J. Multifamily Program

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

- Section J.1 provides a description of the program.
- Section J.2 gives an overview of the evaluation approach.
- Section J.3 looks at survey results and determines verified gross savings.

## J.1 Program Description

The Multifamily Program began implementation in late 2010. The program provided energy-saving products free of charge to multifamily building managers. In addition, the program provided incentives for installation paid either to contractors or directly to building maintenance staff. The MF program offered incentives for both gas and electric savings to customers in MCAAA utility service territories. The program based savings on the most recent MEMD database.

Under the MF program, participants received the following products:

- Compact Fluorescent Lights (CFLs)
- Bathroom Faucet Aerators
- Kitchen Faucet Aerators
- Low Flow Showerheads
- Pipe Wrap
- Programmable Thermostats

Table 129 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 program year. The Multifamily Program is a small portion of the Efficiency United portfolio.

**Table 129. Overview of MF Program Accomplishments per Program Tracking**

| Metric | Full Year |
|---|---|
| Projects | 23 |
| Measures | 87 |
| kWh | 558,424 |
| ccf | 78,443 |
| Product Incentives | $37,892 |
| Installation Incentives | $52,845 |

## J.2 General Approach

The evaluation work plan set one objective for the 2011 MF program impact evaluation: determine program lifetime verified gross savings. To meet this objective, KEMA completed the following tasks:

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

KEMA did not attempt to determine attribution for this program. Section A.5 describes the steps used to complete these tasks in greater detail.

## J.3 Survey Results and Verified Gross Savings

KEMA verified the installation of measures tracked during the 2011 program year through a survey completed with 11 building owners and managers. KEMA asked the owners and managers to verify the quantity of measures installed, and confirm that they were still installed.

Survey respondents had difficulty recalling the exact quantities of equipment installed. Some respondents stated that they installed, for example, eight CFLs in each apartment, but did not recall that several of the apartments received only four. Though some respondents reported quantities that differed from the tracking data, the response was always within a reasonable range of the tracking value given the amount of time that had passed from when the project was installed. 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.” Some respondents reported small numbers of equipment failures. Several respondents said that the contractors left behind a number of extra light bulbs or aerators, which maintenance staff used to replace failed or burned out equipment. One respondent still has 10 faucet aerators in storage. Some respondents said that tenants may have removed equipment when they vacated the apartment at the end of their lease.

Table 130 shows the program measures and quantity installed, removed, and put in storage per the survey responses. Units that were put in storage are listed for informational purposes only; the program did not pay rebates for these units and they were not included in the savings estimates, therefore they were not included in the installation rate. Units that failed and were replaced by energy efficient equipment from storage are listed in the Quantity Verified column, not the Quantity Failed column.

In developing the installation rate, 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.

**Table 130. Installation Rate, Multifamily**

| Measure | Quantity Installed | Quantity Failed | Quantity Verified | In Storage | Installation Rate |
|---|---|---|---|---|---|
| CFLs | 5,699 | 6 | 5,693 | 0 | 100% |
| Programmable Thermosats | 331 | 1 | 330 | 0 | 100% |
| Regular Aerators | 786 | 8 | 778 | 5 | 99% |
| Kitchen Aerators | 582 | 8 | 574 | 5 | 99% |
| Showerheads | 571 | 0 | 571 | 0 | 100% |
| Pipe Wrap | 335 | 0 | 335 | 0 | 100% |
| **Multifamily Overall** | **8,304** | **23** | **8,281** | **10** | **100%** |

KEMA also conducted a documentation review of 10 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 130.

The gross savings adjustment factor was applied to the total savings reported for the Multifamily Program in 2011 to produce the verified gross savings for the program. Table 131 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.

**Table 131. Verified Gross Savings, Multifamily, EU**

| | 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 | 293,040 | 100% | 292,747 | 2,634,723 | 0 | 100% | 0 | 0 |
| Faucet Aerator | 97,608 | 99% | 97,608 | 976,080 | 16,499 | 100% | 16,218 | 162,180 |
| Pipe Wrap | 29,988 | 100% | 29,988 | 389,844 | 8,252 | 100% | 8,252 | 90,776 |
| Showerhead | 137,788 | 100% | 137,788 | 1,377,880 | 22,923 | 100% | 22,923 | 229,230 |
| Thermostat | 0 | 100% | 0 | 0 | 30,769 | 100% | 30,677 | 337,448 |
| **Multifamily Overall** | **558,424** | **100%** | **558,131** | **5,378,527** | **78,443** | **100%** | **78,070** | **819,634** |

# K. Conclusions and Recommendations

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

## K.1 Conclusions

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

### K.1.1 Documentation Verification

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 Audit, 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. KEMA was able to download the sample of application forms directly from the program's document repository on December 2, 2011.

KEMA struggled to complete the documentation review effectively, as many of the measures represented by the downloaded documentation were entered in the 2010 data instead of the 2011 data, even when it appeared on the same application form as a 2011 measure. It is unclear why this is the case.

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

- ENERGY STAR: KEMA found one CFL, one smart strip, and one dishwasher that were not entered into the database.
- HVAC: KEMA found one application with a furnace and programmable thermostat on it; the thermostat was not entered in the database.
- Onsite Audit: KEMA found a number of differences between the quantities installed according to the Onsite Audit documentation and the quantities listed in the database for CFL, thermostat, pipe wrap, showerhead, and faucet aerator measures. We also found one wall insulation measure that had the wrong square footage multiplier entered in the database.
- New Construction: KEMA did not find any errors.

- C&I: KEMA found differences between the quantity listed on the application and the one in the database for five applications.
- Multifamily: KEMA did not find any errors.

### K.1.2 Tracking Verification

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 tracking database improved immensely in 2011. The current database has a sound structure and tracks all of the data required for impact evaluations in an effective manner. We made the following adjustments where necessary as a result of our review:

- Corrected the per-unit savings assignments
- Corrected the multiplier entries (such as square footage of insulation installed, or kBtu of furnace capacity)
- Adjusted calculations to include only one multiplier, rather than two
- Assigned the correct water heater fuel
- Corrected the multiplier units (such as square footage of conditioned space instead of linear feet of rim joist insulation installed)
- Made per-unit savings consistent across programs
- Reviewed the magnitude of C&I savings estimates used that were not in the MEMD to confirm that they were reasonable.

### K.1.3 Installation Rates

Installation rates for the across the HVAC, C&I and Low Income, Onsite Audit, New Construction and Multifamily programs ranged from 89 percent to 100 percent. Together these six programs represent 75 percent of the portfolio savings KEMA evaluated.

The only statistically significant program level changes in installation rate from the 2009-2010 program year to the 2011 program year were declines for the ENERGY STAR program in both kWh and ccf and a decline in Low Income program kWh. In the case of ENERGY STAR, the introduction of energy kits, which customers often purchase with one or two of the technologies in mind, is the likely driver of the decline. For the Low Income program, the decline from 99 percent to 97 percent is related to a less than 100 percent installation rate for refrigerators in addition to an increase in CFL removals.

Across programs, the installation rate for less expensive kit measures (faucet aerators, pipe wrap, and showerheads) was 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.

## K.1.4 Verified Gross Savings

Table 132 shows the verified gross energy savings for every evaluated program in the Efficiency United and Energy Optimization portfolio. Table 133 and Table 134 show the verified gross energy savings for the EU portfolio and EO portfolio respectively.

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 adjustment factors. The gross savings adjustments for C&I include the installation rate, documentation review and in depth engineering reviews KEMA conducted using project documentation and on site verification surveys.

Overall KEMA verified 94 percent of the kWh and 84 percent of the ccf claimed by the program. The C&I program drove these rates: 63 percent of tracked kWh savings and 56 percent of tracked ccf savings came from the C&I program in 2011.

**Table 132. Verified Gross Energy Savings, Portfolio**

| Program | 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 |
| ENERGY STAR | 6,572,899 | 75% | 4,526,895 | 38,987,772 | 98,516 | 67% | 61,197 | 629,074 |
| Appliance Recycling | 3,635,698 | 77% | 2,818,906 | 13,468,272 | | | | |
| HVAC | 582,480 | 95% | 560,788 | 7,996,955 | 648,661 | 100% | 651,478 | 9,290,244 |
| Low Income | 2,094,648 | 97% | 1,977,369 | 22,748,158 | 156,519 | 99% | 152,555 | 1,911,382 |
| Online Audit | 1,588,234 | 50% | 827,513 | 8,091,126 | 59,721 | 60% | 36,615 | 374,308 |
| Onsite Audit | 2,074,578 | 87% | 1,794,811 | 17,675,184 | 250,468 | 90% | 225,336 | 2,490,245 |
| New Construction | 3,300 | 100% | 3,300 | 59,402 | 7,831 | 100% | 7,831 | 140,967 |
| C&I | 29,372,976 | 123% | 30,745,800 | 351,132,516 | 1,651,308 | 87% | 1,255,123 | 13,561,859 |
| Multifamily | 558,424 | 100% | 558,131 | 5,378,527 | 78,443 | 99% | 78,070 | 819,634 |
| **Overall** | **46,483,237** | | **43,813,513** | **465,537,912** | **2,951,467** | | **2,468,205** | **29,217,713** |

**Table 133. Verified Gross Energy Savings, EU Portfolio**

| Program | 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 |
| ENERGY STAR | 3,956,593 | 75% | 2,652,942 | 23,160,885 | 98,516 | 67% | 61,197 | 629,074 |
| Appliance Recycling | 1,408,198 | 77% | 1,092,472 | 5,224,515 | | | | |
| HVAC | 259,548 | 95% | 259,548 | 3,892,592 | 648,661 | 100% | 651,478 | 9,290,244 |
| Low Income | 1,617,652 | 97% | 1,520,960 | 17,254,142 | 156,519 | 99% | 152,555 | 1,911,382 |
| Online Audit | 1,116,661 | 50% | 588,113 | 5,793,327 | 59,721 | 60% | 36,615 | 374,308 |
| Onsite Audit | 2,047,900 | 87% | 1,772,090 | 17,466,740 | 250,468 | 90% | 225,336 | 2,490,245 |
| New Construction | 3,300 | 100% | 3,300 | 59,402 | 7,831 | 100% | 7,831 | 140,967 |
| C&I | 22,029,835 | 123% | 22,862,137 | 261,147,664 | 1,651,308 | 87% | 1,255,123 | 13,561,859 |
| Multifamily | 558,424 | 100% | 558,131 | 5,378,527 | 78,443 | 100% | 78,070 | 819,634 |
| **EU Overall** | **32,998,111** | | **31,309,693** | **339,377,794** | **2,951,467** | | **2,468,205** | **29,217,713** |

**Table 134. Verified Gross Energy Savings, EO Portfolio**

| Program | kWh | | | |
|---|---|---|---|---|
| | Tracking Gross Savings | Gross Savings Adjustment Factor | Verified Gross Annual Savings | Verified Gross Lifetime Savings |
| ENERGY STAR | 2,616,306 | 75% | 1,873,953 | 15,826,886 |
| Appliance Recycling | 2,227,500 | 77% | 1,726,434 | 8,243,757 |
| HVAC | 322,932 | 95% | 301,240 | 4,104,364 |
| Low Income | 476,996 | 97% | 456,410 | 5,494,017 |
| Online Audit | 471,573 | 50% | 239,400 | 2,297,799 |
| Onsite Audit | 26,678 | 87% | 22,720 | 208,444 |
| C&I | 7,343,141 | 123% | 7,883,663 | 89,984,851 |
| **Overall** | **13,485,126** | | **12,503,820** | **126,160,118** |

## K.1.5 Attribution Adjustment Factor

Table 135 shows the attribution adjustment factor calculated in this round of evaluation for every evaluated program in the Efficiency United and Energy Optimization portfolio.

The attribution adjustment factors are relatively low based on 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, KEMA evaluated projects installed through August of 2011. New program initiatives such as a large increase in Onsite Audit participation were implemented after the evaluation period. These changes may have had a different free ridership rate than previous months.

The only statistically significant program level changes in attribution from the 2009-2010 program year to the 2011 program year were improvements for the ENERGY STAR program in both kWh and ccf and a large jump in C&I 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. In the case of ENERGY STAR, the introduction of energy kits, which customers often purchase with one or two of the technologies in mind (making the other technologies attributable to the program), is the likely driver of the increase.

**Table 135. Attribution Adjustment Factors, Portfolio**

| | kWh | | | | ccf | | | |
|---|---|---|---|---|---|---|---|---|
| | Attribution | 90% Confidence Interval | | | Attribution | 90% Confidence Interval | | |
| Program | Adjustment Factor | +/- | Lower Bound | Upper Bound | Adjustment Factor | +/- | Lower Bound | Upper Bound |
| ENERGY STAR | 32% | 3% | 29% | 35% | 25% | 12% | 13% | 37% |
| Appliance Recycling | 58% | 4% | 54% | 61% | - | - | - | - |
| HVAC | 18% | 5% | 12% | 23% | 16% | 3% | 13% | 18% |
| Low Income | N/A | | | | | | | |
| Online Audit | 53% | 7% | 46% | 60% | 43% | <0.1% | 43% | 43% |
| Onsite Audit | 78% | 5% | 72% | 83% | 63% | 7% | 55% | 70% |
| New Construction | N/A | | | | | | | |
| C&I | 40% | 3% | 37% | 43% | 33% | 18% | 16% | 51% |
| Multifamily | N/A | | | | | | | |

## K.2 Recommendations

This section summarizes 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 faucet aerators and low flow showerheads distributed in energy kits, such as installation instructions within the kit or follow-up mailings.
- **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 some measures that show poor attribution.
- **Database:**
  - **Improve nonresidential tracking:** The current database does not track needed information for nonresidential participants. 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).
- **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.
- **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. Two refrigerators were not installed. One was removed by the program and the other was refused. In both cases it is likely that program staff were aware of the issues, but the information did not make it into the database.
- **Online Audit:**
  - Take steps to increase the installation of low flow showerheads and faucet aerators.
- **Onsite Audit:**
  - 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.
- **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.
  - Set qualification rules to maximize verified savings. For example, when rebating pool covers, set qualification rules that require the end-use system affected (i.e. the pool heater) to use electricity or natural gas in order to qualify for a rebate.
  - Establish a deemed calculation for variable frequency drives instead of a single deemed savings value.
  - 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.
  - Require staff to upload clear scans of program documentation. For many 2011 projects, the program documentation was difficult to read due to the scan quality.
  - Do not use a coincident factor (CF) when calculating tracking kWh savings. CF is used to estimate peak period savings and is not appropriate for determining annual kWh savings.

# L. 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 136 and Table 137 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 KEMA on February 27, 2012. Overall, the program was able to claim 5,755,726 kWh and 557,508 ccf through the pilot programs.

**Table 136. Efficiency United Residential Pilot Savings**

| Utility | kWh | ccf |
|---|---|---|
| Alpena Power Company | 40,972 | |
| Bayfield Electric Cooperative | | |
| Daggett Electric Company | 735 | |
| Edison Sault Electric Company | 137,003 | |
| Indiana Michigan Power Company | 1,353,020 | |
| Michigan Gas Utilities Corporation | | 17,209 |
| SEMCO Energy Gas Company | | 236,093 |
| Upper Peninsula Power Company | 288,616 | |
| We Energies | 138,881 | |
| Wisconsin Public Service Corporation | 57,605 | 2,531 |
| XCEL Energy | 59,411 | 2,057 |
| **EU Residential Pilots Overall** | **2,076,244** | **257,890** |

**Table 137. Efficiency United Commercial and Industrial Pilot Savings**

| Utility | kWh | ccf |
|---|---|---|
| Alpena Power Company | 261,158 | |
| Bayfield Electric Cooperative | | |
| Daggett Electric Company | 373 | |
| Edison Sault Electric Company | 578,572 | |
| Indiana Michigan Power Company | 1,740,699 | |
| Michigan Gas Utilities Corporation | | 98,558 |
| SEMCO Energy Gas Company | | 192,010 |
| Upper Peninsula Power Company | 658,832 | |
| We Energies | 143,245 | |
| Wisconsin Public Service Corporation | 213,562 | 6,307 |
| XCEL Energy | 83,041 | 2,743 |
| **EU C&I Pilots Overall** | **3,679,482** | **299,618** |

Table 138 and Table 139 show the savings for the Energy Optimization Coop residential and commercial/industrial pilot programs respectively, by utility. These savings are based on the savings reported in the final database received by KEMA on February 27, 2012 and email communications from MECA on March 19, 2012. Overall, the program was able to claim 45,396 kWh through the pilot programs.

