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Energy Efficiency / Demand Response Plan: Plan Year 3 (6/1/2010-5/31/2011) Evaluation Report:

Central Air Conditioning Efficiency Services (CACES) Program

Presented to

Commonwealth Edison Company

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Section E. Executive Summary

This document is the Evaluation Report of the ComEd Residential Central Air Conditioning Efficiency Services (CACES) program for program year 3 (PY3). This evaluation describes the PY3 evaluation activities, findings, and recommendations for ComEd's CACES program.

The main goals of the CACES program are to increase the efficiency of existing air conditioning equipment and promote the quality installation of high-efficiency equipment in replacement situations and in new construction. The program also seeks to improve the overall quality of residential HVAC services by increasing the visibility of participating independent contractors as vendors focusing on quality and using state-of-the-art diagnostic tools.

The residential CACES program consists of two distinct programs serving different markets through a common marketing and delivery infrastructure. The Diagnostics and Tune-Up program targets improved efficiency for existing residential air conditioning equipment. The Quality Installation program addresses high-efficiency equipment installations for new and replacement air conditioning equipment. Both of these programs are co-marketed and branded as CACES and they have the same administrative staff at ComEd, Implementation Contractor (IC) and network of independent participating contractors that deliver the programs to consumers. Because of the close links between these programs, the Evaluator is submitting a single unified report for CACES.

E.1 Evaluation Objectives

The primary objectives of the Impact Evaluation are to review and verify or adjust reported savings for both the Quality Installation and Diagnostics and Tune-up programs, to recommend general improvements to the savings estimation process, and to quantify gross and net savings impacts from review of the program tracking and engineering calculations. The Process Evaluation addresses key process-related program strengths and weaknesses and identifies ways in which the program can be improved.

E.2 Evaluation Methods

The CACES program is a combination of two residential air conditioning programs, each of which requires a different impact evaluation approach. For the Diagnostics and Tune-Up program, the evaluation used on-site data collection, and analysis of load research data to determine impact parameters. This approach was selected because of the diagnostic technology deployed for the program and the diverse group of technicians that deliver the program to consumers. The Quality Installation program was planned to have thousands of participants with replacement equipment for which a billing analysis approach is a robust estimator of impacts.

Process questions and interviews with key personnel are common to both programs in CACES. The process evaluation employed in-depth interviews with key program personnel and computer assisted telephone interviews (CATI) with HVAC contractors and residential consumers to research relevant process questions.

E.3 Key Impact Findings and Recommendations

Participation in the CACES programs were mixed in PY3. Quality installation participation met its revised goals, but those goals were revised down to less than 10% of the original plan based on PY2 results. The diagnostics and tune-up program achieved less than 50% of its participation goal.

The impact results for the Diagnostic and Tune-Up program and the Quality Installation program are shown in Table E-1 and Table E-2, respectively. The combined CACES results are shown in Table E-3.

Diagnostics and Tune-Up program participation fell short of goals by more than 50%; however, savings *per participant* was very close to planned values, thus the realization rate among program participants was nearly 100%. Planned savings per participant was sharply reduced during PY3 to reflect the evaluation results from PY2[1]. The factors contributing to low savings in PY2 appear to persist. These include:

1. Poor economic conditions might mean that mostly homes with annual service contracts were tested with this program. Annual service should serve to increase the initial baseline efficiency of central air conditioners.
2. Conversely, homes that might have less efficient equipment perhaps did not get tune-ups because of the economy.
3. Hours of operation have been over-estimated in *ex ante* simulations. Residential behavior is extremely difficult to capture in simulations.

One piece of information does support the first hypothesis: more than 70% of PY3 Diagnostics and Tune-Up participants were also participants in PY2. The other hypotheses cannot be tested with the data collected in PY3. Diagnostic and Tune-Up program results using are shown in Table E-1.

[1] PY2 results were lower than the original *Commonwealth Edison 2008-2010 Energy Efficiency and Demand Response Plan*, November 15, 2007 due to lower estimates of hours of operation and baseline equipment efficiency that was better than anticipated during PY2.

Table E-1. Ex Post Program Savings - Diagnostics and Tune-Ups

	PY3 Goal[1]	PY3 *Ex Ante*[2]	Evaluate PY3 Gross	Evaluated PY3 Net*	Realization Rate
Participants (#customers)	29,450	14,550	14,550	14,550	100%
Energy Savings (MWh)	6,067	1,479	1,476	1,476	99.8%
Demand Savings (MW)[3]	NA	NA	1.99	1.99	NA

1 revised goals per ComEd memo 8/13/2010
2 ComEd email 8/31/2011
3 ComEd does not have demand savings goals for this program
** Net-to-Gross ratio = 1.0 for PY3 evaluation*

Persistence of tune-up savings is notably high. Many program participants tuned-up equipment in both PY2 and PY3, probably due to having annual service contracts. By comparing PY2 post-installation performance to PY3 pre-installation performance we see very little decrease in the efficiency index. A drop of 2-3% in performance from one year to the next is typical.

The Quality Installation program was greatly scaled back in the revised program goals. Actual participation did exceed the reduced goals. The weather-normalized billing analysis of the savings show realized savings per unit comparable to the PY2 analysis[2], thus the realization rate for the Quality Installation program is near 100%.