**Table 138. Energy Optimization Residential Pilot Savings, Coop**

| Utility | kWh |
|---|---|
| Alger Delta Electric | |
| Cloverland Elective Cooperative | |
| Great Lakes Energy | |
| Homeworks Tri-county Cooperative | |
| Midwest Energy | 33,793 |
| Ontonagon County REA | |
| Presque Isle Electric & Gas Cooperative | |
| Thumb Electric Cooperative | 5,145 |
| **Residential Pilots EO Coops Overall** | **38,938** |

**Table 139. Energy Optimization Commercial and Industrial Pilot Savings, Coop**

| Utility | kWh |
|---|---|
| Alger Delta Electric | |
| Cloverland Elective Cooperative | |
| Great Lakes Energy | |
| Homeworks Tri-county Cooperative | |
| Midwest Energy | 3,358 |
| Ontonagon County REA | |
| Presque Isle Electric & Gas Cooperative | 1,317 |
| Thumb Electric Cooperative | 1,783 |
| **C&I Pilots EO Coops Overall** | **6,458** |

# M. 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. Pilot savings must be split between the residential and commercial/industrial budgets.

Table 140 and Table 141 show the savings for the Efficiency United residential and commercial/industrial pilot programs respectively, by utility. Overall, the program was able to claim 1,233,194 kWh and 132,744 ccf through the pilot programs.

**Table 140. Efficiency United Residential Education Savings**

| Utility | kWh | ccf |
|---|---|---|
| Alpena Power Company | 20,013 | |
| Bayfield Electric Cooperative | | |
| Daggett Electric Company | | |
| Edison Sault Electric Company | 39,592 | |
| Indiana Michigan Power Company | 291,544 | |
| Michigan Gas Utilities Corporation | | 21,482 |
| SEMCO Energy Gas Company | | 38,046 |
| Upper Peninsula Power Company | 62,146 | |
| We Energies | 35,747 | |
| Wisconsin Public Service Corporation | 15,963 | 687 |
| XCEL Energy | 12,738 | 636 |
| **EU Residential Education Overall** | **477,743** | **60,850** |

**Table 141. Efficiency United Commercial and Industrial Education Savings**

| Utility | kWh | ccf |
|---|---|---|
| Alpena Power Company | 52,595 | |
| Bayfield Electric Cooperative | | |
| Daggett Electric Company | | |
| Edison Sault Electric Company | 111,264 | |
| Indiana Michigan Power Company | 381,927 | |
| Michigan Gas Utilities Corporation | | 23,949 |
| SEMCO Energy Gas Company | | 45,773 |
| Upper Peninsula Power Company | 128,873 | |
| We Energies | 15,715 | |
| Wisconsin Public Service Corporation | 46,858 | 1,514 |
| XCEL Energy | 18,220 | 658 |
| **EU C&I Education Overall** | **755,451** | **71,894** |

Table 142 and Table 143 show the savings for the Energy Optimization Coop residential and commercial/industrial pilot programs respectively, by utility. Overall, the program was able to claim 251,952 kWh through the pilot programs.

**Table 142. Energy Optimization Residential Education Savings, Coop**

| Utility | kWh |
|---|---|
| Alger Delta Electric | |
| Cloverland Elective Cooperative | 17,619 |
| Great Lakes Energy | 48,848 |
| Homeworks Tri-county Cooperative | 2,595 |
| Midwest Energy | 44,661 |
| Ontonagon County REA | 6,423 |
| Presque Isle Electric & Gas Cooperative | 3,179 |
| Thumb Electric Cooperative | 13,905 |
| **Residential Education EO Coops Overall** | **137,230** |

**Table 143. Energy Optimization Commercial and Industrial Education Savings, Coop**

| Utility | kWh |
|---|---|
| Alger Delta Electric | |
| Cloverland Elective Cooperative | 7,124 |
| Great Lakes Energy | 103,943 |
| Homeworks Tri-county Cooperative | |
| Midwest Energy | |
| Ontonagon County REA | |
| Presque Isle Electric & Gas Cooperative | 2,885 |
| Thumb Electric Cooperative | 770 |
| **C&I Education EO Coops Overall** | **114,722** |

# N. Evidence of Spillover – Audit Programs

KEMA investigated whether any spillover occurred as a result of the Online Audit (OA) or Onsite Audit (AW) programs. To address this issue, KEMA asked participants from the two audit programs and non-participant utility customers a number of questions about energy efficiency upgrades recently made to their homes. KEMA compared the responses given by the two groups (participants and non-participants) to determine whether participants installed more upgrades than non-participants. We chose to ask about energy saving actions that were recommended by the Online Audit program. Statistically significant increases in actions between the audit participants and the general population indicate evidence of spillover savings that may be attributable to the program.

## N.1.1 Findings

Table 144 through Table 151 show the responses to survey questions from respondents who participated in the OA program, respondents who participated in the AW program, and respondents who did not participate in any program (Population). The columns labeled “n” refer to the number of respondents. Those labeled “Percent” refer to the percent of respondents who provided each response, weighted to represent their survey group.[18] Highlighted cells indicate whether the difference between program participants and the population is statistically significant at the 90 percent confidence level.

The survey questions delivered to the OA and Population respondents were identical but different from the questions delivered to the AW respondents. The AW survey did not include the same number of questions and asked some questions differently than the surveys given to the other groups. Where the AW survey did not include a question, the AW columns are missing. Where the AW survey asked a question differently, this is indicated with an asterisk.

Table 144 shows the response to a general question about whether participants took actions to reduce infiltration in their building shell. The table shows that OA participants took steps to reduce shell infiltration at a higher rate than the general population, a difference that is statistically significant. The AW participants did not differ significantly from the general population in their responses.

[18] The customer weighting methodology can be found in the process evaluation report.

### Table 144. General Response, Building Shell

| EE1. In the past 12 months have you taken any actions to reduce drafts coming in through your home's door or windows? | | | | | | |
|---|---|---|---|---|---|---|
| | Population | | Online Audit | | Onsite Audit* | |
| Response | n | Percent | n | Percent | n | Percent |
| Yes | 433 | 46% | 119 | 59% | 47 | 50% |
| No | 363 | 53% | 81 | 42% | 47 | 48% |
| Don't Know | 4 | 0% | 0 | 0% | 2 | 3% |

Table 145 shows the response to a more specific question about which actions participants took to reduce energy loss through their building shell. The table shows that, while participants generally reported taking more action, none of the differences between program participants and the general population were statistically significant.

### Table 145. Specific Actions, Building Shell

| EE2. Which of the following have you done? | | | | | | |
|---|---|---|---|---|---|---|
| | Population | | Online Audit | | Onsite Audit | |
| Response | n | Percent | n | Percent | n | Percent |
| None | 5 | 2% | 4 | 3% | 1 | 2% |
| Added window shades or curtains | 125 | 26% | 25 | 21% | 0 | 0% |
| Caulked windows or doors | 168 | 37% | 50 | 40% | 11 | 24% |
| Installed weather stripping on windows or doors | 210 | 44% | 54 | 44% | 22 | 45% |
| Installed sweeps under your door | 79 | 17% | 24 | 18% | 13 | 33% |
| Installed a new threshold | 50 | 7% | 15 | 12% | 1 | 6% |
| Added weather stripping to attic access | 53 | 10% | 18 | 16% | 3 | 5% |
| Installed a crawl space vapor shield | 31 | 5% | 5 | 5% | 2 | 3% |
| Other | 145 | 34% | 0 | 0% | 20 | 48% |
| Don't know | 9 | 2% | 0 | 0% | 0 | 0% |
| Refused | 1 | 1% | 0 | 0% | 0 | 0% |

Table 146 shows the response to a general question about whether participants took actions to reduce heat loss in their ductwork, plumbing, or chimney. The table shows that OA participants took steps to reduce heat loss at a higher rate than the general population, but the difference is not statistically significant. The AW survey did not ask this question.

**Table 146. General Response, Ducts, Pipes, and Chimney**

| EE3. In the past 12 months, have you taken any actions to reduce heat loss in your air ducts, water pipes, or chimney? | | | | |
|---|---|---|---|---|
| | Population | | Online Audit | |
| Response | n | Percent | n | Percent |
| Yes | 128 | 14% | 50 | 24% |
| No | 663 | 85% | 148 | 76% |
| Don't Know | 9 | 1% | 2 | 1% |

Table 147 shows the response to a more specific question about which actions participants took to reduce energy loss in their ductwork, plumbing, and chimneys. The table shows that OA participants insulated their hot water pipes at a higher rate than the general population, a difference that is statistically significant. The AW survey did not have enough responses to determine statistical significance.

**Table 147. Specific Actions, Ducts, Pipes, and Chimney**

| EE4. Which of the following have you done? | | | | | | |
|---|---|---|---|---|---|---|
| | Population | | Online Audit | | Onsite Audit* | |
| Response | n | Percent | n | Percent | n | Percent |
| None | 3 | 2% | 2 | 6% | | |
| Insulated hot water pipes | 62 | 46% | 33 | 63% | | |
| Insulated air ducts | 28 | 21% | 8 | 16% | | |
| Sealed air ducts | 26 | 18% | 8 | 14% | | |
| Insulated attic access doors | 26 | 14% | 5 | 9% | 2 | 3% |
| Installed damper or internal seal on chimney | 20 | 20% | 8 | 15% | 2 | 5% |
| Something else | 23 | 14% | 8 | 18% | | |
| Don't know | 7 | 5% | 0 | 0% | | |

Table 148 shows the response to a general question about whether participants performed maintenance on their heating equipment. The table shows that both OA and AW participants performed maintenance at a higher rate than the general population, a difference that is statistically significant for the OA responses.

**Table 148. General Response, Heating Maintenance**

| EE5. In the past 12 months, have you done any maintenance on your furnace, boiler or heat pump? | | | | | | |
|---|---|---|---|---|---|---|
| | Population | | Online Audit | | Onsite Audit | |
| Response | n | Percent | n | Percent | n | Percent |
| Yes | 246 | 28% | 90 | 48% | 32 | 39% |
| No | 545 | 70% | 108 | 51% | 62 | 59% |
| Don't Know | 9 | 2% | 1 | 0% | 2 | 2% |

Table 149 shows the response to a more specific question about which maintenance actions participants implemented on their heating equipment. The table shows that both OA and AW participants replaced furnace or heat pump filters at a higher rate than the general population, differences that are statistically significant for both groups.

**Table 149. Specific Actions, Heating Maintenance**

| EE6. Which of the following have you done? | | | | | | |
|---|---|---|---|---|---|---|
| | Population | | Online Audit | | Onsite Audit* | |
| Response | n | Percent | n | Percent | n | Percent |
| None | 1 | 0% | 0 | 0% | 0 | 0% |
| Replaced furnace or heat pump filter | 110 | 38% | 53 | 61% | 62 | 52% |
| Had furnace or boiler tuned-up by a professional | 119 | 50% | 40 | 45% | 60 | 51% |
| Something else | 48 | 23% | 16 | 17% | 0 | 0% |
| Don't know | 5 | 0% | 0 | 0% | 0 | 0% |

Table 150 shows the response to a general question about whether participants reduced energy use in their major appliances. The table shows that OA participants took actions to reduce appliance energy use at a higher rate than the general population, a difference that is not statistically significant. The AW survey did not ask this question.

**Table 150. General Response, Appliance Use**

| EE7. In the past 12 months, have you done anything to reduce how much energy your major home appliances use? | | | | |
|---|---|---|---|---|
| | Population | | Online Audit | |
| Response | n | Percent | n | Percent |
| Yes | 185 | 20% | 78 | 38% |
| No | 597 | 78% | 122 | 62% |
| Don't Know | 16 | 2% | 0 | 0% |
| Refused | 2 | 0% | 0 | 0% |

Table 151 shows the response to a more specific question about which actions participants took to reduce energy use in their major appliances. The table shows that, while generally participants took more actions, none of the differences were statistically significant. The AW survey did not ask this question.

**Table 151. Specific Action, Appliance Use**

| EE8. Which of the following have you done? | | | | |
|---|---|---|---|---|
| | Population | | Online Audit | |
| Response | n | Percent | n | Percent |
| **Total** | **26** | **10%** | **10** | **12%** |
| None | 47 | 29% | 20 | 23% |
| Lowered water heater temperature | 74 | 45% | 24 | 32% |
| Set back thermostat temperature | 17 | 14% | 5 | 7% |
| Increase refrigerator or freezer temperature | 41 | 22% | 17 | 21% |
| Used clothesline to dry clothes | 15 | 8% | 9 | 10% |
| Installed a water heater blanket | 9 | 4% | 5 | 6% |
| Added occupancy or daylight sensors | 57 | 36% | 23 | 33% |
| Replaced or cleaned dryer vent | 30 | 15% | 25 | 32% |
| Don't know | 4 | 4% | 0 | 0% |
| Refused | 0 | 0% | 0 | 0% |

## N.1.2 Summary and Conclusions

Overall, the spillover portion of the impact evaluation surveys found the following statistically significant differences between the general population and participants of the OA and AW programs.

- **Shell Infiltration:** OA participants took more actions to reduce building shell infiltration than the general population, though none of the specific action differences were statistically significant.
- **Ducts, Pipes, Chimneys:** OA participants insulated their hot water pipes at a higher rate than the general population.
- **Heating Maintenance:** OA participants performed more maintenance on their heating equipment than the general population. Both OA and AW participants replaced their furnace or heat pump filters at a higher rate than the general population.
- **Home Appliances:** OA participants took more actions to reduce appliance energy use than the general population, though none of the specific action differences were statistically significant.

# O. Geographical Comparison – UP / LP

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. Despite oversampling the UP to ensure enough completes to make this comparison, many programs had very few completed surveys from UP participants.

Table 152 and Table 153 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.

Three programs had statistically significant differences in installation rate: Low Income for electricity and ENERGY STAR and Onsite Audit for natural gas. In two of those cases (Low Income electricity and Onsite Audit natural gas), the LP participants reported a lower installation rate than the UP participants. For ENERGY STAR, only five surveys were completed with UP natural gas participants, and four of those respondents purchased kits, which had lower installation rates than other technologies in the program. Therefore, KEMA found no evidence of a lower installation rate for UP program participants.

**Table 152. UP vs. LP Electric Installation Rate, by Program**

| Program | UP | | LP | |
|---|---|---|---|---|
| | n | Ratio | n | Ratio |
| ENERGY STAR | 537 | 78% | 417 | 73% |
| HVAC | 8 | 100% | 60 | 95% |
| C&I | 72 | 100% | 142 | 100% |
| Onsite Audit | 3 | 93% | 91 | 89% |
| Online Audit | 32 | 62% | 142 | 48% |
| Low Income | 114 | 99% | 130 | 95% |

**Table 153. UP vs. LP Natural Gas Installation Rate, by Program**

| Program | UP | | LP | |
|---|---|---|---|---|
| | n | Ratio | n | Ratio |
| ENERGY STAR | 5 | 44% | 61 | 70% |
| HVAC | 15 | 100% | 361 | 100% |
| C&I | 2 | 100% | 23 | 100% |
| Onsite Audit | 32 | 99% | 158 | 91% |
| Online Audit | 2 | 44% | 11 | 62% |
| Low Income | 35 | 100% | 151 | 99% |

# P. Measure Life

KEMA's analysis of the EO/EU programs produced verified lifetime energy savings. Since the program tracking database reports annual savings only, KEMA applied a measure life (effective useful life) to the annual savings to produce lifetime savings. 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[19] and the most recent California DEER database. 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 EO/EU programs.

## P.1.1 Residential

Table 154 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 2010 evaluation estimate to show changes from round 1 to round 2 of the evaluation. In most cases, 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, KEMA feels that the results are applicable to Michigan for most technologies.

There is one change in the evaluation measure life estimates that will have a large effect on the program savings, and that is the estimate for CFLs. In 2010, KEMA used six years for a residential CFL based on a calculated DEER range. In 2011, KEMA changed our approach and used the program estimate, based on the DEER maximum value of 15 years. Since DEER does not have an explicit value for residential CFLs, and the program estimate is less than the maximum DEER value, KEMA chose to use the program estimate. The only other change from 2010 to 2011 is the EUL for weather-stripping, which increased from five years to 11 years. Since weather-stripping is such a small measure in the portfolio, this change will have very little impact on the overall results.

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

For ENERGY STAR new homes, 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, KEMA used a measure life estimate of 18 years for the house as a whole.