Table E-2. *Ex Post* Program Savings - Quality Installation

	PY3 Goal[1]	PY3 *Ex Ante*	Evaluated PY3 Gross	Evaluated PY3 Net*	Realization Rate
Participants (#customers)	1,550	1,687	1,687	1,687	100%
Energy Savings (MWh)	649	685	750	750	109.4%
Demand Savings (MW)[2]	NA	NA	1.01	1.01	NA

1 revised goals per ComEd memo 8/13/2010
2 ComEd does not have demand savings goals for this program
** Net -to-Gross ratio = 1.0 for PY3 evaluation*

[2] *Ex ante* per unit savings in PY3 was based on the results of the PY2 evaluation

Table E-3. *Ex Post* Program Savings – CACES (combined)

	PY3 Goal	PY3 *Ex Ante* **	Evaluated PY3 Gross	Evaluated PY3 Net*	Realization Rate
Participants (#customers)	31,000	16,237	16,237	16,237	100.0%
Energy Savings (MWh)	6,696	6,007	2,225	2,225	37%
Demand Savings (MW)	NA	NA	3.0	3.0	NA

** Net -to-Gross ratio = 1.0 for PY3 evaluation*

*** ComEd's ex ante adjusted gross was 2,164 so the realization rate on ComEd's adjusted gross was 102.8%*

Table E-4. Year-to-Year Comparison – PY2 and PY3

	Diagnostic/Tune-Up		Quality Installation	
	PY2	PY3	PY2	PY3
Participants (# of customers)	16,293	14,550	871	1,687
Program MWh – evaluated net	1,632	1,476	332	750
Energy (MWh) Realization Rate	29.70%	99.80%	69.60%	109.4%
Savings (kWh) / Customer	100.2	101.4	381.2	444.3

In general, Navigant notes that the PY3 results are consistent with the PY2 results (see Table E-4), on a per participant basis. PY3 Quality Installation per customer results include re-analysis of PY2 participants with more post-installation data points. Navigant also notes that these results represent the only the second year of operation for this program. The program is innovative in its use of generally small vendors to market and deliver the program. Outreach to participating contractors and consumers continues with high-level goals to grow the program and change the way HVAC service is delivered in the ComEd service territory. Furthermore, the impacts of a poor economy are very difficult to determine.

An assessment of net-to-gross was made through interviews with independent participating and non-participating air conditioning contractors. Since the incentive is paid to the contractors, changes in contractor behavior is used to determining the net-to-gross ratio. Most responses support NTG near 1.0: contractors have improved their tune-up techniques using more sensors

and data to optimize equipment. When sizing and installing equipment they are more likely to use more rigorous and accurate techniques than they were without the program.

Navigant Proposes the following impact-related recommendations for future residential AC programs:

> ***Recommendation.*** Consider researching better estimates for equipment runtime. Improvements might include earlier installation of runtime equipment, a larger run-time evaluation sample, and a more diverse sample across the service territory or further analysis of load research data that integrates field data results.
> ***Recommendation.*** Consider studying tune-up persistence for another year to answer the following questions. Do machines maintain higher efficiency indices for several years? Can the program be used to determine cost-effective tune-up intervals or flag units that are annual problems? Do we see differences in persistence from annual versus biennial tune-ups?

E.4 Key Process Findings and Recommendations

The process evaluation included telephone interviews with program managers, the implementation contractors, independent participating contractors, independent *non*-participating contractors and consumers who received qualifying services. Key findings include:

1. Participating contractors express high overall satisfaction with the CACES Program. Seventy percent rate the program 7-10 (mean score 6.8 of 10).
2. Participating customers express high overall satisfaction with the program. Eighty percent rate the program 7-10 (mean score 8.0 of 10).
3. Participating contractors use best-practices Manual J calculations not only for Quality Installation program participants, but also 70% of the time when working outside the ComEd service territory. This is an improvement from 42-49% use of Manual J in and out of ComEd territory prior to the program.
4. Seventy-five percent of new equipment installed through Quality Installation is to replace failed or nearly failed equipment. Twenty-five percent of replaced units are retired early.
5. Despite taking more time to use, 57% of independent participating contractors use the Service Assistant outside of the ComEd service territory, even though they do not receive incentives to do so.
6. Contractors report that 68% of equipment they service through the program receives annual or biennial service. Nearly half (45%) of participating customers report they have their equipment tuned up annually or biennially.

   > ***Recommendation.*** Consider limiting incentives or participation when customers have annual tune-ups as these customers have little additional savings year-to-

year. Alternatively, consider scaling incentives to the improvement in the efficiency index parameter.

7. Fifty-seven percent of customers installing new equipment had decided to buy high-efficiency equipment before selecting a contractor. Among these customers they rate efficiency 7.9 on a scale of 1-10 in importance.

   Recommendation. Consider ways to limit free-riders for efficient equipment. Perhaps incentives should increase from a lower level as equipment efficiency increases over SEER 14.

E.5 Summary

The CACES programs have mixed results in PY3. Realization rates are near 100% for both programs, but the ex ante savings per participant were revised downward from the initial program plans, thus overall program savings is somewhat disappointing for this innovative program. Participation in the tune-up program was also well below program goals. Low participation may be a result of recent national economic conditions which cause consumers to postpone discretionary air conditioner tune-ups.

The Net-to-Gross estimate for both programs remains at 1.0. Contractor interviews confirm that they have, in general, implemented more rigorous and improved methods for equipment service, sizing and installation. Improved practices have also carried over into service territories outside of ComEd's territory, suggesting market transformation. Persistence of savings also appears to be good. Many PY3 participants also participated in PY2. Navigant saw very small (less than 2%) year-to-year decreases in the performance of equipment as measured by the efficiency index on the service equipment. While savings persistence is encouraging, it does also depress program savings when participants get annual tune-ups through the program.