**Table 154. Measure Life Estimates for Residential Programs**

| Measure | Program | KEMA Study | DEER | DEER Range | Evaluation Value | |
|---|---|---|---|---|---|---|
| | | | | | 2010 | 2011 |
| Ceiling Fan* | 10 | N/A | N/A | 10-20 | N/A | 15 |
| Air Sealing | 13 | N/A | 11 | 10 - 11 | 11 | 11 |
| Boiler | 20 | 18 | 20 | N/A | 20 | 20 |
| Central Air Conditioner | 15 | 15 | 15 | 11 - 20 | 15 | 15 |
| CFL | 9 | N/A | 15 (max) | 15 (max) | 6 | 9 |
| Clothes Dryer | 14 | N/A | N/A | N/A | N/A | 14 |
| Clothes Washer | 14 | N/A | 11 | 10 - 11 | 11 | 11 |
| Dishwasher | 11 | 10 - 12 | 11 | 11 | N/A | 11 |
| ECM | 15 | 15 | N/A | N/A | 15 | 15 |
| Faucet Aerator | 12 | N/A | 10 | 10 | 10 | 10 |
| Furnace | 15 | 15 | 20 | 15 - 25 | 15 | 15 |
| Furnace Tune-up | 5 | 5 | N/A | N/A | 5 | 5 |
| Heat Pump | 15 | 15 | 15 | 11 - 20 | 15 | 15 |
| Insulation - Ceiling | 20 | 20 | 20 | 20 - 25 | 20 | 20 |
| Insulation - Floor | 20 | 20 | 20 | 20 - 25 | 20 | 20 |
| Insulation - General | 20 | 20 | 20 | 20 - 25 | 20 | 20 |
| Insulation - Rim Joist | 20 | 20 | 20 | 20 - 25 | 20 | 20 |
| Insulation - Wall | 20 | 20 | 20 | 20 - 25 | 20 | 20 |
| LED Night Light | 12 | N/A | 16 | 16 | 16 | 16 |
| Low Flow Showerhead | 12 | N/A | 10 | 10 | 10 | 10 |
| Pipe Wrap | 6 | N/A | 13 (electric)<br>11 (gas) | 6-25 (electric)<br>6-25 (gas) | 13 (electric)<br>11 (gas) | 13 (electric)<br>11 (gas) |
| Programmable Thermostat | 9 | N/A | 11 | 10 - 11 | 11 | 11 |
| Recycling - Freezer | 8 | N/A | 5 | | 5 | 5 |
| Recycling - Refrigerator | 8 | N/A | 4 | | 4 | 4 |
| Refrigerator | 12 | 11 | 14 | 13 - 20 | 14 | 14 |
| Smart Strip | 5 | N/A | N/A | N/A | 5 | 5 |
| Water Heater | 15 | 15 | 13 (electric)<br>11 (gas)<br>20 (tankless) | 13-15 (electric)<br>11-15 (gas) | 13 (electric)<br>11 (gas)<br>20 (tankless) | 13 (electric)<br>11 (gas)<br>20 (tankless) |
| Weather-stripping | 5 | N/A | 11 | 11 | 5 | 11 |
| Windows | 20 | N/A | 20 | 20 | N/A | 20 |

## P.1.2 Commercial and Industrial

Table 155 shows the shows the program estimate, the KEMA study estimate, and the DEER estimate for each measure with data available from that source. The last column in the table shows the measure life that was used in this evaluation. The evaluation team developed the

measure life used based on the best available references. Values in the MEMD study were not referenced, leading to a preference for the other sources.

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. When a value was not available from the KEMA study, preference was given to the DEER data and, if necessary, to the program estimate. The exception is the evaluation value for LED lamps, which was determined from the Efficiency Vermont technical resource manual.

**Table 155. Measure Life Estimates for Commercial and Industrial Program**

| Measure | Program | KEMA Study | DEER | Evaluation Value |
|---|---|---|---|---|
| Anti-Sweat Controls | 15 | 9 | 12 | 9 |
| Boiler (Tune-ups) | 2 | 1 | N/A | 1 |
| Heating - Furnace | 15 | 15 | N/A | 15 |
| Heating - Infrared Heater | 15 | 15 | N/A | 15 |
| Lighting - CFL | 2 | 4 - 7 | 2 | 4 |
| Lighting - Controls | 10 | 10 | 8 | 10 |
| Lighting - De-Lamping | 12 | 10 | N/A | 10 |
| Lighting - Exit Sign LED | 15 | 10 | 16 | 10 |
| Lighting - High Bay | 12 | 12 | 15 | 12 |
| Lighting - HPT8 | 12 | 12 | 15 | 12 |
| Lighting - LED Lamps | 15 | N/A | N/A | 20 |
| Lighting - LWT8 | 12 | 12 | 15 | 12 |
| Lighting - Standard T8 | 12 | 12 | 15 | 12 |
| Motor | 15 | 16 | 15 | 16 |
| Night Cover - Cooler | 5 | N/A | 5 | 5 |
| Other (Custom) | N/A | 12 | N/A | 12 |
| Thermostat Setback | 9 | N/A | 11 | 11 |
| VFD | 15 | 16 | 15 | 16 |

# Q. Tracking Review

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.

KEMA found a marked improvement in the savings assignments from the 2010 to 2011 databases.

- The per-unit savings were entered directly into the database, which made it easier to confirm that MEMD measure that was the source of the savings.
- The 2011 database clearly identified the "multipliers" used to determine the program savings for measures such as insulation, programmable thermostats, and air sealing, including their units.
- For most measures in most programs, the measure codes were consistent throughout the year. When measures were changed, new codes were assigned.

KEMA did find the following errors:

- ENERGY STAR:
  - The savings for ceiling fans were assigned incorrectly. The database used 181 kWh/unit; it was corrected to 156 kWh/unit.
  - The savings for one of the kits was assigned incorrectly. The kit includes 12 CFLs, two power strips, two faucet aerators, six feet of pipe wrap, two showerheads, and four LED night lights for a total savings of 2,658 kWh/kit. The database was using 2,636 kWh/kit. These were corrected.
- Appliance Recycling:
  - One record used per-unit savings that were twice as high as they should have been. This was corrected.
- HVAC:
  - Savings for self-implemented programmable thermostats were changed from 125 kWh/unit to 138 kWh/unit to make them consistent with the MEMD value.
  - Six measures (two furnace, one furnace tune-up, and three thermostats) used invalid multipliers to determine savings. These were corrected.

  - The savings for ground source heat pumps did not match the values in the program-specific MEMD data. These were corrected.
- Low Income:
  - Some measures (such as rim joist insulation) use two different per-unit savings estimates. The values are close and the difference stems from a rounding error. These were not corrected. In the future, the program should use a single per-unit savings value for each measure in the database.
  - Two (substantially) different per-unit savings values were used for wall insulation measures. These were corrected.
  - Six furnace measures used invalid multiplier entries. These were corrected.
  - Thirteen air sealing measures used incorrect or invalid multipliers. These were corrected.
  - Ten rim joist insulation measures used multipliers in two different fields, which overestimated the savings impacts. These were corrected.
- Onsite Audit:
  - Seven thermostat measures used incorrect square footage multipliers. These were corrected.
  - Two faucet aerator measures used multipliers in two different fields, which overestimated the savings impacts. These were corrected.
  - The database used 0.053994 ccf/sq ft for window replacement measures. This was corrected to 0.53994 ccf/sq ft.
- New Construction:
  - The database used 0.1174 ccf/sq ft to calculate energy savings. This was corrected to 0.1231 ccf/sq ft.
- Commercial and Industrial:
  - There were a number of measures that did not have supporting savings information in the original program-specific MEMD that KEMA received. An additional file, Morgan's Modeling for 2011 with units.xls, was provided to document those measures.
  - A number of measures were used in the program that did not have corresponding MEMD savings, including pipe wrap, faucet aerators, showerheads, and bi-level lighting controls. KEMA reviewed the magnitudes of savings and compared them to the residential program to determine whether they were reasonable; however, we did not do an engineering review on those values.
  - Two savings estimates were used for measure code DL4T12HPT8. The savings were corrected to 165.4 kWh/unit.

  - Two savings values were used for measure code DL8T12HPT8. The savings were corrected to 239.2 kWh/unit.
- 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.
  - In the Low Income and Onsite Audit programs, the database used linear feet of insulation installed to determine energy savings for rim joist or band joist insulation when the multiplier should have been square feet of conditioned space. These were corrected.
  - Natural gas programmable thermostat savings were inconsistent within and across the programs. All savings were changed to 47.12 ccf/unit or 0.03624 ccf/conditioned square feet.
  - Six showerhead measures with electric water heaters in the Low Income and Multifamily programs had savings of 27 kWh/unit entered instead of 518 kWh/unit. These were corrected.

# R. Documentation Verification

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 Audit, 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. KEMA was able to download the sample of application forms directly from the program's document repository on December 2, 2011.

KEMA struggled to complete the documentation review effectively, as many of the measures represented by the downloaded documentation were entered in the 2010 data instead of the 2011 data, even when it appeared on the same application form as a 2011 measure. It is unclear why this is the case.

## R.1.1 ENERGY STAR

Table 156 shows the measures and utilities represented by the documentation downloaded for the ENERGY STAR Program. KEMA downloaded documentation representing 18 of the 23 participating utilities, with Midwest Energy represented by the greatest number of units. The measure most represented was CFLs with 299 units, followed by Smart Strips and kits with CFLs.

**Table 156. ESP Documentation Verification Measure and Utility Distribution**

| Consortium | Utility | Number of Units | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ceiling Fan | CFL | Clothes Dryer | Dishwasher | Faucet Aerator | Kit - CFL | Kit - NO CFL | LED Night Light | Pipe Wrap | Showerhead | Smart Strip | Washing Machine, elec WH | Washing Machine, gas WH | |
| MECA | Alger Delta Electric | | 4 | | 1 | | 6 | | | | | 11 | 1 | | **23** |
| | Cloverland Elective Cooperative | | 11 | 2 | | | 6 | | | | | 17 | 2 | | **38** |
| | Homeworks Tri-county Cooperative | | 57 | 1 | | | | | | | | 28 | 1 | | **87** |
| | Ontonagon County REA | | 11 | | | | 1 | | | | | | | | **12** |
| | Great Lakes Energy | | 34 | 4 | 2 | | 1 | | | | | 16 | 9 | | **66** |
| | Marquette Board of Light & Power | | 3 | | | 24 | 8 | | 1 | 24 | | 5 | | | **65** |
| | Midwest Energy | 4 | 39 | 1 | 1 | | 20 | 3 | 2 | | 1 | 34 | 2 | | **107** |
| | Thumb Electric Cooperative | | 17 | | | | 12 | | 21 | | | 11 | 1 | | **62** |
| | Presque Isle Electric & Gas Cooperative | 1 | 63 | 1 | | | 2 | | | | | 9 | 1 | | **77** |
| MECALP | Marquette Board of Light & Power | | 17 | | | 44 | 8 | | 1 | 24 | | 6 | | | **100** |
| | Escanaba Energy | | 4 | | | | 1 | 1 | | | | 1 | | | **7** |
| | Newberry Water & Light Board | | | | | | | | | | | | | | |
| | City of Stephenson | | 2 | | | | | | | | | 1 | | | **3** |
| MCAAA | Alpena Power Company | | | | | | | | | | | | | | |
| | Indiana Michigan Power Company | | 2 | | | | 8 | 1 | 3 | | | 15 | 1 | | **30** |
| | Michigan Gas Utilities Corporation | | | | | | | 20 | | | 1 | | | 4 | **25** |
| | SEMCO Energy Gas Company | | | | | 8 | | 17 | | 2 | 6 | | | 9 | **42** |
| | We Energies | | 7 | | | | 4 | | 3 | | | 6 | | | **20** |
| | Wisconsin Public Service Corporation | | | | | | | | | | | | | | |
| | Bayfield Electric Cooperative | | | | | | | | | | | | | | |
| | Daggett Electric Company | | | | | | | | | | | | | | |
| | Edison Sault Electric Company | | 15 | 1 | 2 | | 6 | 2 | | | | 14 | 2 | | **42** |
| | Upper Peninsula Power Company | | 13 | | | | 4 | 2 | 9 | | | 30 | 1 | | **59** |
| | XCEL Energy | | | | | | | | | | | | | | |
| **Total ENERGY STAR** | | **5** | **299** | **10** | **6** | **76** | **87** | **46** | **40** | **50** | **8** | **204** | **21** | **13** | **865** |

KEMA's review found one CFL, one smart strip, and one dishwasher that were not entered into 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. The adjustment factors for ENERGY STAR are found in Table 157.

**Table 157. ENERGY STAR Documentation Adjustment Factors**

| Measure | Documentation Adjustment Factor |
|---|---|
| CFL | 100% |
| Smart Strip | 101% |
| Dishwasher | 120% |

## R.1.2 HVAC

Table 158 shows the measures and utilities represented by the documentation downloaded for the HVAC Program. KEMA downloaded documentation representing 9 of the 23 participating utilities, with SEMCO represented by the greatest number of units. The measure most represented was furnaces with 221 units, followed by programmable thermostats.

**Table 158. HVAC Documentation Verification Measure and Utility Distribution**

| Consortium | Utility | Number of Units | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Boiler | Central Air Conditioner | ECM | Furnace | Heat Pump | Pipe Wrap | Thermostat | Water Heater | |
| MECA | Alger Delta Electric | | | | | | | | | |
| | Cloverland Elective Cooperative | | | | | | | | | |
| | Homeworks Tri-county Cooperative | | | | | | | | | |
| | Ontonagon County REA | | | | | | | | | |
| | Great Lakes Energy | | | 2 | | | | 2 | 1 | **5** |
| | Marquette Board of Light & Power | | | 2 | | | | | | **2** |
| | Midwest Energy | | | | | | 1 | | 1 | **2** |
| | Thumb Electric Cooperative | | | | | | | | 1 | **1** |
| | Presque Isle Electric & Gas Cooperative | | | | | | | | | |
| MECALP | Marquette Board of Light & Power | | | | | | | | | |
| | Escanaba Energy | | | | | | | | | |
| | Newberry Water & Light Board | | | | | | | | | |
| | City of Stephenson | | | | | | | | | |
| MCAAA | Alpena Power Company | | | | | | | | | |
| | Indiana Michigan Power Company | | 7 | 20 | | 3 | | | | **30** |
| | Michigan Gas Utilities Corporation | 4 | | | 90 | | | 60 | 2 | **156** |
| | SEMCO Energy Gas Company | 6 | | | 128 | | | 82 | 7 | **223** |
| | We Energies | | | 5 | | | | | | **5** |
| | Wisconsin Public Service Corporation | | | 2 | 3 | | | 1 | | **6** |
| | Bayfield Electric Cooperative | | | | | | | | | |
| | Daggett Electric Company | | | | | | | | | |
| | Edison Sault Electric Company | | | | | | | | | |
| | Upper Peninsula Power Company | | | | | | | | | |
| | XCEL Energy | | | | | | | | | |
| **Total HVAC** | | **10** | **7** | **31** | **221** | **3** | **1** | **145** | **12** | **430** |

KEMA's review found one application with a furnace and programmable thermostat measure on it. The programmable thermostat was not entered in the database. Since the measure was tied to a furnace, this finding resulted in an adjustment of 100.1 percent to the tracking savings for

furnaces, which was included in the gross savings adjustment factor in the program-specific reporting sections.

## R.1.3 Onsite Audit

Table 159 shows the measures and utilities represented by the documentation downloaded for the Onsite Audit Program. KEMA downloaded documentation representing four MCAAA utilities, with Indiana Michigan Power represented by the greatest number of units. The measure most represented was CFLs with 793 units, followed by faucet aerators and pipe wrap.

**Table 159. Onsite Audit Documentation Verification Measure and Utility Distribution**

| Consortium | Utility | Number of Units | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Band Joist Insulation | Basement Wall Insulation | Crawlspace Wall insulation | Wall Insulation | Ceiling Insulation | Floor Insulation | CFL | Faucet Aerator | Pipe Wrap | Showerhead | Thermostat | Window Replacement | |
| MCAAA | Alpena Power Company | | | | | | | | | | | | | |
| | Indiana Michigan Power Company | | | | | | | 766 | 65 | 32 | 30 | | | **893** |
| | Michigan Gas Utilities Corporation | | | | 1 | 5 | 1 | | 113 | 60 | 47 | 60 | 1 | **288** |
| | SEMCO Energy Gas Company | 2 | 1 | 2 | 3 | 8 | | | 190 | 101 | 87 | 95 | 2 | **491** |
| | We Energies | | | | | | | | | | | | | |
| | Wisconsin Public Service Corporation | | | | | | | | | | | | | |
| | Bayfield Electric Cooperative | | | | | | | | | | | | | |
| | Daggett Electric Company | | | | | | | | | | | | | |
| | Edison Sault Electric Company | | | | | | | | | | | | | |
| | Upper Peninsula Power Company | | | | | | | 27 | | | | | | **27** |
| | XCEL Energy | | | | | | | | | | | | | |
| **Total AW** | | **2** | **1** | **2** | **4** | **13** | **1** | **793** | **368** | **193** | **164** | **155** | **3** | **1699** |

KEMA's review found a number of differences between the quantities installed according to the Onsite Audit documentation and the quantities listed in the database. We also found one wall insulation measure that had the wrong square footage multiplier entered in the database. These findings resulted in an adjustment to the tracking savings that was included in the gross savings adjustment factor in the program-specific reporting sections. The adjustment factors for Onsite Audit are found in Table 160.