Process evaluation questions do not point to any significant process-related problems with the program. Outreach to tune-up customers without service contracts could be improved. Enrolling more participating independent contractors would expand the program reach.

E.6 Cost-Effectiveness Review

ComEd uses DSMore™ software for the calculation of the Illinois TRC test[3]. Table E-5 summarizes the unique inputs used in the DSMore model to assess the TRC ratio for the CACES program in PY3. Most of the unique inputs come directly from the evaluation results presented previously in this report. Measure life estimates and program costs come directly from ComEd. All other inputs to the model, such as avoided costs, come from ComEd and are the same for this program and all programs in the ComEd portfolio.

[3] Demand Side Management Option Risk Evaluator (DSMore) software is developed by Integral Analytics.

Table E-5. Inputs to DSMore Model for CACES Program

Item	Value Used
Measure Life	15
Utility Administration and Implementation Costs	$1,043,560
Utility Incentive Costs	$1,073,874
Net Participant Costs	$0

Based on these inputs, the Illinois societal TRC for this program is 0.52 and the program does not pass the Illinois TRC test.

Section 1. Introduction to the Program

The residential Central Air Conditioning Efficiency Services (CACES) program consists of two distinct programs serving different markets though a common marketing and delivery infrastructure. The Diagnostics and Tune-Up program targets improved efficiency for *existing* residential air conditioning equipment. The Quality Installation program targets *new and replacement* air conditioning equipment. Both of these programs are co-marketed and branded as CACES and they have the same administrative staff at ComEd, Implementation Contractor (IC), and independent participating contractors who deliver the programs to consumers.

Roughly 90% of the combined CACES planned savings and costs are attributed to the Diagnostics and Tune-Up program.

Program revised program goals[4] are shown in Table 1-1 and Table 1-2. These revised goals differ significantly from those of the original program plan[5], where the Quality Installation program was to contribute the bulk of savings and participation. The revised goals were based on PY2 performance of both programs and a continued sluggish economy which is believed to have adversely affected program participation.

Table 1-1. Diagnostic and Tune-Up Program Goals *(revised)*

	PY 1	PY 2	PY 3
Participation Goals	0	28,576	29,450
Energy Savings Goals (MWh)	0	10,030	6,067
Demand Savings Goals (MW)	0	NA	NA

Table 1-2. Residential New HVAC with Quality Installation Program Goals *(revised)*

	PY 1	PY 2	PY 3
Participation Goals	0	1,000	1,550
Energy Savings Goals (MWh)	0	352	649
Demand Savings Goals (MW)	0	NA	NA

Both programs kicked off in June 2009 at the start of PY2 in the Plan, and the PY3 evaluation is looking at the second full year of implementation. ComEd has no stated goals for demand savings from the CACES Program.

[4] ComEd memo to Navigant, 8/13/2010.
[5] *Commonwealth Edison 2008-2010 Energy Efficiency and Demand Response Plan*, November 15, 2007.

1.1 Implementation Strategy

Roles of the Implementation Contractor

Honeywell Utility Solutions is the Implementation Contractor for the CACES program. Together, ComEd and Honeywell recruited independent participating contractors to deliver the program through their normal business activities. Honeywell and their partner, Field Diagnostic Services, Inc. (FDSI), sold the equipment required[6] of the contractors and conducted Business and Technical training sessions for the program and the diagnostic equipment, respectively. Beyond training Honeywell is responsible for day-to-day program administration, including conducting quality control activities, maintaining consumer and participating contractor relations, and administering data flow during the program cycle using the FDSI databases and field data collection protocols.

Program Timeline

The seasonality of cooling in Illinois forces the program delivery timeline to be out-of-synch with the program year reporting structure, which is June 1 – May 31. Recruiting and training of independent participating contractors occurs year-round, but is concentrated in the spring of the prior program year. Likewise, much tune-up activity occurs in the spring. Roughly 50% of equipment installations and tune-up activities incented through the program are performed from late April to the end of May at the end of the one program year and the rest occur June through September at the beginning of the next program year. Participation in a given year is based on the date that incentive checks are written to independent participating contractors for installations and service completed between June 1 and May 31 of the following year. For PY3 those checks had to be cut prior to June 30, 2011. Incentives paid after June 29, 2011 will be counted in PY4. This method of accounting ensures that projects are not counted in more than one program year, but gives independent participating contractors and ComEd a reasonable window to complete administrative tasks after the last day of the program year, May 31.

Program Delivery Mechanisms and Marketing Strategy

The CACES program is delivered through a network of independent participating HVAC contractors operating in ComEd's service territory that have been trained in program protocols and participation processes. ComEd and the IC conducted multiple recruitment and training

[6] Both programs required contractors to use the Service Assistant (SA) diagnostic tool to measure and report field data. This tool is designed and sold by FDSI. It incorporates electronic sensors to measure system temperatures and pressures which are linked back to a PDA device that compares field data with expected values given the nameplate information of the unit. Programmed diagnostic logic suggests corrective courses of action to optimize sensor outputs and thus unit efficiency and capacity. The principle is that this device is superior to traditional gauges used by contractors, because it has expert logic built in and sensor readings are compared simultaneously to get a more accurate snapshot of system performance. The Service Assistant also uplinks field data to the FDSI data server where data are compiled for reporting to Honeywell and ComEd.

events to inform contractors of opportunities and incentives available through the HVAC Diagnostics & Tune-Up program and the New HVAC with Quality Installation program.