**Table 160. Onsite Audit Documentation Adjustment Factors**

| Measure | Documentation Adjustment Factor | |
|---|---|---|
| | kWh | ccf |
| CFL | 97% | N/A |
| Thermostat | N/A | 99% |
| Pipe Wrap | 96% | 98% |
| Showerhead | N/A | 99% |
| Faucet Aerator | N/A | 100% |
| Wall Insulation | N/A | 98% |

## R.1.4 New Construction

KEMA reviewed the documentation for all 33 New Construction participants in the sample frame. We found that the program accurately entered all of the information into the database, resulting in no documentation review adjustment.

## R.1.5 C&I

Table 161 shows the measures and utilities represented by the documentation downloaded for the C&I program. KEMA downloaded documentation representing all of the participating utilities, with Indiana Michigan Power represented by the greatest number of units. The measure most represented was high performance T8s with 96 units, followed by high bay fluorescents.

**Table 161. C&I Documentation Verification Measure and Utility Distribution**

| Consortium | Utility | Measure | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lighting | | | | | | | | | | | | | |
| | | LED | CFL | De-lamping | High-Bay | High Performance T8 | T8 retrofit/install | VFD | LED Exit Sign | Refrigeration | Controls | Motors | HVAC | Custom | Total |
| MCAAA | Alpena Power Company | | 6 | 3 | 6 | 20 | 1 | | 3 | 1 | 6 | | | 2 | **48** |
| | Daggett Electric Company | | | | 1 | | | | | | | | | | **1** |
| | Edison Sault Electric Company | | 5 | 2 | 2 | 15 | 4 | | 1 | | 4 | | | 1 | **34** |
| | Indiana Michigan Power Company | 1 | | 5 | 28 | 18 | 1 | 1 | 2 | 4 | 4 | | | 12 | **76** |
| | Michigan Gas Utilities Corporation | | | | | | | | | | | | 8 | | **8** |
| | SEMCO Energy Gas Company | | | | | | | | | | 2 | | 17 | 4 | **23** |
| | Upper Peninsula Power Company | | | | 4 | 2 | | 6 | | | 1 | | | 1 | **14** |
| | We Energies | | | 3 | 3 | 12 | 1 | 2 | 2 | | 4 | 1 | | 3 | **31** |
| | Wisconsin Public Service Corporation | | 2 | | 4 | 2 | | | | | 1 | | 1 | 2 | **12** |
| MECA Cooperative | Cloverland Elective Cooperative | | 1 | | | 3 | | | | | 1 | | | 1 | **6** |
| | Great Lakes Energy | | 1 | 1 | 7 | 5 | 1 | | | | | | | 4 | **19** |
| | Homeworks Tri-county Cooperative | | | | 2 | 2 | 1 | 2 | | | | | | | **7** |
| | Midwest Energy | | | 1 | 3 | 2 | | | 1 | | 1 | | | 2 | **10** |
| | Ontonagon County REA | | | | 1 | | | | | | 1 | | | | **2** |
| | Presque Isle Electric & Gas Cooperative | | | | | 3 | 1 | | | | | | | 3 | **7** |
| | Thumb Electric Cooperative | | | | | 2 | 1 | | | | 1 | | | | **4** |
| MECAUP | City of Stephenson | | 1 | | 2 | | | | 2 | | | | | | **5** |
| | Escanaba Energy | | 3 | 1 | 8 | 10 | 4 | | 1 | | 4 | | | 1 | **32** |
| | Marquette Board of Light & Power | | | | | | | | | | | | | 2 | **2** |
| **Total C&I** | | **1** | **19** | **16** | **71** | **96** | **15** | **11** | **12** | **5** | **30** | **1** | **26** | **38** | **341** |

KEMA's review of the documentation found eight applications with errors:

- One application had the incorrect company name entered in the database.
- There were two sets of paperwork for the same application.
- The quantity of installed equipment was incorrect on five applications.

For the C&I program, the adjustments resulting from these findings were already included in the engineering review factor reported in Section I.2.4.

### R.1.6 Multifamily

KEMA reviewed the documentation for 11 Multifamily participants. We found that the program accurately entered all of the information into the database, resulting in no documentation review adjustment.

# S. MEMD Savings Information

KEMA did not do a full deemed savings review on the assumptions and calculations used by the program. Such a study was beyond the scope of this evaluation. However, we did survey participants regarding the equipment installed or replaced and how that equipment was used in their household. The data we collected is reported in the following sections and is presented to inform the MEMD savings estimates prepared by Morgan Marketing Partners (MMP). We are aware that self-reported data (especially in the residential sector) is not always a reliable indication of how equipment is actually being used. As a result, we are not recommending that MMP change the MEMD based solely on the data below. Rather, we are providing the data we have available in the interest of adding to a potential pool of information coming out of program evaluations across the state.

## S.1 ENERGY STAR

For the ENERGY STAR Program, the measures addressed are CFLs and clothes dryers.

### S.1.1 CFLs

Seventy-seven percent of bulbs purchased through the program in 2011 were installed rather than stored. Table 162 shows the type of bulb that was replaced by the installed CFLs. The table shows that 61 percent of participants who replaced an existing bulb replaced a CFL or an LED, which would not produce any energy savings. The program assumed that 100 percent of CFLs installed replaced incandescent bulbs.

**Table 162. Type of Bulb Replaced**

| Type of bulb Replaced | Participants n=1419 |
|---|---|
| Incandescent | 38% |
| CFL | 58% |
| LED | 3% |
| Other | 1% |

### S.1.2 Clothes Dryers

KEMA collected valid survey data from 29 participants who purchased high efficiency clothes dryers, including the number of loads dried. Table 163 shows the number of loads of laundry washed per week. When combined, the average number of loads is 6.1 per week, or 320 loads per year.

**Table 163. Number of Loads per Week**

| Number of Loads | Participants (n=29) |
|---|---|
| 1 | 3% |
| 2 | 10% |
| 3 | 7% |
| 4 | 32% |
| 5 | 15% |
| 6 | 2% |
| 7 | 15% |
| 8 | 7% |
| 10 or more | 10% |

# S.2 HVAC

For the HVAC Program, the measures addressed are programmable thermostats, furnace fans, and heating systems.

## S.2.1 Thermostats

KEMA collected survey data from 110 HVAC Program participants regarding their installation of a programmable thermostat.

- All programmable thermostats replaced an existing thermostat.
- Fifty-two percent replaced an existing programmable thermostat.
- Seventy percent use a different temperature setting during the winter than they did prior to installation.
- Of those who use a different temperature setting (n=76), 72 percent set the temperature cooler at night, while 11 percent set the temperature higher at night.
- Of those who use a different temperature setting (n=76), 23 percent set the temperature cooler during the day when occupied, while 16 percent set the temperature higher during the day when occupied.
- Of those who use a different temperature setting (n=76), 58 percent set the temperature cooler during the day when unoccupied, while 3 percent set the temperature higher during the day when unoccupied.

## S.2.2 Furnace Fans

KEMA collected survey data from 33 HVAC Program participants regarding their installation of an efficient furnace fan.

**Table 164. Thermostat Setting *Before* Getting New Furnace Fan**

| Thermostat Setting (before) | Percent |
|---|---|
| Thermostat does not have switch | 8% |
| Auto | 67% |
| On | 18% |
| Both | 7% |

**Table 165. Thermostat Setting *After* Getting New Furnace Fan**

| Thermostat Setting (after) | Percent |
|---|---|
| Auto | 78% |
| On | 17% |

Eighty percent of those who purchased a furnace fan have a central air conditioner.

### S.2.3 Heating systems

Participants (n=264) were asked the age of their previous heating system. Seventy-three percent were older than fifteen years old.

**Table 166. Age of Previous Heating System**

| Years old | Percent |
|---|---|
| 5 to 10 | 2% |
| 10 to 15 | 14% |
| 15 to 20 | 23% |
| 20 to 25 | 29% |
| 25 to 30 | 6% |
| 30 to 35 | 7% |
| 35 to 40 | 2% |
| Greater than 40 | 6% |
| Don't Know | 12% |

## S.3 Onsite Audit

For the Onsite Audit Program, the measures addressed are CFLs, faucet aerators, and showerheads.

## S.3.1 CFLs

KEMA collected survey data from 286 Onsite Audit Program participants regarding the location of CFL bulbs installed as part of the audit. Table 167 shows the locations in which the CFLs were installed. KEMA is aware of recent large-scale metering studies on residential lighting that report operating hours by room type. We used the results of a California study[20] conducted by KEMA to determine the average number of operating hours per bulb based on the location information found in Table 167. KEMA found that the average hours of use for a CFL in the EO/EU programs is 2.2 hours per day. This is slightly lower than the 2.3 hours per day assumed by the program.

**Table 167. Location of Bulb Replaced**

| Installation Location | Percent |
|---|---|
| Kitchen | 15% |
| Dining Room | 11% |
| Living Room | 13% |
| Famliy Room | 2% |
| Bedroom | 19% |
| Bathroom | 14% |
| Laundry/Utility Room | 6% |
| Closet | 1% |
| Garage | 0% |
| Hallway | 3% |
| Other Room | 2% |
| Porch | 11% |
| Entryway | 3% |
| Other Outdoor Location | 0% |

## S.3.2 Faucet Aerators

KEMA collected survey data on the room within the home that faucet aerators were installed. Table 168 shows the percent of faucet aerators installed in each room.

[20] KEMA, Inc. Final Evaluation Report: Upstream Lighting Program. Prepared for California Public Utilities Commission, Energy Division. February, 2010.

**Table 168. Location of Faucet**

| Installation Location | Percent |
|---|---|
| Kitchen | 53% |
| Bathroom | 46% |
| Laundry Room | 1% |
| Total | 100% |

## S.3.3 Showerheads

KEMA collected survey data on the number of showers per week from participants who purchased showerheads. On average, each participating household took 11 showers per week.

# T. Sample Design and Disposition

## T.1 Sample Design

KEMA drew our sample from frames developed from the program database through August 31, 2011. The data was provided in the form of nine Excel files sent on September 6, 2011.

The primary objective of 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. KEMA used a model-based sampling approach to develop efficient sample designs and to assess the likely statistical precision.

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. KEMA used a model based sampling approach for some designs and simple random sampling for others.

KEMA collected data from customers based on a randomized order within the stratum. When a given measure was up for completion, 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, 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, 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, KEMA asked customers about all of the measures they installed regardless of where each fell within the call order. When 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 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.

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, 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 KEMA was unable to recruit one of those sites, that sample point would then be allocated to the furnace sample. In that way KEMA was still able utilize the entire sample and target the optimal precision for the sample design.

### T.1.1 Sample Design Strategy

KEMA used the same general sample design approach for the ENERGY STAR, HVAC, Appliance Recycling, Online Audit, Onsite Audit, and Low Income programs. For each program, 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 client, measure group, geography (upper or lower peninsula), and fuel (gas or electric savings). For Appliance Recycling, we also assigned strata for participants who recycled multiple appliances. For each program, KEMA targeted the number of completes shown in Table 169. Table 170 through Table 175 summarize the sample frame and measure group mapping for each of the programs.

KEMA did not complete a sample design for the Multifamily, New Construction, or Commercial and Industrial programs. For Commercial and Industrial and New Construction, 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. Because of the small number of participants prior to August 31, KEMA used the program database provided on January 2, 2012, to develop the sample frame for the Multifamily Program.

## Table 169. Completion Targets by Program

| Program | Completion Target | Unit of Completion |
|---|---|---|
| ENERGY STAR | 600 | Measure |
| Appliance Recycling | 400 | Measure |
| HVAC | 300 | Measure |
| Low Income | 250 | Measure |
| Online Audit | 200 | Measure |
| Onsite Audit | 200 | Measure |
| New Construction | Census | N/A |
| Commercial and Industrial | Census | N/A |
| Multifamily | 10 | Participant |

## Table 170. Sample Frame Summary, ENERGY STAR

| Measure Code | Measure Description | Measure Category | # Measures | # Customers | kWh | ccf |
|---|---|---|---|---|---|---|
| ESCD | Clothes Dryer | Clothes Dryer | 101 | 101 | 14,544 | 0 |
| ESCF | Ceiling Fan w/ light kit | Ceiling Fan | 10 | 8 | 3,077 | 0 |
| ESCFL | Compact Fluorescent Bulbs | CFL | 311 | 303 | 122,012 | 0 |
| ESCFLR | EVENT CFL - 3 PACK | CFL | 278 | 277 | 83,424 | 0 |
| ESDW | Dishwasher | Dishwasher | 28 | 28 | 3,780 | 0 |
| ESLEDNLTH | LED Night Light - THUMB EVENT ONLY | LED Night Light | 196 | 196 | 4,312 | 0 |
| ESLEDR | LED NIGHTLIGHT EVENT | LED Night Light | 120 | 119 | 4,114 | 0 |
| ESLFA | Low Flow Faucet Aerator 1.5 gpm | Faucet Aerator | 4 | 4 | 0 | 77 |
| ESLFS | High Efficiency Showerhead Event Sales | Showerhead | 1 | 1 | 518 | 0 |
| ESLFS | Low Flow Shower Head, 1.75 gpm | Showerhead | 4 | 4 | 0 | 189 |
| ESMFFA | Low Flow Faucet Aerator | Faucet Aerator | 146 | 146 | 41,832 | 0 |
| ESMFPW | Pipe Wrap | Pipe Wrap | 150 | 150 | 45,900 | 0 |
| ESMPEER | EVENT MAX PACK GAS WH ELECTRIC SIDE 12 CFLS. 2 SPS | Kit - CFL | 3 | 3 | 2,688 | 0 |
| ESMPER | EVENT MAX PACK ELEC WH 12 CFLS, 2 SPS, WATER KIT | Kit - CFL | 58 | 58 | 119,016 | 0 |
| ESPW | Pipe Wrap - 5 ft | Pipe Wrap | 3 | 3 | 0 | 65 |
| ESSPS | Smart Power Strip | Smart Strip | 80 | 80 | 20,608 | 0 |
| ESSPSO | Smart Power Strip - Online Order | Smart Strip | 213 | 213 | 76,544 | 0 |
| ESSPSR | SMART POWER STRIP EVENT | Smart Strip | 882 | 871 | 256,680 | 0 |
| ESVPEER | VALUE PACK ELEC CUST GAS WH (CFL,LED NL,SPS) | Kit - CFL | 39 | 39 | 13,182 | 0 |
| ESVPER | VALUE PACK ELEC CUST ELEC WH (CFL, LED NL, SPS, KIT) | Kit - CFL | 178 | 177 | 265,932 | 0 |
| ESVPGR | VALUE PACK GAS CUST GAS WH (KIT) | Kit - NO CFL | 41 | 41 | 0 | 2,444 |
| ESWHKE | ES Water Kit (S, FA, KFA, PW) | Kit - NO CFL | 5 | 5 | 5,780 | 0 |
| ESWHKER | ELECTRIC WATER HEATER KIT EVENT (1 SH. 2 FA, 6FT PW) | Kit - NO CFL | 27 | 27 | 31,212 | 0 |
| ESWHKGR | GAS WATER HEATER KIT (SH, 2 FA, 6FT PW) | Kit - NO CFL | 93 | 93 | 0 | 5,543 |
| ESWMT2EE | Washing Machine T2 electric, electric dryer | Washing Machine, elec WH | 25 | 25 | 8,050 | 0 |
| ESWMT2EG | Washing Machine T2 electric, gas dryer | Washing Machine, elec WH | 1 | 1 | 207 | 0 |
| ESWMT2GG | Washing Machine T2 gas, gas dryer | Washing Machine, gas WH | 14 | 14 | 0 | 192 |
| ESWMT3EE | Washing Machine T3 electric, electric dryer | Washing Machine, elec WH | 101 | 101 | 37,572 | 0 |
| ESWMT3EG | Washing Machine T3 electric, gas dryer | Washing Machine, elec WH | 16 | 16 | 3,600 | 0 |
| ESWMT3GE | Washing Machine T3 gas, electric dryer | Washing Machine, gas WH | 26 | 26 | 0 | 255 |
| ESWMT3GG | Washing Machine T3 gas, gas dryer | Washing Machine, gas WH | 61 | 61 | 0 | 958 |
| **Total ENERGY STAR Frame** | | | **3,215** | **3,191** | **1,164,584** | **9,721** |

## Table 171. Sample Frame Summary, Appliance Recycling

| Measure Code | Measure Description | Measure Category | # Measures | # Customers | kWh |
|---|---|---|---|---|---|
| ARFR | Freezer (Actual cost per unit - $150) | Freezer | 303 | 303 | 488,565 |
| ARRF | Refrigerator (Actual cost per unit - $150) | Refrigerator | 908 | 902 | 1,621,840 |
| **Total Appliance Recycling Frame** | | | **1,211** | **1,205** | **2,110,405** |

## Table 172. Sample Frame Summary, HVAC

| Measure Code | Measure Description | Measure Category | # Measures | # Customers | kWh | ccf |
|---|---|---|---|---|---|---|
| HVACASHP15 | AIR SOURCE HEAT PUMP 15 SEER | Heat Pump | 2 | 2 | 1592.5 | 0 |
| HVACASHP16 | AIR SOURCE HEAT PUMP 16 SEER | Heat Pump | 2 | 2 | 2496 | 0 |
| HVACASHP16SI | SELF IMPLEMETED AIR SOURCE HEAT PUMP 16 SEER | Heat Pump | 1 | 1 | 1248 | 0 |
| HVACASHP17 | AIR SOURCE HEAT PUMP 17 SEER | Heat Pump | 2 | 2 | 3072 | 0 |
| HVACB87 | Boiler AFUE 87% - 91% | Boiler | 2 | 2 | 0 | 508 |
| HVACB92 | Boiler AFUE 92% - 94% | Boiler | 2 | 2 | 0 | 3,432 |
| HVACB95 | Boiler AFUE 95% + | Boiler | 18 | 18 | 0 | 25,234 |
| HVACCAC14 | CENTRAL AIR CONDITIONER SEER 14 | Central Air Conditioner | 4 | 4 | 2135.38 | 0 |
| HVACCAC15 | CENTRAL AIR CONDITIONER SEER 15 | Central Air Conditioner | 14 | 14 | 5893.32 | 0 |
| HVACCAC15SI | SELF IMPLEMENTED CENTRAL AIR CONDITIONER SEER 15 | Central Air Conditioner | 1 | 1 | 703.68 | 0 |
| HVACCAC16 | CENTRAL AIR CONDITIONER SEER 16 | Central Air Conditioner | 13 | 13 | 3505.23 | 0 |
| HVACCAC16SI | SELF IMPLEMENTED CENTRAL AIR CONDITIONER SEER 16 | Central Air Conditioner | 4 | 4 | 1208.7 | 0 |
| HVACCAC17 | CENTRAL AIR CONDITIONER SEER 17 | Central Air Conditioner | 5 | 5 | 1756.666 | 0 |
| HVACECM | ECM blower- average | ECM | 116 | 115 | 84680 | 0 |
| HVACECMSI | ECM blower- SELF IMPLEMENTED | ECM | 28 | 28 | 20440 | 0 |
| HVACEWH | (ESE CLOVERLAND ONLY)Water Heater, Electric, 93% | Water Heater | 1 | 1 | 157 | 0 |
| HVACEWH | Water Heater, Electric, 93% | Water Heater | 1 | 1 | 157 | 0 |
| HVACF92 | Furnace, High Efficiency, 92% | Furnace | 9 | 9 | 0 | 1,867 |
| HVACF94 | High Eff 94 AFUE Furnace | Furnace | 2 | 2 | 0 | 302 |
| HVACF95 | Furnace, High Efficiency, 95% | Furnace | 789 | 786 | 0 | 222,244 |
| HVACGSHP17ASI | SELF IMPLEMENTED GOUND SOURCE HEAT PUMP EER 17 ASHP BASE | Heat Pump | 1 | 1 | 10752 | 0 |
| HVACGSHP19 | GROUND SOURCE HEAT PUMP EER 19, EER BASE | Heat Pump | 2 | 2 | 4712 | 0 |
| HVACPWSI | SELF IMPLEMENTED HVAC PIPEWRAP - 5 ft | Pipe Wrap | 49 | 49 | 13005 | 0 |
| HVACSTM | Thermostat, Moderate Setback | Thermostat | 457 | 457 | 0 | 29,497 |
| HVACTSTATSI | SELF IMPLEMENTED HVAC T-STAT MOD SETBACK | Thermostat | 22 | 22 | 2750 | 0 |
| HVACWH | Water Heater, High Efficiency, >62% | Water Heater | 23 | 23 | 0 | 230 |
| HVACWHKSI | Water Heater Kit Self Implemented | Water Heater | 37 | 32 | 42809 | 0 |
| HVACWHSI | SELF IMPLEMENTED WATER HEATER | Water Heater | 39 | 39 | 6123 | 0 |
| HVACWHT | Water Heater, Tankless | Water Heater | 7 | 7 | 0 | 469 |
| **Total HVAC Frame** | | | **1,653** | **1,644** | **209,196** | **283,782** |

## Table 173. Sample Frame Summary, Low Income

| Measure Code | Measure Description | Measure Category | # Measures | # Customers | kWh | ccf |
|---|---|---|---|---|---|---|
| LIAS-SQ | Air Sealing, Gas Heat | Air Sealing | 142 | 142 | 0 | 3429.352215 |
| LIBJI | Rim Joist Insulation | Insulation | 32 | 32 | 0 | 60.1342 |
| LICFL | Compact Fluorescent Bulbs | CFL | 648 | 648 | 235488 | 0 |
| LICI-SQ | Ceiling Insulation | Insulation | 148 | 148 | 0 | 6224.48787 |
| LIECM | ECM Blower Upgrade | ECM | 2 | 2 | 1460 | 0 |
| LIF92 | Furnace, High Efficiency, 92% | Furnace | 86 | 86 | 0 | 21583.7785 |
| LIF92MF | IWC Multi-Family Furnace, High Efficiency, 92% | Furnace | 1 | 1 | 0 | 1508.326039 |
| LIFTU | Furnace Tune-up, O&M | Furnace Tune-up | 81 | 81 | 0 | 5536.447906 |
| LIMHBI | Mobile Home Belly (Floor) Insulation | Insulation | 15 | 15 | 0 | 482.8659 |
| LIRF | Refrigerators | Refrigerator | 475 | 475 | 593750 | 0 |
| LISTM | Thermostat, Moderate Setback | Thermostat | 42 | 42 | 0 | 2391.437736 |
| LISTMMF | IWC Multi-Family Thermostat, Moderate Setback | Thermostat | 1 | 1 | 0 | 304.380666 |
| LIWI-SQ | Wall Insulation | Insulation | 79 | 79 | 0 | 3470.889252 |
| **Total Low Income Frame** | | | **1,752** | **1,752** | **830,698** | **44,992** |

## Table 174. Sample Frame Summary, Online Audit

| Measure Code | Measure Description | Measure Category | # Measures | # Customers | kWh | ccf |
|---|---|---|---|---|---|---|
| OAKEE200 | Online Audit Kit # 200 Electric Water Heater | Kit 200 | 405 | 405 | 433755 | 0 |
| OAKG203 | Online Audit Kit # 203 Gas Water Heater | Kit 203 | 43 | 43 | 0 | 2657.4 |
| OAKGNGWH | Gas Customer Online Audit Kit # 203 Electric Water Heater | Kit 203 | 10 | 10 | 0 | 22 |
| OAKNE200 | Online Audit Kit # 200 Electric Cust Gas Water Heater | Kit 200 | 236 | 236 | 51920 | 0 |
| OAKNE201 | Online Audit Kit # 201 Elec Cust Gas Water Heater | Kit 201 | 59 | 59 | 15576 | 0 |
| **Total Online Audit Frame** | | | **753** | **753** | **501,251** | **2,679** |

**Table 175. Sample Frame Summary, Onsite Audit**

| Measure Code | Measure Description | Measure Category | # Measures | # Customers | kWh | ccf |
|---|---|---|---|---|---|---|
| AWXBJI | BAND JOIST INSULATION | Insulation | 4 | 4 | 0 | 22.41508 |
| AWXBWI | BASEMENT WALL INSULATION | Insulation | 1 | 1 | 0 | 105.568 |
| AWXCI | CEILING INSULATION | Insulation | 32 | 32 | 0 | 2134.1934 |
| AWXCWI | CRAWLSPACE WALL INSULATION | Insulation | 3 | 3 | 0 | 57.0856 |
| AWXFI | FLOOR INSULATION | Insulation | 1 | 1 | 0 | 22.54 |
| AWXICCFL | DIRECT INSTALL CFL INDEPENDENT CONTRACTOR | CFL | 4 | 4 | 1716 | 0 |
| AWXICFA | DIRECT INSTALL FAUCET AREATOR INDEPENDENT CONTRACTOR | Faucet Aerator | 13 | 13 | 0 | 195.5 |
| AWXICPW | DIRECT INSTALL PIPE WRAP 6FT INDEPENDENT CONTRACTOR | Pipe Wrap | 12 | 12 | 0 | 187.2 |
| AWXICSH | DIRECT INSTALL SHOWER HEAD INDEPENDENT CONTRACTOR | Showerhead | 9 | 9 | 0 | 243 |
| AWXICTSTAT | DIRECT INSTALL T-STAT INDEPENDENT CONTRACTOR | Thermostat | 14 | 14 | 0 | 1202.00832 |
| AWXIGCFL | DIRECT INSTALL CFL INSPIRED GREEN | CFL | 118 | 118 | 54516 | 0 |
| AWXIGFA | DIRECT INSTALL FAUCET AREATOR INSPIRED GREEN | Faucet Aerator | 262 | 262 | 14774 | 3340.5 |
| AWXIGPW | DIRECT INSTALL PIPE WRAP 6FT INSPIRED GREEN | Pipe Wrap | 258 | 258 | 13158 | 3354 |
| AWXIGSH | DIRECT INSTALL SHOWER HEAD INSPIRED GREEN | Showerhead | 216 | 216 | 21238 | 4725 |
| AWXIGTSTAT | DIRECT INSTALL T-STAT INSPIRED GREEN | Thermostat | 192 | 192 | 0 | 13077.67512 |
| AWXWI | WALL INSULATION | Insulation | 7 | 7 | 0 | 359.79 |
| AWXWR | WINDOW REPLACEMENT | Window Replacement | 5 | 5 | 0 | 343.1642664 |
| **Total Onsite Audit Frame** | | | **1,151** | **1,151** | **105,402** | **29,370** |

## T.1.2 Sampling Methodology

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, the total incentive amount was used as a proxy to represent the energy savings. 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:

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

where

- $x_k > 0$ is known throughout the population.
- *K* denotes the sampling unit, i.e., the project.
- $\varepsilon_1, \ldots, \varepsilon_N$ are independent random variables with *an* expected value of zero, and
- $\beta, \sigma_0$, and $\gamma$ (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 $\mu_k$ and standard deviation $\sigma_k$.

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.

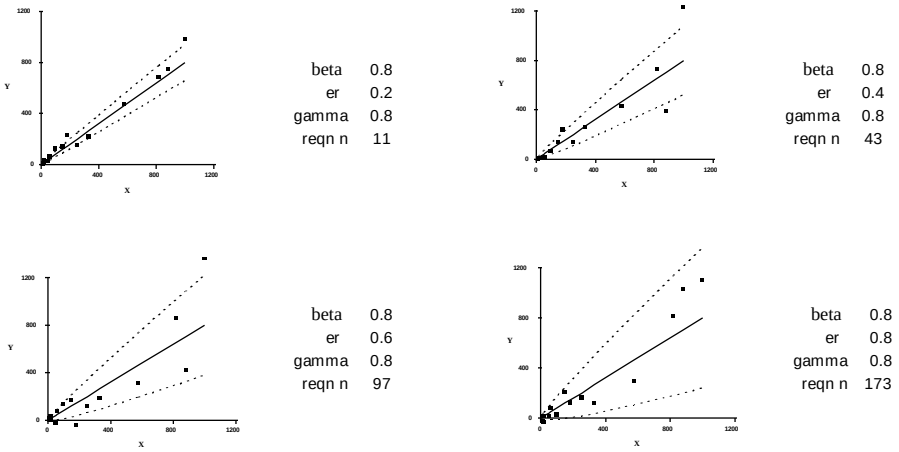
Using the model discussed above, the error ratio, *er*, is defined to be:

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

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 $\pm$ 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**




# T.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, KEMA often moved targets from one stratum to another to achieve the overall number of target completes.

## T.2.1 Participant Surveys

Table 176 through Table 184 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 KEMA attempted to contact every customer in that stratum.

KEMA completed a census of program participants for the ENERGY STAR, HVAC, Onsite Audit, New Construction, C&I, and Multifamily samples. Only New Construction and C&I were designed to be census samples. The remaining programs became a census because we did not achieve our targeted customer completes despite calling everyone in the program. For ENERGY STAR, KEMA completed surveys representing 580 out of 600 targeted measures. For

HVAC, we completed 446 out of 300 targeted measures; for Onsite Audit, 300 out of 200, and for Multifamily, 11 out of 10. HVAC and Onsite Audit ended up completing 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 able to meet our measure-level targets despite missing our customer-level targets.

KEMA did not complete a census of the Appliance Recycling, Low Income, or Online Audit programs. Low Income exceeded its target by completing surveys representing 430 measures out of a targeted 250 measures, while Online Audit completed 200 out of 200. Online Audit had very few respondents with more than one measure, which made it easier to match the customer-level sample design to the measure-level sample design.

Multifamily, New Construction, and Appliance Recycling all worked off of a participant-level rather than measure-level sample design.