The contractor training had two parts. Technical training addressed the use of diagnostic tools to check refrigerant charge and airflow over AC system coils, and was targeted toward the field technicians. The technical training included both classroom work and practical field use of the diagnostic equipment, the Service Assistant (SA) made by FDSI. Business training was targeted to the office staff of the HVAC contractors to make them familiar with the program administrative requirements and to assist with the marketing aspect of the program.

The diagnostic process is based on an automated analysis of the manual and automated sensor inputs to the SA provided by the technician. The SA tool suggests changes to refrigerant charge, general service and/or airflow based on operating data, and the technician then makes the necessary modifications. Use of the diagnostic tool and the extra time adhering to the protocols are additional costs to the HVAC contractors, but the resulting diagnosis and repairs should provide better service for consumers. ComEd seeks to encourage improved service and offset the additional costs with incentives that are paid to the HVAC contractor on a per job basis. The contractors have the option of passing the incentive through to the consumer in the form of a lower fee for the service, or retaining the incentive, depending on their own marketing strategy.

The HVAC Diagnostics & Tune-Up program is aimed at the mass market and, as such, requires a higher level of marketing activity to capture consumers' attention and generate sufficient project flow. Key elements of the marketing strategy include:

- Direct consumer marketing: To increase consumer awareness about the value of HVAC tune-up services, ComEd marketed the program through bill inserts and other direct mail approaches. Customers are directed to the ComEd website as a primary source of information and to the Call Center as a secondary source of information.
- Mass-market advertising: During special promotions, ComEd used mass-market advertising (radio/newspaper/television) to promote services provided through the program.
- Cooperative advertising: ComEd offered co-marketing advertising templates (e.g., brochures and customer postcards) for participating HVAC contractors to use in their marketing efforts.

HVAC Contractor Participation

In its second year, the program has seen continued growth in HVAC contractor participation. More than one hundred and thirty different contractors have purchased more than 270 Service Assistant tools for the program. Three companies with multiple locations have 15 or more SAs registered with the program, and five more have five or more SAs. ComEd feels that these data demonstrate the potential wide reach of the program.

Program Incentives

Contractors gain several benefits through program participation. They can represent that they perform a premium service, they gain marketing visibility with listing among program independent participating contractors, and there is a cash incentive paid to contractors. These payments are based on the number of service calls that pass ComEd-established criteria. ComEd payments decreases with the volume of service calls completed, but volume eligibility is determined for each Service Assistant tool. This incentive design serves several purposes: successful contractors will have multiple tools in the field; incentives are front loaded to speed the payback of the investment the contractor made with the Service Assistant and limits ComEd financial exposure if the program is substantially over-subscribed.

Table 1-3. Incentive Structure

		Incentive Revenue Earnings Per Individual Service Assistant Tool		
		$0 - $10,000	>$10,000	Over Subscription
Incentive Level	Tune-Up	$100	$50	$10
	Quality Installation & Right-sizing	$150	$100	$10
	SEER 14 or better	$150	$100	NA

Source: CACES Participating Contractor Agreement – Attachment A 4/10/2009

Diagnostic and Tune-Up incentives are only paid if the service call "passes" certain performance criteria. The contractor must use the Service Assistant (SA) tool to assess the equipment performance; perform basic service to the unit as needed, including coil cleaning and filter changes; check thermostat operation; document a post service efficiency index (EI) greater than 90% as determined by the SA; review results with the consumer; and transmit data to program tracking database. Furthermore, if, after completing all of the applicable corrective actions listed above, a system fails to meet the 90% EI threshold, but does have an efficiency index of at least 85% or achieves an efficiency gain of at least 10% points, it will be eligible for a tune-up incentive, providing the contractor performs the following:

a. Determines and documents the cause(s) for the system's reduced efficiency index.
b. Provides customer with a written explanation of the deficiency and an estimate to correct it.[7]

[7] CACES Participating Contractor Agreement – Attachment B Tune-up process 4/10/2009.

The Quality Installation and Right-Sizing criteria for passing and earning an incentive include: using the SA to document a final efficiency index of greater than 90%; documented use of Manual J procedures and calculations to select the capacity of the equipment. An alternate path to incentives is also provided for equipment installed on deficient existing ductwork:

> *Installations that utilize a home's existing ductwork and fail to achieve an EI of at least 90%, but do achieve an EI of at least 85% after the contractor has performed the air flow corrections/adjustments listed below, will be eligible for a QIV incentive, if the reduced efficiency is related to a deficiency in the system's ducting, provided the contractor provides the customer with a written explanation of the deficiency and an estimate to correct it.*
>
> *Air-flow corrections/adjustments:*
> - *Adjust trunk and branch dampers as required*
> - *Check and adjust supply registers*
> - *Verify proper fan speed (correct if required)*
> - *Ensure that no return vents are blocked or covered*

Additional Quality Installation incentives are earned if the unit installed is SEER 14.0 or better.

1.2 Evaluation Questions

The evaluation sought to answer the following key researchable questions.

Impact Questions:

1. Update gross savings estimates based on field verification of a sample of participants.
2. Estimate net-to-gross ratio based on HVAC contractor interviews.
3. Investigate persistence of optimized HVAC system parameters – efficiency index.
4. Create improved deemed savings estimates and NTG estimates for use in future year DSM plans.