## Table 176. 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 | |
| 4010101011 | CFL | 131 | 10 | 24 | 2% | 0% | 0% | 0% | Exhausted |
| 4010101012 | CFL | 70 | 10 | 10 | 2% | 0% | 0% | 0% | Exhausted |
| 4010101013 | CFL | 58 | 10 | 13 | 3% | 0% | 1% | 0% | Exhausted |
| 4010101014 | CFL | 58 | 10 | 10 | 3% | 0% | 0% | 0% | Exhausted |
| 4010101015 | CFL | 58 | 10 | 7 | 3% | 0% | 0% | 0% | Exhausted |
| 4010102011 | CFL | 71 | 8 | 17 | 1% | 0% | 0% | 0% | Exhausted |
| 4010102012 | CFL | 38 | 8 | 7 | 1% | 0% | 0% | 0% | Exhausted |
| 4010201011 | Ceiling Fan | 10 | 3 | 4 | 0% | 0% | 0% | 0% | Exhausted |
| 4010801011 | Clothes Dryer | 77 | 7 | 18 | 1% | 0% | 0% | 0% | Exhausted |
| 4010802011 | Clothes Dryer | 18 | 2 | 2 | 0% | 0% | 0% | 0% | Exhausted |
| 4011601011 | Kit - CFL | 32 | 12 | 4 | 4% | 0% | 0% | 0% | Exhausted |
| 4011601012 | Kit - CFL | 30 | 12 | 1 | 4% | 0% | 0% | 0% | Exhausted |
| 4011601013 | Kit - CFL | 30 | 12 | 4 | 4% | 0% | 1% | 0% | Exhausted |
| 4011601014 | Kit - CFL | 24 | 12 | 8 | 4% | 0% | 1% | 0% | Exhausted |
| 4011601015 | Kit - CFL | 24 | 12 | 7 | 4% | 0% | 1% | 0% | Exhausted |
| 4011602011 | Kit - CFL | 28 | 9 | 6 | 2% | 0% | 0% | 0% | Exhausted |
| 4011602012 | Kit - CFL | 18 | 8 | 6 | 2% | 0% | 1% | 0% | Exhausted |
| 4011602013 | Kit - CFL | 17 | 8 | 7 | 2% | 0% | 1% | 0% | Exhausted |
| 4011701011 | Kit - NO CFL | 10 | 7 | 1 | 1% | 0% | 0% | 0% | Exhausted |
| 4011702011 | Kit - NO CFL | 1 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 4012001011 | LED Night Light | 242 | 4 | 37 | 1% | 0% | 0% | 0% | Exhausted |
| 4012002011 | LED Night Light | 19 | 1 | 5 | 0% | 0% | 0% | 0% | Exhausted |
| 4012901011 | Smart Strip | 200 | 16 | 33 | 3% | 0% | 1% | 0% | Exhausted |
| 4012901012 | Smart Strip | 119 | 16 | 20 | 4% | 0% | 1% | 0% | Exhausted |
| 4012901013 | Smart Strip | 115 | 16 | 17 | 4% | 0% | 1% | 0% | Exhausted |
| 4012901014 | Smart Strip | 115 | 16 | 34 | 4% | 0% | 1% | 0% | Exhausted |
| 4012901015 | Smart Strip | 115 | 16 | 21 | 4% | 0% | 1% | 0% | Exhausted |
| 4012902011 | Smart Strip | 79 | 10 | 20 | 1% | 0% | 0% | 0% | Exhausted |
| 4012902012 | Smart Strip | 55 | 9 | 10 | 1% | 0% | 0% | 0% | Exhausted |
| 4012902013 | Smart Strip | 46 | 9 | 9 | 1% | 0% | 0% | 0% | Exhausted |
| 4012902014 | Smart Strip | 46 | 9 | 9 | 1% | 0% | 0% | 0% | Exhausted |
| 4013001011 | Washing Machine | 55 | 10 | 10 | 2% | 0% | 0% | 0% | Exhausted |
| 4013001012 | Washing Machine | 49 | 10 | 10 | 2% | 0% | 0% | 0% | Exhausted |
| 4013002011 | Washing Machine | 19 | 4 | 4 | 1% | 0% | 0% | 0% | Exhausted |
| 4013202011 | Faucet Aerator | 60 | 9 | 0 | 1% | 0% | 0% | 0% | Exhausted |
| 4013202012 | Faucet Aerator | 43 | 8 | 0 | 1% | 0% | 0% | 0% | Exhausted |
| 4013202013 | Faucet Aerator | 43 | 8 | 0 | 1% | 0% | 0% | 0% | Exhausted |
| 4013301011 | Showerhead | 1 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 4013402011 | Pipe Wrap | 50 | 9 | 0 | 1% | 0% | 0% | 0% | Exhausted |
| 4013402012 | Pipe Wrap | 50 | 9 | 0 | 1% | 0% | 0% | 0% | Exhausted |
| 4013402013 | Pipe Wrap | 50 | 9 | 0 | 1% | 0% | 0% | 0% | Exhausted |
| 4013601011 | Dishwasher | 24 | 3 | 8 | 0% | 0% | 0% | 0% | Exhausted |
| 4013602011 | Dishwasher | 1 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 4020101011 | CFL | 25 | 5 | 5 | 1% | 0% | 0% | 0% | Exhausted |
| 4020102011 | CFL | 53 | 8 | 10 | 1% | 0% | 0% | 0% | Exhausted |
| 4020102012 | CFL | 27 | 8 | 4 | 1% | 0% | 0% | 0% | Exhausted |
| 4020802011 | Clothes Dryer | 6 | 2 | 2 | 0% | 0% | 0% | 0% | Exhausted |
| 4021601011 | Kit - CFL | 22 | 7 | 5 | 1% | 0% | 0% | 0% | Exhausted |
| 4021601012 | Kit - CFL | 9 | 6 | 1 | 1% | 0% | 0% | 0% | Exhausted |
| 4021602011 | Kit - CFL | 16 | 8 | 3 | 2% | 0% | 0% | 0% | Exhausted |
| 4021602012 | Kit - CFL | 14 | 8 | 2 | 2% | 0% | 0% | 0% | Exhausted |
| 4021602013 | Kit - CFL | 14 | 8 | 5 | 2% | 0% | 1% | 0% | Exhausted |
| 4021701011 | Kit - NO CFL | 1 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 4021701021 | Kit - NO CFL | 22 | 9 | 5 | 0% | 13% | 0% | 3% | Exhausted |
| 4021701022 | Kit - NO CFL | 22 | 9 | 3 | 0% | 13% | 0% | 2% | Exhausted |
| 4021701023 | Kit - NO CFL | 23 | 8 | 8 | 0% | 14% | 0% | 5% | Exhausted |
| 4021701024 | Kit - NO CFL | 22 | 8 | 6 | 0% | 13% | 0% | 4% | Exhausted |
| 4021701025 | Kit - NO CFL | 23 | 8 | 6 | 0% | 14% | 0% | 4% | Exhausted |
| 4021702011 | Kit - NO CFL | 15 | 8 | 3 | 1% | 0% | 0% | 0% | Exhausted |
| 4021702021 | Kit - NO CFL | 11 | 10 | 1 | 0% | 7% | 0% | 1% | Exhausted |
| 4021702022 | Kit - NO CFL | 11 | 10 | 0 | 0% | 7% | 0% | 0% | Exhausted |
| 4022001011 | LED Night Light | 21 | 1 | 2 | 0% | 0% | 0% | 0% | Exhausted |
| 4022002011 | LED Night Light | 34 | 2 | 7 | 0% | 0% | 0% | 0% | Exhausted |
| 4022901011 | Smart Strip | 50 | 7 | 9 | 1% | 0% | 0% | 0% | Exhausted |
| 4022901012 | Smart Strip | 31 | 6 | 9 | 1% | 0% | 0% | 0% | Exhausted |
| 4022902011 | Smart Strip | 73 | 9 | 11 | 1% | 0% | 0% | 0% | Exhausted |
| 4022902012 | Smart Strip | 43 | 9 | 11 | 1% | 0% | 0% | 0% | Exhausted |
| 4022902013 | Smart Strip | 44 | 9 | 11 | 1% | 0% | 0% | 0% | Exhausted |
| 4022902014 | Smart Strip | 44 | 9 | 13 | 1% | 0% | 0% | 0% | Exhausted |
| 4023001011 | Washing Machine | 9 | 3 | 4 | 0% | 0% | 0% | 0% | Exhausted |
| 4023001021 | Washing Machine | 52 | 10 | 9 | 0% | 7% | 0% | 1% | Exhausted |
| 4023001022 | Washing Machine | 45 | 10 | 14 | 0% | 7% | 0% | 2% | Exhausted |
| 4023002011 | Washing Machine | 11 | 4 | 4 | 0% | 0% | 0% | 0% | Exhausted |
| 4023002021 | Washing Machine | 2 | 2 | 1 | 0% | 0% | 0% | 0% | Exhausted |
| 4023002022 | Washing Machine | 2 | 2 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 4023201021 | Faucet Aerator | 2 | 2 | 1 | 0% | 0% | 0% | 0% | Exhausted |
| 4023201022 | Faucet Aerator | 2 | 2 | 0 | 0% | 1% | 0% | 0% | Exhausted |
| 4023301021 | Showerhead | 1 | 1 | 1 | 0% | 0% | 0% | 0% | Exhausted |
| 4023301022 | Showerhead | 3 | 3 | 0 | 0% | 2% | 0% | 0% | Exhausted |
| 4023401021 | Pipe Wrap | 1 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 4023401022 | Pipe Wrap | 2 | 2 | 1 | 0% | 1% | 0% | 0% | Exhausted |
| 4023602011 | Dishwasher | 3 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| **Total ENERGY STAR** | | **3,210** | **600** | **580** | **100%** | **100%** | **19%** | **22%** | |

## Table 177. Appliance Recycling Sample Disposition

| Measure | Participants in Frame | Target Completes | Sample Completes | Fraction of Frame Total Reported Savings | | Status |
|---|---|---|---|---|---|---|
| | | | | Frame | Sample | |
| Refrigerator Only | 846 | 282 | 286 | 72% | 23% | Available |
| Freezer Only | 248 | 96 | 90 | 19% | 7% | Exhausted |
| Refrigerator and Freezer | 53 | 22 | 24 | 8% | 4% | Exhausted |
| **Total Appliance Recycling** | **1,147** | **400** | **400** | **100%** | **33%** | |

## Table 178. 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 | |
| 5010601011 | CAC | 5 | 1 | 0 | 1% | 0% | 0% | 0% | Exhausted |
| 5010901011 | ECM | 28 | 2 | 6 | 10% | 0% | 2% | 0% | Exhausted |
| 5010902011 | ECM | 6 | 1 | 3 | 2% | 0% | 1% | 0% | Exhausted |
| 5011301011 | Heat Pump | 2 | 1 | 1 | 6% | 0% | 1% | 0% | Exhausted |
| 5011701011 | Water Heater Kit | 37 | 5 | 3 | 20% | 0% | 2% | 0% | Exhausted |
| 5012301011 | Pipe Wrap | 49 | 2 | 8 | 6% | 0% | 1% | 0% | Exhausted |
| 5012401011 | Thermostat | 22 | 1 | 4 | 1% | 0% | 0% | 0% | Exhausted |
| 5013101011 | Water Heaters | 39 | 1 | 9 | 3% | 0% | 1% | 0% | Exhausted |
| 5013102011 | Water Heaters | 1 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 5020401021 | Boiler | 20 | 10 | 8 | 0% | 9% | 0% | 3% | Exhausted |
| 5020402021 | Boiler | 2 | 1 | 1 | 0% | 1% | 0% | 0% | Exhausted |
| 5020601011 | CAC | 36 | 2 | 11 | 6% | 0% | 2% | 0% | Exhausted |
| 5020901011 | ECM | 84 | 7 | 19 | 29% | 0% | 7% | 0% | Exhausted |
| 5020902011 | ECM | 26 | 2 | 5 | 9% | 0% | 2% | 0% | Exhausted |
| 5021201021 | Furnace | 188 | 44 | 66 | 0% | 14% | 0% | 5% | Exhausted |
| 5021201022 | Furnace | 172 | 44 | 56 | 0% | 15% | 0% | 5% | Exhausted |
| 5021201023 | Furnace | 153 | 44 | 49 | 0% | 15% | 0% | 5% | Exhausted |
| 5021201024 | Furnace | 141 | 44 | 39 | 0% | 16% | 0% | 4% | Exhausted |
| 5021201025 | Furnace | 120 | 44 | 33 | 0% | 16% | 0% | 4% | Exhausted |
| 5021202021 | Furnace | 26 | 8 | 10 | 0% | 3% | 0% | 1% | Exhausted |
| 5021301011 | Heat Pump | 8 | 1 | 1 | 6% | 0% | 1% | 0% | Exhausted |
| 5022401021 | Thermostat | 198 | 10 | 53 | 0% | 3% | 0% | 1% | Exhausted |
| 5022401022 | Thermostat | 145 | 10 | 29 | 0% | 3% | 0% | 1% | Exhausted |
| 5022401023 | Thermostat | 104 | 10 | 23 | 0% | 4% | 0% | 1% | Exhausted |
| 5022402021 | Thermostat | 10 | 1 | 2 | 0% | 0% | 0% | 0% | Exhausted |
| 5023101021 | Water Heaters | 27 | 1 | 5 | 0% | 0% | 0% | 0% | Exhausted |
| 5023102011 | Water Heaters | 1 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 5023102021 | Water Heaters | 3 | 1 | 2 | 0% | 0% | 0% | 0% | Exhausted |
| **Total HVAC** | | **1,653** | **300** | **446** | **100%** | **100%** | **19%** | **31%** | |

## Table 179. 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 | |
| 7010101011 | CFL | 103 | 7 | 13 | 3% | 0% | 1% | 0% | Available |
| 7010101012 | CFL | 72 | 6 | 15 | 4% | 0% | 1% | 0% | Exhausted |
| 7010102011 | CFL | 45 | 6 | 7 | 2% | 0% | 0% | 0% | Available |
| 7012501011 | Refrigerator | 39 | 9 | 11 | 6% | 0% | 2% | 0% | Exhausted |
| 7012501012 | Refrigerator | 39 | 9 | 11 | 6% | 0% | 2% | 0% | Available |
| 7012501013 | Refrigerator | 40 | 8 | 10 | 6% | 0% | 2% | 0% | Available |
| 7012502011 | Refrigerator | 25 | 7 | 10 | 4% | 0% | 2% | 0% | Available |
| 7012502012 | Refrigerator | 26 | 7 | 7 | 4% | 0% | 1% | 0% | Available |
| 7020101011 | CFL | 121 | 8 | 18 | 5% | 0% | 1% | 0% | Available |
| 7020101012 | CFL | 98 | 7 | 16 | 5% | 0% | 1% | 0% | Available |
| 7020102011 | CFL | 118 | 8 | 17 | 5% | 0% | 1% | 0% | Available |
| 7020102012 | CFL | 91 | 7 | 16 | 5% | 0% | 1% | 0% | Available |
| 7020901011 | ECM | 2 | 2 | 0 | 0% | 0% | 0% | 0% | Available |
| 7021201021 | Furnace | 25 | 9 | 7 | 0% | 10% | 0% | 3% | Available |
| 7021201022 | Furnace | 20 | 9 | 8 | 0% | 11% | 0% | 4% | Available |
| 7021201023 | Furnace | 16 | 8 | 10 | 0% | 13% | 0% | 7% | Available |
| 7021201024 | Furnace | 1 | 1 | 0 | 0% | 3% | 0% | 0% | Exhausted |
| 7021202021 | Furnace | 14 | 7 | 6 | 0% | 7% | 0% | 3% | Available |
| 7021202022 | Furnace | 11 | 6 | 2 | 0% | 8% | 0% | 1% | Available |
| 7021301021 | Furnace Tune-up | 45 | 6 | 14 | 0% | 6% | 0% | 2% | Available |
| 7021301022 | Furnace Tune-up | 33 | 6 | 11 | 0% | 6% | 0% | 2% | Available |
| 7021302021 | Furnace Tune-up | 3 | 2 | 1 | 0% | 0% | 0% | 0% | Exhausted |
| 7021501021 | Insulation | 143 | 8 | 36 | 0% | 8% | 0% | 2% | Available |
| 7021501022 | Insulation | 70 | 7 | 20 | 0% | 9% | 0% | 3% | Available |
| 7021502021 | Insulation | 61 | 8 | 22 | 0% | 6% | 0% | 2% | Available |
| 7022401021 | Thermostat | 40 | 8 | 12 | 0% | 6% | 0% | 1% | Available |
| 7022402021 | Thermostat | 2 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| 7022402022 | Thermostat | 1 | 1 | 1 | 0% | 0% | 0% | 0% | Exhausted |
| 7022501011 | Refrigerator | 38 | 9 | 15 | 6% | 0% | 2% | 0% | Available |
| 7022501012 | Refrigerator | 39 | 9 | 8 | 6% | 0% | 1% | 0% | Available |
| 7022501013 | Refrigerator | 39 | 8 | 13 | 6% | 0% | 2% | 0% | Available |
| 7022502011 | Refrigerator | 47 | 9 | 13 | 7% | 0% | 2% | 0% | Available |
| 7022502012 | Refrigerator | 48 | 9 | 13 | 7% | 0% | 2% | 0% | Available |
| 7022502013 | Refrigerator | 47 | 9 | 20 | 7% | 0% | 3% | 0% | Available |
| 7022502014 | Refrigerator | 48 | 8 | 11 | 7% | 0% | 2% | 0% | Available |
| 7022701021 | Air Sealing | 133 | 9 | 33 | 0% | 7% | 0% | 2% | Available |
| 7022702021 | Air Sealing | 9 | 2 | 3 | 0% | 0% | 0% | 0% | Available |
| **Total Low Income** | | **1,752** | **250** | **430** | **100%** | **100%** | **26%** | **32%** | |

## Table 180. 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 | |
| 10011701011 | Kit 200 | 197 | 17 | 31 | 10% | 0% | 2% | 0% | Available |
| 10011701012 | Kit 200 | 62 | 17 | 17 | 13% | 0% | 4% | 0% | Available |
| 10011701013 | Kit 200 | 61 | 17 | 16 | 13% | 0% | 3% | 0% | Available |
| 10011701014 | Kit 200 | 62 | 17 | 21 | 13% | 0% | 4% | 0% | Available |
| 10011701015 | Kit 200 | 62 | 16 | 22 | 13% | 0% | 5% | 0% | Available |
| 10011702011 | Kit 200 | 54 | 8 | 16 | 4% | 0% | 1% | 0% | Available |
| 10011702012 | Kit 200 | 20 | 8 | 5 | 4% | 0% | 1% | 0% | Available |
| 10011702013 | Kit 200 | 21 | 8 | 8 | 4% | 0% | 2% | 0% | Exhausted |
| 10021701011 | Kit 200 | 23 | 10 | 6 | 5% | 0% | 1% | 0% | Available |
| 10021701012 | Kit 200 | 23 | 10 | 5 | 5% | 0% | 1% | 0% | Available |
| 10021701013 | Kit 200 | 23 | 9 | 8 | 5% | 0% | 2% | 0% | Exhausted |
| 10021701014 | Kit 200 | 23 | 9 | 9 | 5% | 0% | 2% | 0% | Exhausted |
| 10021702011 | Kit 200 | 10 | 4 | 4 | 2% | 0% | 1% | 0% | Available |
| 10021801011 | Kit 201 | 50 | 8 | 15 | 3% | 0% | 1% | 0% | Available |
| 10021802011 | Kit 201 | 9 | 2 | 2 | 0% | 0% | 0% | 0% | Available |
| 10021901021 | Kit 203 | 18 | 10 | 5 | 0% | 21% | 0% | 5% | Available |
| 10021901022 | Kit 203 | 10 | 10 | 2 | 0% | 23% | 0% | 5% | Available |
| 10021901023 | Kit 203 | 10 | 9 | 4 | 0% | 23% | 0% | 9% | Exhausted |
| 10021901024 | Kit 203 | 10 | 9 | 3 | 0% | 23% | 0% | 7% | Available |
| 10021902021 | Kit 203 | 5 | 2 | 1 | 0% | 9% | 0% | 2% | Exhausted |
| **Total Online Audit** | | **753** | **200** | **200** | **100%** | **100%** | **29%** | **28%** | |