Process questions:

1. What are key barriers to participation for eligible ComEd customers? What are key barriers to participation for eligible independent participating contractors? How can they be addressed by the program?
2. How did customers become aware of the program? How did eligible independent participating contractors become aware of the program? What marketing strategies could be used to boost program awareness and participation, if needed?
3. How efficiently is the program being administered? What methods could be implemented to improve the efficiency of program delivery?

Section 2. Evaluation Methods

For the Diagnostic and Tune-Up Program participants in PY3, the Navigant Consulting team conducted field research to gather data about equipment size, rated efficiency and operating efficiency. For all but run-times, our research was primarily focused on confirming data collected and reported by the trade-allies.

2.1 Analytical Methods

2.1.1 Impact Evaluation Methods

The Diagnostic and Tune-up and Quality Installation programs benefit from two different evaluation approaches with complementary data – engineering assessment and billing analysis.

Diagnostics and Tune Up

Residential air conditioning energy use is typically that of an on/off device. There is some minor unit performance variation, relative to outdoor ambient temperature, and some new and high-efficiency machines have variable airflow and compression controls, but most air conditioners installed in the residential market turn on, use a constant power draw to serve the cooling needs of the home, and then turn off. As such, electric demand can be characterized by:

Rated Unit Efficiency (kW/ capacity) x *in situ* efficiency adjustments x Capacity = Unit kW

Total air conditioning energy use is determined by multiplying unit kW by the hours of operation for a given unit. Hotter and more humid outdoor conditions typically result in longer hours of operation.

Unit kW x hours of operation = annual kWh

In this evaluation, each of these parameters in the equations above was examined and verified. The independent participating contractors recorded rated unit efficiency and capacity based on nameplate data and used the Service Assistant diagnostic tool (required for the program) to determine adjustments to efficiency. The Navigant Consulting team confirmed these data with our own Service Assistant and we analyzed whole-house load research data to estimate air conditioning hours of operation.

Quality Installation

The anticipated savings from the Quality Installation program reflect the effects of two separate features of the program: (1) improved installation techniques that achieve operating efficiency closer to manufacturer specifications, and (2) installation of equipment with rated efficiency

greater than federally mandated minimum standards (currently SEER 13.0). Given the size of the anticipated participant population, the evaluation plan for this program proposed a fixed-effects billing analysis for the participants. Billing analysis is an effective and relatively inexpensive method for estimating savings when the savings are expected to be greater than 5% of the bill. Navigant anticipates savings of this magnitude from proper sizing, refrigerant charge and higher SEER levels if only summer bills are analyzed. The results of the billing analysis will be a reliable estimate of savings for equipment replacement customers and a good comparison number for the estimate of savings for new equipment customers that come from the building simulation method used in the *Energy Efficiency and Demand Response Plan*.

Fixed effects billing analysis, where participants are compared to their own prior usage, has internal controls for consumer behavior and can be normalized to typical weather, the two leading factors when looking at residential air-conditioning energy usage. Of the 1,687 Quality Installation participants in PY3, 1,153 installed equipment during the cooling season of 2010. In order to support the analysis with as many data points as possible, Navigant included all PY3 and PY2 participant installation data and billing records that include the summer of 2008 through the summer of 2011. In most cases, this breadth of data will ensure at least a full year of pre-installation and post-installation data for each participant. A total of 2,399 participants are included in the evaluation. Some sites have more than one unit installed.

Gross Program Savings

For the Diagnostic and Tune Up Program Navigant estimates the gross program savings based on unit-by-unit estimates of demand saving for a census of participants. The estimates are based on unit nameplate information and the efficiency index from the Service Assistant. Energy savings is the product of demand savings and estimated hours of operation by climate zone.

For the Quality Installation program the billing analysis results in energy savings per home per Cooling Degree Day. Gross program savings is the product of participation, savings per CDD and normalized annual CDD.

Net Program Savings

The Navigant Team interviewed independent participating contractors for indications of free-ridership and spillover (net-to-gross- NTG - in combination). Net savings is the produce of gross savings and the NTG factor. Navigant found little indication of free-ridership or spillover within ComEd's service territory.

2.1.2 Process Evaluation Methods

The CACES process evaluation was based on in-depth interviews with key personnel at ComEd and Honeywell Energy Services. The Navigant Team conducted computer assisted telephone interviews (CATI) with independent participating air conditioning contractors and *non*-participating air conditioning contractors to assess program process matters. Finally, consumers

who received service from independent participating contractors were interviewed to examine their experiences with the programs. The Navigant team tabulated the interview results to assess the programs' processes.

2.2 *Data Sources*

For both the Diagnostics and Tune-Up and Quality Installation programs, ComEd provided participation records as part of the Program Tracking Database administered by ComEd and the implementation contractor. The criteria used to determine participation was whether an incentive check was authorized for a particular consumer. This criterion excluded consumers with data in the database that might have been excluded from the program because the service address was not in the ComEd service territory, or they did not meet the program criteria of sufficient performance improvement.

2.2.1 Diagnostics and Tune-Up Data

In addition to tracking program participation metrics, the program tracking database contains key equipment performance data collected by independent participating contractors in the field and uploaded to the FDSI data server. These data include: equipment make and model information, rated capacity and efficiency, plus other equipment and site-related fields. Furthermore, the database includes all pre-implementation and post-implementation performance data generated by the Service Assistant from each of the units serviced that earned program incentives. Thus, the program tracking database is the primary source of program data used in the evaluation.

For forty-three participants, program tracking data were confirmed independently on-site for the evaluation. Given the tight variance with post-service data these sites deliver 90/10 confidence and precision in the sample. Unit operating data were derived from nameplate model numbers and lookups against the Preston's Guide.[8] We also referred to manufacturer literature if model year was not clear from the nameplate information. The efficiency adjustments were estimated with the Service Assistant tool. As in PY2, Navigant estimated equipment runtime by analyzing load research data for almost 2,000 customers covering the 2008 – 2010 calendar years. This source of data was chosen because Navigant and ComEd had reservations about using a smaller sample of end-use metered data during a recessionary period.

2.2.2 Quality Installation Data

The Quality Installation Program participants had similar data in the program tracking database, except that only post-installation data are captured with the Service Assistant.

[8] Preston's Guide 2005 edition. Comprehensive database of air conditioner manufacturer specifications for most equipment sold in North America in the past 40 years. Given the model number and serial numbers Preston's guide provides unit efficiency (SEER) and capacity.

Navigant used these data to characterize the Quality Installation population. In addition , ComEd supplied up to 48 months of billing records through September 2011 for a census of PY2 and PY3 Quality Installation participants. Navigant used these data and weather data from NOAA weather stations (O'Hare, Midway, Rockford and Moline) to set up regression models for energy use. Navigant included the PY2 participants in the regression analysis to increase the sample size and enhance confidence in the results at different levels of segmentation, i.e. dwelling type and installed unit efficiency.

Billing Analysis Data

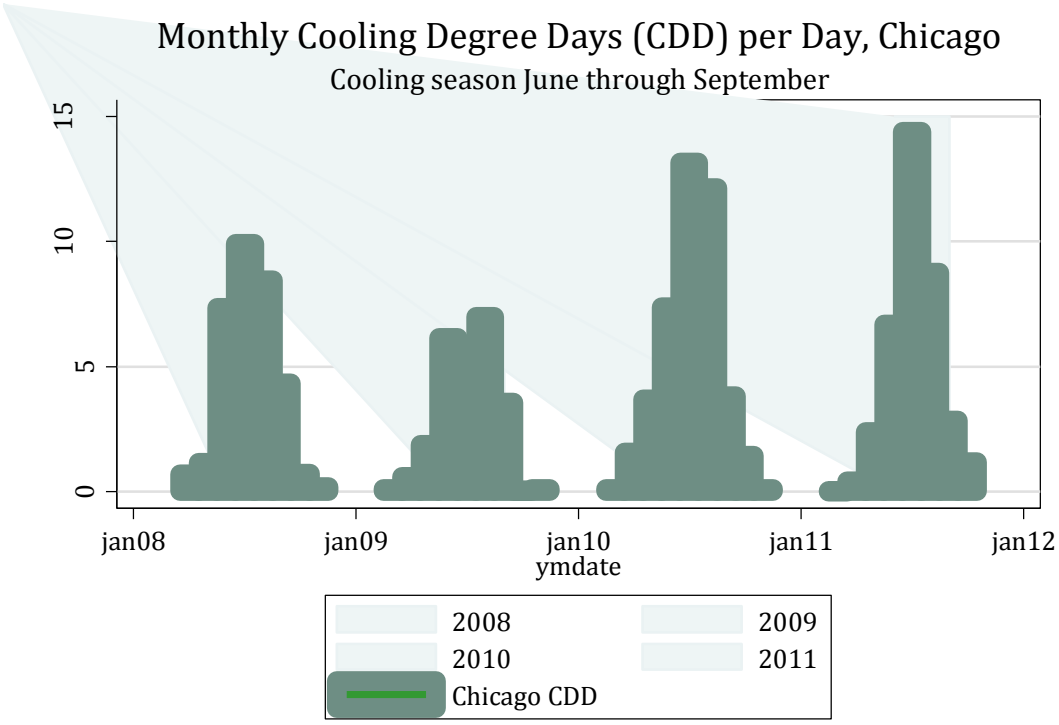
The billing data included 2399 residences with 34,500 summer season billing records. Several criteria for inclusion in the analysis reduced these counts:

- The analysis omitted the billing period in which the AC unit was installed.
- The analysis included only those billing periods for which the cooling degree days per day (CDDd) was at least 5.0. This was done to better isolate the effect of AC efficiency gains. The cooling degree day data are presented in Figure 2-1.
- The analysis excluded all installations for which there was not at least one feasible billing period before installation (i.e., a billing period with CDDd>5.0), and one feasible period after installation.

Because *ex ante* savings are based on dwelling type, Navigant conducted separate regression analyses for single-family attached, single-family detached and multi-family dwellings. After applying the inclusion criteria to the billing data, the combined PY2 and PY3 pre-installation data set of single family residences consists of 2007 residences and 9754 billing record observations, the multi-family data consists of 385 residences and 1713 billing observations. The combined 11,467 observations and 2392 households provide over 4.75 billing record observations per household.

High-SEER equipment was also segmented in the billing analysis. In the analysis of the 2009, 2010, and 2011 cooling seasons, there were 3936 SEER 14+ billing records among 796 residences. Figure 2-1 presents cooling degree days over the study period 2008-2011 at the Chicago O'Hare weather station. While the summer of 2009 was unusually cool, the 2010 cooling season was slightly warmer than long-term averages. In the typical meteorological year, the number of cooling degree days at O'Hare is 816; in the summer of 2009 it was 587. In 2010 the total was 1064 cooling degree days.

Figure 2-1. Daily Cooling Degree Days – Chicago O'Hare Airport 2007 - 2011



Source: http://www.degreeday.net weather station KORD Chicago O'Hare International airport.