## Table 181. Onsite 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 | |
| 2020101011 | CFL | 39 | 8 | 15 | 12% | 0% | 6% | 0% | Exhausted |
| 2020101012 | CFL | 26 | 8 | 8 | 13% | 0% | 4% | 0% | Exhausted |
| 2020101013 | CFL | 27 | 8 | 10 | 14% | 0% | 5% | 0% | Exhausted |
| 2020101014 | CFL | 27 | 7 | 9 | 14% | 0% | 5% | 0% | Exhausted |
| 2020102011 | CFL | 3 | 1 | 3 | 1% | 0% | 1% | 0% | Exhausted |
| 2021001011 | Faucet Aerator | 48 | 9 | 20 | 14% | 0% | 6% | 0% | Exhausted |
| 2021001021 | Faucet Aerator | 112 | 9 | 20 | 0% | 5% | 0% | 1% | Exhausted |
| 2021001022 | Faucet Aerator | 98 | 9 | 22 | 0% | 6% | 0% | 1% | Exhausted |
| 2021002021 | Faucet Aerator | 17 | 2 | 10 | 0% | 1% | 0% | 0% | Exhausted |
| 2021501021 | Insulation | 24 | 6 | 7 | 0% | 3% | 0% | 1% | Exhausted |
| 2021501022 | Insulation | 14 | 6 | 0 | 0% | 4% | 0% | 0% | Exhausted |
| 2021502021 | Insulation | 10 | 3 | 0 | 0% | 2% | 0% | 0% | Exhausted |
| 2022301011 | Pipe Wrap | 43 | 8 | 19 | 12% | 0% | 6% | 0% | Exhausted |
| 2022301021 | Pipe Wrap | 210 | 18 | 42 | 0% | 11% | 0% | 2% | Exhausted |
| 2022302021 | Pipe Wrap | 17 | 2 | 10 | 0% | 1% | 0% | 1% | Exhausted |
| 2022401021 | Thermostat | 61 | 11 | 10 | 0% | 8% | 0% | 1% | Exhausted |
| 2022401022 | Thermostat | 43 | 11 | 7 | 0% | 9% | 0% | 1% | Exhausted |
| 2022401023 | Thermostat | 36 | 11 | 9 | 0% | 9% | 0% | 2% | Exhausted |
| 2022401024 | Thermostat | 32 | 10 | 12 | 0% | 10% | 0% | 4% | Exhausted |
| 2022401025 | Thermostat | 23 | 10 | 4 | 0% | 10% | 0% | 2% | Exhausted |
| 2022402021 | Thermostat | 11 | 4 | 6 | 0% | 3% | 0% | 1% | Exhausted |
| 2022801011 | Showerhead | 41 | 12 | 16 | 20% | 0% | 8% | 0% | Exhausted |
| 2022801021 | Showerhead | 170 | 21 | 33 | 0% | 16% | 0% | 3% | Exhausted |
| 2022802021 | Showerhead | 14 | 3 | 8 | 0% | 1% | 0% | 1% | Exhausted |
| 2023901021 | Window Replacement | 4 | 2 | 0 | 0% | 1% | 0% | 0% | Exhausted |
| 2023902021 | Window Replacement | 1 | 1 | 0 | 0% | 0% | 0% | 0% | Exhausted |
| **Total Onsite Audit** | | **1,151** | **200** | **300** | **100%** | **100%** | **40%** | **22%** | |

## Table 182. New Construction Sample Disposition

| Measure | Measures in Frame | Target Completes | Sample Completes | Fraction of Frame Total Reported Savings | | | | Status |
|---|---|---|---|---|---|---|---|---|
| | | | | Frame | | Sample | | |
| | | | | kWh | ccf | kWh | ccf | |
| ENERGY STAR New Home | 33 | Census | 17 | 100% | 100% | 55% | 54% | Exhausted |

**Table 183. 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 | |
| 302050102 | Boiler Tune-Up | 22 | census | 16 | 57% | 10% | 0% | 55% | Exhausted |
| 301010101 | CFL | 1 | census | 1 | 0% | 0% | 0% | 0% | Exhausted |
| 301010201 | CFL | 5 | census | 4 | 0% | 0% | 0% | 0% | Exhausted |
| 302010101 | CFL | 6 | census | 4 | 0% | 0% | 0% | 0% | Exhausted |
| 302010201 | CFL | 7 | census | 4 | 0% | 7% | 5% | 0% | Exhausted |
| 301070101 | Custom | 9 | census | 8 | 0% | 3% | 2% | 0% | Exhausted |
| 301070201 | Custom | 4 | census | 2 | 0% | 3% | 4% | 0% | Exhausted |
| 302070101 | Custom | 14 | census | 14 | 0% | 9% | 11% | 0% | Exhausted |
| 302070102 | Custom | 3 | census | 3 | 29% | 5% | 0% | 29% | Exhausted |
| 302070201 | Custom | 7 | census | 7 | 0% | 2% | 2% | 0% | Exhausted |
| 302070202 | Custom | 1 | census | 1 | 4% | 1% | 0% | 4% | Exhausted |
| 302140102 | Heating | 3 | census | 2 | 1% | 0% | 0% | 1% | Exhausted |
| 302140202 | Heating | 1 | census | 1 | 8% | 1% | 0% | 8% | Exhausted |
| 301020101 | Lighting | 33 | census | 32 | 0% | 6% | 7% | 0% | Exhausted |
| 301020201 | Lighting | 31 | census | 15 | 0% | 6% | 6% | 0% | Exhausted |
| 302020101 | Lighting | 81 | census | 66 | 0% | 28% | 32% | 0% | Exhausted |
| 302020201 | Lighting | 54 | census | 26 | 0% | 6% | 5% | 0% | Exhausted |
| 301210101 | Motors | 2 | census | 2 | 0% | 1% | 1% | 0% | Exhausted |
| 302210101 | Motors | 3 | census | 3 | 0% | 1% | 1% | 0% | Exhausted |
| 302210201 | Motors | 9 | census | 6 | 0% | 7% | 2% | 0% | Exhausted |
| 301410101 | Occupancy Sensors | 2 | census | 2 | 0% | 0% | 0% | 0% | Exhausted |
| 301410201 | Occupancy Sensors | 6 | census | 3 | 0% | 1% | 0% | 0% | Exhausted |
| 302410101 | Occupancy Sensors | 10 | census | 7 | 0% | 1% | 1% | 0% | Exhausted |
| 302410201 | Occupancy Sensors | 10 | census | 5 | 0% | 1% | 0% | 0% | Exhausted |
| 302400101 | Other | 3 | census | 3 | 0% | 1% | 1% | 0% | Exhausted |
| 302400102 | Other | 2 | census | 2 | 0% | 0% | 0% | 0% | Exhausted |
| **Total C&I** | | **329** | **census** | **239** | **100%** | **100%** | **82%** | **97%** | |

**Table 184. Multifamily Sample Disposition**

| Measure Code | Measures in Frame | Target Completes (Customers) | Sample Completes (Measures) | Fraction of Frame Total Reported Savings | | | | Status |
|---|---|---|---|---|---|---|---|---|
| | | | | Frame | | Sample | | |
| | | | | kWh | ccf | kWh | ccf | |
| CFLs | 26 | | 11 | 57% | n/a | 26% | n/a | |
| Programmable Thermostats | 15 | | 6 | n/a | 32% | n/a | 11% | |
| Faucet Aerators | 28 | N/A | 9 | 8% | 14% | 4% | 3% | Exhausted |
| Kitchen Aerators | 24 | | 7 | 7% | 11% | 4% | 2% | |
| Showerheads | 27 | | 9 | 22% | 37% | 11% | 7% | |
| Pipe Wrap | 13 | | 4 | 6% | 6% | 3% | 3% | |
| **Total Multifamily** | **133** | **10** | **46** | **100%** | **100%** | **48%** | **25%** | |

## T.2.2 General Population Survey

KEMA also completed a Residential General Population survey, which was intended to gather information about households within the territories of participating MECA/MCAAA 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, KEMA contracted Relevate to provide all residential phone numbers for the zip codes within the territories of all MECA and MCAAA utilities. Relevate provided KEMA with over 670,000 phone numbers.

KEMA contracted Research America (RA) to conduct computer-aided telephone interviews (CATI) of program participants. KEMA released 30,895 phone numbers to RA. Of those numbers, about one-third (10,413) was deemed ineligible for the survey. Ineligibility resulted from several situations:

- *Disconnected phone numbers*: About 70 percent of the ineligible phone numbers were disconnected.
- *Ineligible household*: Respondents who did not purchase energy from a participating MECA or MCAAA utility and those who said they participated in an energy efficiency program were considered ineligible. This category accounted for about 15 percent of the ineligible numbers. Respondents in zip codes served by Great Lakes Energy were especially likely to fall into this category because many of these zip codes are also served by Consumer's Energy.
- *Fax/computer tones*: About eight percent of the ineligible numbers were due to fax machines or computers answering the call.
- *Non-residential:* The remaining ineligible numbers (about 6%) reported that the phone number was for a business rather than a residence.

Another 13,690 phone numbers were never answered. RA called these numbers at least eight times, across at least two weeks before considering them unreachable. Based on the ineligibility rate for the numbers for which RA did get an answer, KEMA estimates that most (8,286) of these unanswered phone numbers would have been ineligible.

The final estimated eligible sample was 12,196 phone numbers. RA completed interviews with 800 households in January and February, 2011. This was a final response rate of seven percent.

**Table 185. General Population Sample Disposition**

| Sample Description | Number | Percent |
|---|---|---|
| Starting Sample | **30,895** | |
| Never Called | - | |
| **Sample Used** | **30,895** | |
| Known Not Eligible | 10,413 | |
| Estimated additional not eligible | 8,286 | |
| **Sample-Valid** | **12,196** | |
| Complete | 800 | 7% |
| Refused | 5,717 | 47% |
| Not Completed - Eligible | 275 | 2% |
| Not Completed - Est. Eligible | 5,404 | 44% |

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 program territory (EO, EU, or unknown) and peninsula (upper, lower) they were in based on zip code. Results are weighted based on the number of participants in the population strata divided by the number of completed surveys.

# U. Attribution Analysis Methodology

## U.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 Audits, 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, Multifamily, or New Construction programs.

### U.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 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, 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**, $\mathbf{m_L}$: 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.

$$f_E = 1 - A_E$$

$$f_Q = 1 - A_Q$$

## U.2 Attribution Analysis

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

### U.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

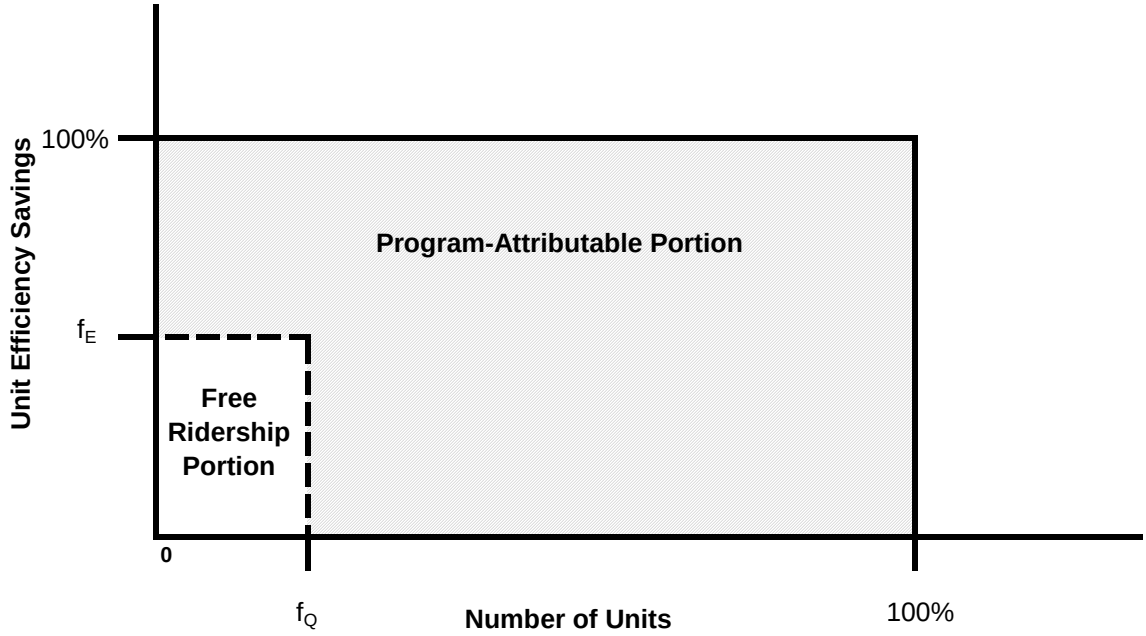
$$f_{QE} = (2/3) \times (1/2) = 1/3.$$

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.

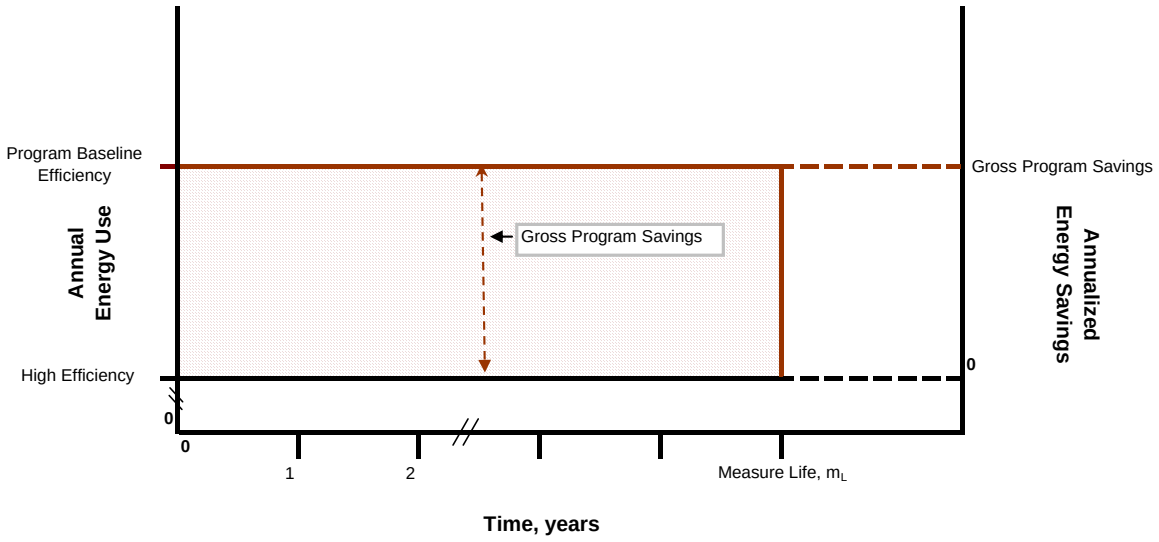
**Figure 9. Graphical Derivation of the SPA Equation**




## U.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**

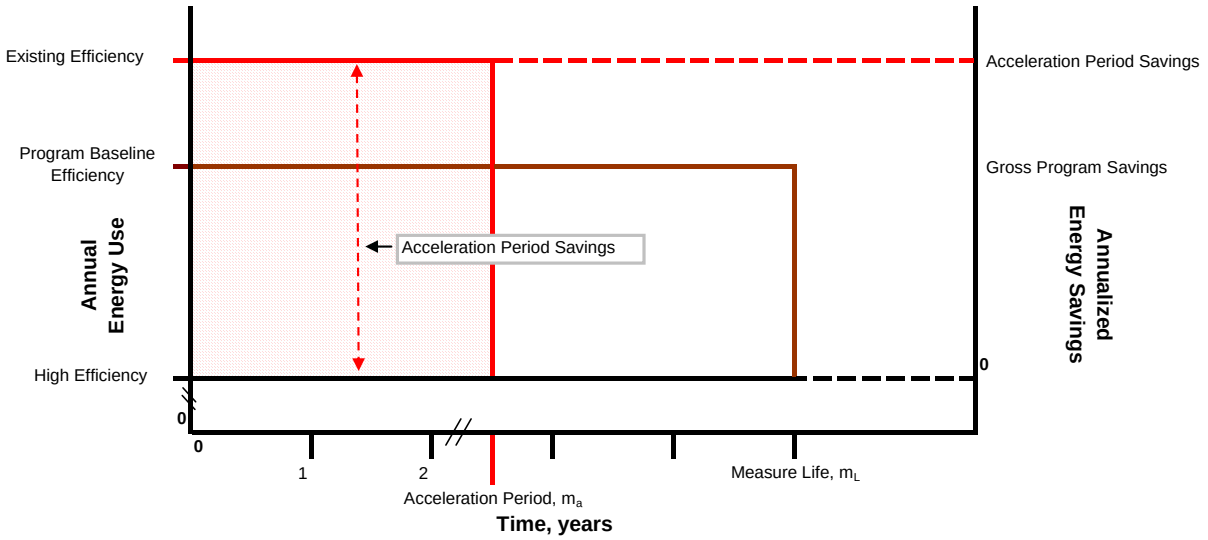



For a replacement measure with acceleration, the program caused the participant to install an energy efficiency measure before they originally intended to do so. During the acceleration period, the energy savings caused by the program are the difference between the energy use of the high efficiency equipment 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, $m_a$.