2.2.3 Process Evaluation Data

The process evaluation efforts used four main sources of data: interviews with ComEd and Honeywell program staff, telephone surveys with participating customers, telephone surveys with participating trade allies, and interviews with non-participating trade allies. Based on current enrollment of 130 trade allies, more than 270 Service Assistants assigned to technicians and targeting 90/10 confidence and precision, the Navigant Consulting team aimed to survey at least 55 participating contractors and 100 participating customers. Table 2-1 shows the data sources used in the evaluation.

Table 2-1. Data Sources for the Process Evaluation

Data Source	Population Size	Sample Size
In-depth interviews with program staff	4	4
Telephone survey with participating trade allies	276	56
In-depth interviews with non-participating trade allies	n/a	16
Telephone survey with participating customers	Approx. 14,000	100

The evaluation team gathered feedback from contractors participating in the CACES program as well as those that have not participated in the program. We asked participating contractors about installation and tune-up practices both in and outside of the program, the rebates, training, and satisfaction with program processes. We asked non-participating contractors questions regarding their awareness of the program; reasons for not participating; demand for high efficiency equipment among their customers; importance of incentives and rebates to customers; and their company's overall marketing, promotion, technical, and training practices. Although we did not stratify them in the sample, for the purpose of analysis, we grouped trade allies by size, defining small firms as those with less than 10 employees and large firms as those with more than 10.

The team also surveyed customers that have participated in the program. Topics in this survey included program awareness and experience with the contractor, satisfaction with the program and contractor, and barriers to participation.

Section 3. Program Level Results

3.1 Impact Results

In the *Energy Efficiency and Demand Response Plan*, ComEd estimated savings from the Diagnostics and Tune-Up program and the Quality Installation program with eQuest energy simulations of three residential types: multifamily, single-family attached, and single-family detached. The models were run with three weather data sets: Chicago, Rockford, and Moline. Hours of operation will depend on the weather region and interior comfort set points. Key assumptions include pre-service effective equipment efficiency of SEER 8.0 and post service effective efficiency of SEER 10.16.

3.1.1 Verification and Due Diligence

As part of this evaluation, the Navigant Consulting team explored the quality assurance and verification activities currently carried out by program and implementation staff. We compared these activities to industry best practices[9] for similar residential programs to determine:

1. If any key QA and verification activities that should take place are currently not being implemented.
2. If any of the current QA and verification activities are biased (i.e., incorrect sampling that may inadvertently skew results, purposeful sampling that is not defendable, etc.).
3. If any of the current QA and verification activities are overly time-consuming and might be simplified or dropped.

This assessment primarily relied on in-depth interviews with program and implementation staff and documentation of current program processes, where available. In general, Navigant did not find differences from the PY2 Quality Assurance steps.

The remainder of this section includes a summary of key quality assurance and verification activities currently conducted by ComEd's residential air conditioning programs and recommendations for improvement; an overview of data collection activities carried out for this task; and detailed findings on current QA and verification activities by program.

Data for this task were gathered through in-depth interviews with the following program and implementation staff, Table 3-1. An observation of the program's business training[10] and review of related training materials was also used for this task.

[9] See the Best Practices Self Benchmarking Tool developed for the Energy Efficiency Best Practices Project: http://www.eebestpractices.com/benchmarking.asp.

Table 3-1. In-Depth Interviews

Program	Person
Residential HVAC program	ComEd Program Manager
Residential HVAC program	Honeywell Manager

The Due Diligence and Quality assurance review examined four factors: contractor eligibility, customer and equipment eligibility, data verification, and record retention.

Contractor Eligibility

To participate in the program, contractors must attend trainings to become familiar with the program processes. Trainings consist of two parts:

- Technical training – The technical training teaches HVAC contractors the proper installation and tune-up of central air conditioning systems. This includes hands-on training with the Service Assistant diagnostic and verification tool from Field Diagnostics.
- Business training – The contractors' business staff must attend a training to learn about the program and its administrative requirements. The program's incentives are outlined, including their thresholds and tiers. Administrative tasks such as preloading information into the Service Assistant tool, obtaining ARI numbers and uploading customer data onto Honeywell's contractor portal are covered in detail. After attending this training, contractors are sent their log-in information to access the contractor portal which allows them to apply for and receive incentives.

Participating contractors can be located outside of ComEd's service territory as long as they serve ComEd territories. Contractors provide ComEd with the ZIP codes of their served markets, which are used for lead generation.

Assessment: ComEd's procedures for the verification of contractor eligibility ensure that participating contractors are trained in both the technical and administrative aspects of the program and serve relevant geographic markets. No changes are needed in this area.

Customer and Equipment Eligibility

For the contractor to receive an incentive for the installation or tune-up of a system, the customer must be a ComEd residential customer. The web-based Honeywell contractor portal has a "verify" button to verify the customer's meter number when entered. If an address comes

[10] The evaluation team attended the program's Business and Sales Training at Honeywell's offices in Arlington Heights, IL on May 27, 2009. Based on program staff interviews the training has not changed much since initial evaluation observations.

up in the verification window that does not match the account, the contractor should contact Honeywell for support.

The program defines a residential central air conditioning system as one that is ducted and cools more than one space or room.

Assessment: The definitions of eligible customers and equipment are very simple and do not need additional criteria. Allowing the contractor to verify the customer information when inputting their data online should reduce input mistakes and limit non-eligible customers.