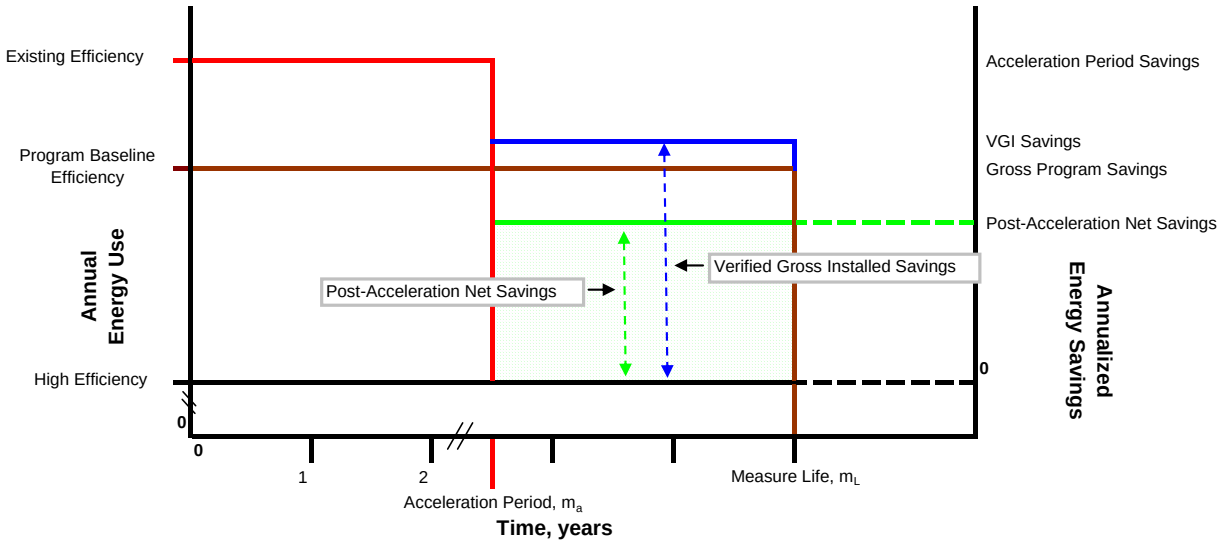
**Figure 11. Acceleration Period Savings**




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 U.2.1

**Figure 12. Post-Acceleration Period Net Savings**

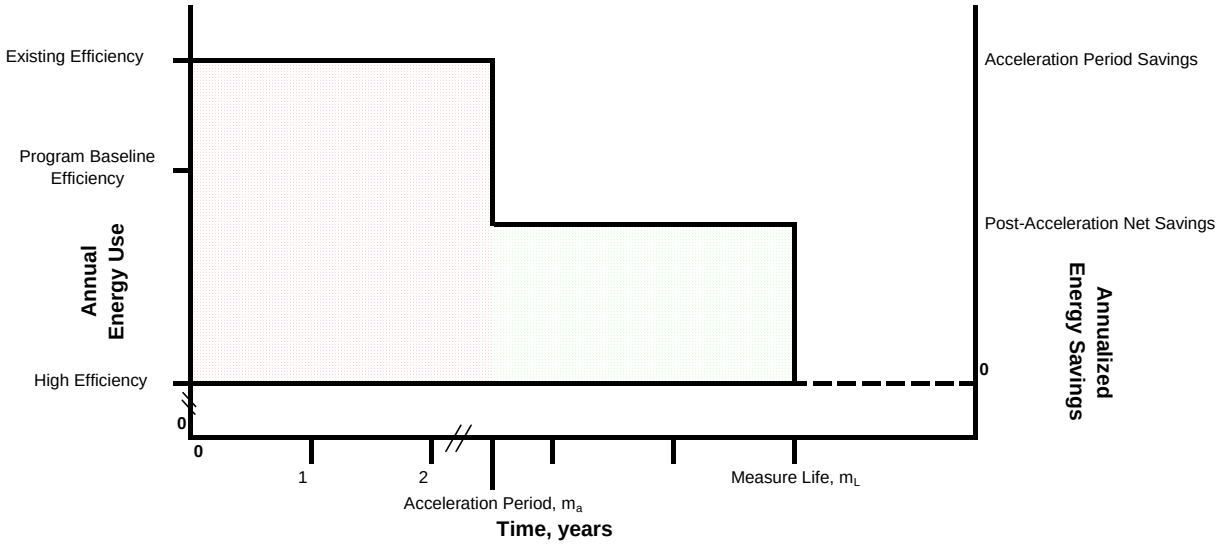



The lifetime net savings for an accelerated measure are the sum of the acceleration period savings and the post-acceleration net savings. This can also be written as

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

The lifetime net savings are shown graphically in Figure 13.

**Figure 13. Simple Lifetime Net Savings**



# U.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 Online Audit and ENERGY STAR CFL analysis are described in later sections.

## U.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 186. 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 186. Efficiency Attribution Assignments**

| Efficiency That Would Have Been Installed without EO/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 meas grp |
| Same | *NA* | 0% |
| Greater | *NA* | 0% |
| Don't Know/ Refused | *NA* | Avg of all respondents for |

- **Quantity Attribution, $A_Q$:** 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 $A_Q$ = |(Amount installed / Amount would have installed without program) - 100%|.

The next few sections deal with determining the timing, efficiency, and quantity attributions on a more detailed level.

## U.4.2 Detailed Assignments

This section gives a detailed accounting of how the attribution factors are determined from the survey responses.

### U.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?"

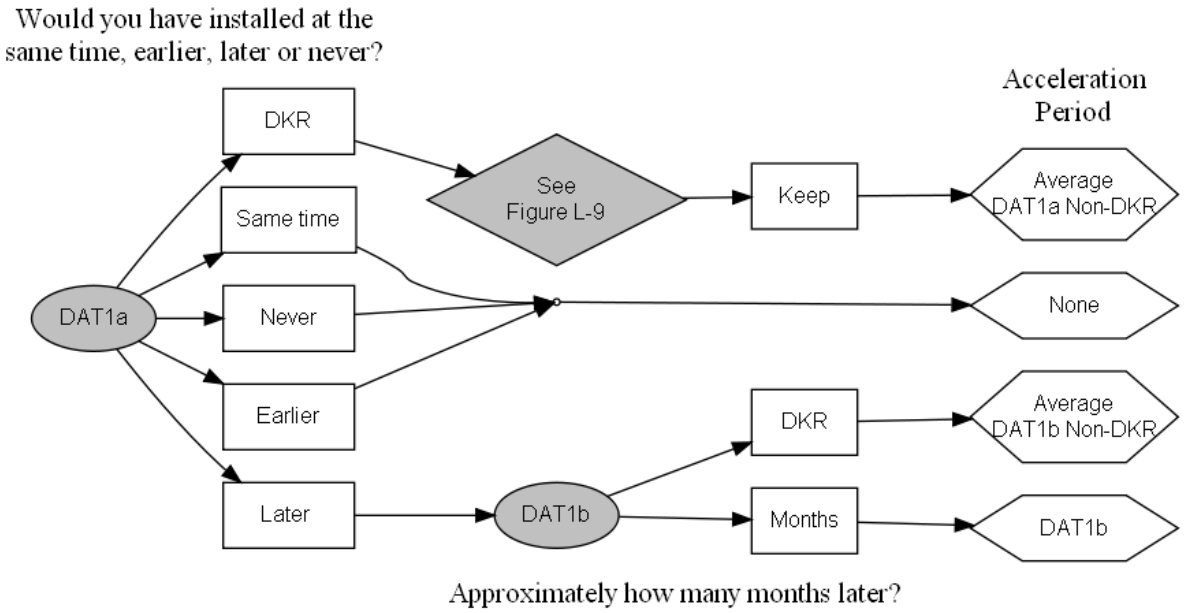
DAT1b: "Approximately how many months later?" (DAT1b is only asked if DAT1a is "Later".)

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.

#### U.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.

### U.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 187. For measures with limited efficiency options, such as faucet aerators and showerheads, 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 187. Efficiency Attribution Assignments**

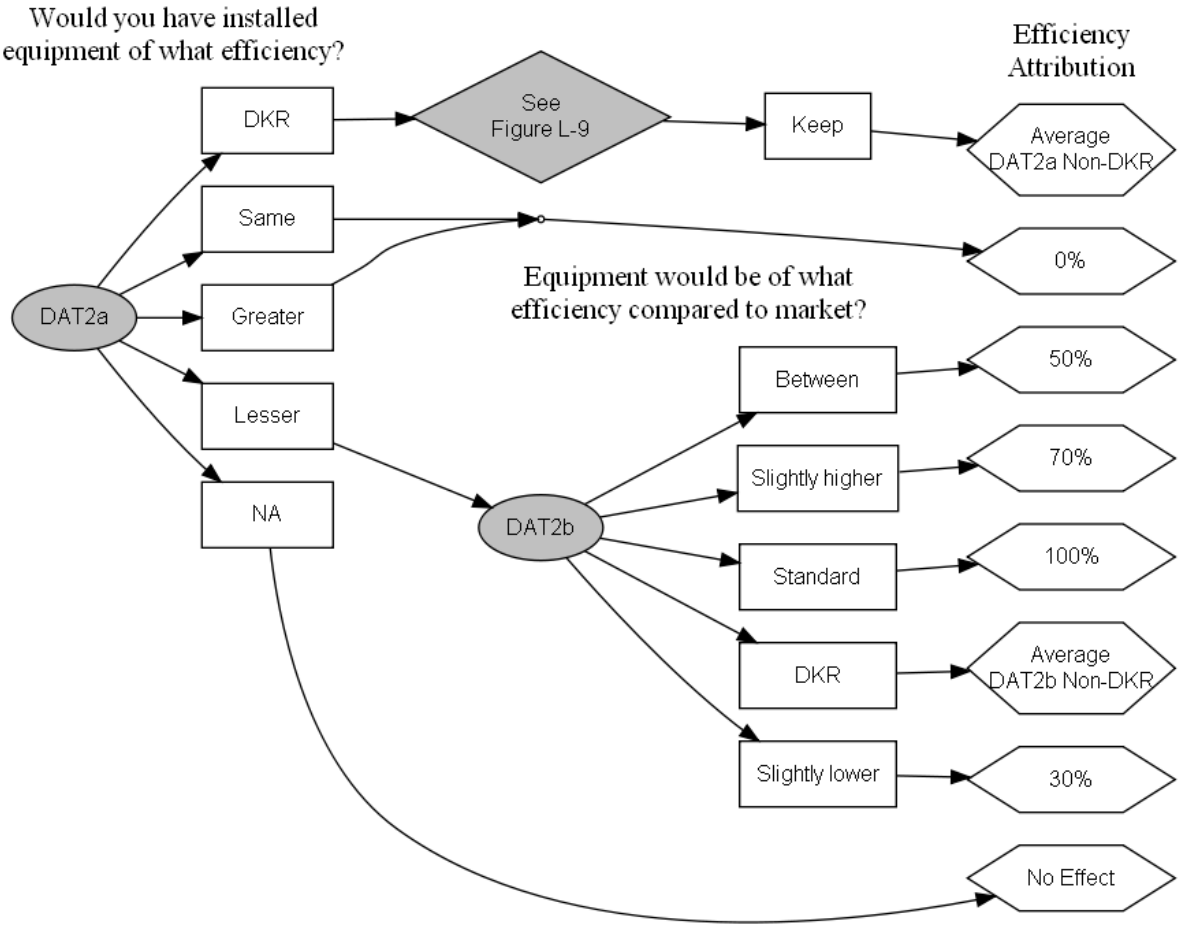
| Efficiency That Would Have Been Installed without EO/EU | | |
|---|---|---|
| **Coarse Cut (DAT2a)** | **Finer Cut (DAT2b)** | **Efficiency Attribution, E** |
| Lesser | Standard efficiency or according to code | 100% |
| | Slightly higher than standard efficiency | 70% |
| | Between standard efficiency 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 meas grp |
| Same | *NA* | 0% |
| Greater | *NA* | 0% |
| Don't Know/ Refused | *NA* | Avg of all respondents for |

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**




### U.4.2.3 Quantity

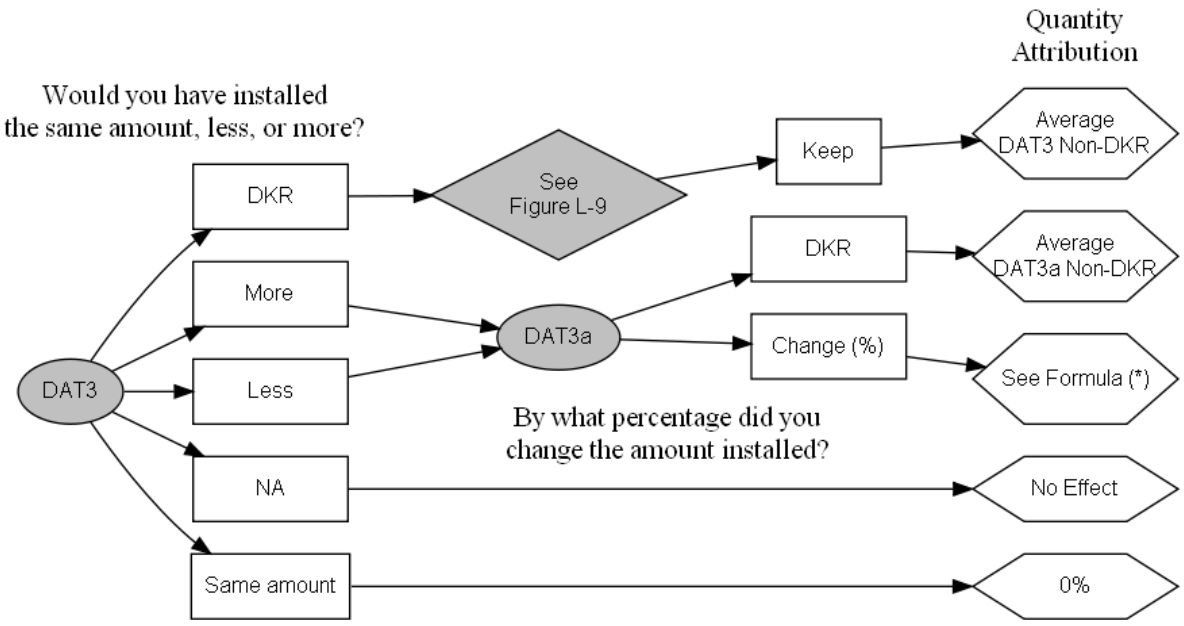
Quantity Attribution, $A_Q$, gives the program credit for increasing the quantity of a measure above what would have been installed in the absence of the program. The two relevant questions are DAT3 and DAT3a.

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

$$A_Q = |(\textit{Amount installed / Amount would have installed without program}) - 100\%|.$$

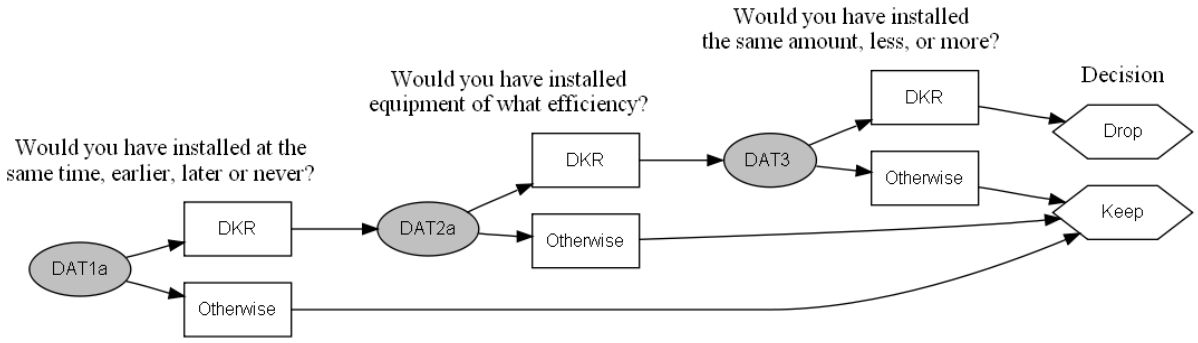
If the respondent answers DAT3 with Same Amount then the survey skips to the next section and there is zero Quantity Attribution. If the respondent answers DAT3 or DAT3a with Don't

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.

#### U.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**




## U.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.

### U.5.1 CFLs

#### U.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.

### U.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.

### U.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.

### U.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, 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.

## U.5.2 Kits

The Online Audit, HVAC 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.

### U.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.