Verification of Data by Service Assistant Tool

The program's quality control protocols center on the Service Assistant tool[11] with the assumption that each tool is assigned to one technician. If that technician leaves the company, the replacement employee will attend the program's technical training and be assigned the unassigned Service Assistant tool.

To ensure that each tool (and the assigned contractor) is performing and gathering the data correctly, Honeywell performs a follow-up quality control test. At least one quality control test must be performed per tool before any incentive payments are made to the contractor. Following that, two quality control tests per tool must take place in the first 90 days. After these initial three tests, 10% of jobs are selected and tested.

"Notice of Inspection" forms are left with each customer following a tune-up or installation. This form does not need to be signed by the customer and only informs them that their contractor is participating in a ComEd program and they may be contacted for quality control purposes. Jobs chosen for quality control tests are selected within two weeks of the tune-up or installation. The customer is not required to agree to the quality control test and Honeywell maintains that they will try to accommodate customers' schedules by offering evening and Saturday morning hours. The program staff believes that one out of five customers contacted for the quality control test will agree. The Honeywell quality control staff will continue to contact customers until the required testing numbers are met. When a job is selected, the associated contractor is notified.

Once agreed to by the customer, the quality control test will check the pressure and temperature measurements reported by the contractor. To account for variability in operating conditions, the readings may be within 5% of the reported number. According to the contractor participation agreement, "if actual field conditions do not corroborate conditions indicated on the participating contractor's incentive application, then the participating contractor will have 14 days to correct for any deficiencies, or he/she may become ineligible for the applied for incentive applied for." During the training, Honeywell states that if the readings are different,

[11] The Service Assistant tool is a device manufactured by Field Diagnostics (FDSI) that combines a Palm PDA with sensors to measure the temperature and pressure of an HVAC system.

they will assume the difference is due to a reporting or clerical error and will work with the contractor to identify the problem. If a tool (and associated technician) is consistently off compared to others in the program, Honeywell will share this information with the contractor.

Assessment: The process to verify data by the service assistant tool is adequate for quality control. Contractors cannot receive incentive payments until their first job is reviewed and there is a requirement for multiple reviews during the first three months of participation. Continued random testing helps to ensure that contractors maintain a desired level of quality. The program may consider requiring a higher number of inspections during the first 90 days up to the 10% on-going inspection rate (three inspections per tool in this time period are currently required). This would ensure that technicians new to the use of the tool receive the same ratio of inspections during their learning curve as on-going use. The 10% inspection rate following the initial 90 day period is adequate.

Record Retention Audit

In addition to the field audit, the program also performs a record retention audit to ensure that the correct documentation is maintained and that contractors provide customers with a description of the work required. Auditors review the documentation of the same customers who are audited in the field. Honeywell currently plans to spend one day a week in the contractor offices reviewing paperwork and four days in the field. In both cases, the auditors will work from a defined sample of jobs to be reviewed.

For repairs that would typically be actionable by the service technician, the program requires that contractors provide a price (or, at a minimum, a price range) to the customer. For other services requiring the expertise of an estimator (such as a system replacement), the program accepts written documentation of the identified issues and the recommended course of action, but does not require a cost estimate.

Contractors must retain these documents for a minimum of six months from the date of completion of the service. Failure to produce any of the listed documents will result in a "failed audit." Contractors will have 30 days to correct any problems identified in the audit or may lose the eligibility for incentives. If the office audit reveals deficiencies with the list of documentation, additional work orders will be reviewed. Multiple failures may result in the contractor's removal from the program.

Assessment: The program's record retention audit is comprehensive and ensures that contractors are providing their customers with detailed descriptions of the problems and possible solutions, including price. This also helps the program check discrepancies with their field audits.

Overall, ComEd and its implementer, Honeywell, provide acceptable levels of quality assurance and verification for its residential HVAC programs. The programs seek to ensure that both the contractor and customers are eligible, that the contractor properly uses the Service Assistant

Tool and its related protocols, and that the contractor maintains relevant records of its activities related to the program.

3.1.2 Tracking System Review

The tracking system consists of three tables in a relational database. These tables were mostly organized around customer contact and tracking data (table: RAC_IncentiveFile), unit nameplate data (table: RAC_UnitDataFile), and diagnostic parameters data (table: RAC_CycleDataFile). The database is capable of tracking participation by location (premise ID), by customer (Site ID, ComEd account number and HVAC Unit ID) and by participating contractor (Work order ID and service assistant number). The Premise ID, Site ID, Unit ID and Work order ID are the primary key fields for linking tables together.

Several important milestone dates are tracked in the database:

- New Date – the date a work order is generated through the ComEd system to perform qualifying tune-ups or installations
- Scheduled Date – the date service is scheduled to be performed. The field is not always updated with field changes
- Service Date Completed – the date service is actually performed as updated from field tools.
- Check Date – the date ComEd cuts the incentive check to the service contractor.
- Log time – the date and time the Service Assistant is used to take field measurements.
- RecordInsertTime – the date and time that Service Assistant data are uploaded to the FDSI database. This date is often many days after the field service occurs.

On the advice of ComEd, the evaluation determined participation based on the date that incentive checks were written to contractors for each participant. Due to un-avoidable administrative lag, this date is later than the program year conclusion. For PY3, participants were included in the program population if incentive checks were written prior to June 30, 2011.

The data provided by ComEd and Honeywell were adequate for the evaluation task, though some quality control issues are apparent. A small number (less than 80) of participants had incomplete data with respect to Unit nameplate information and/or matched pairs of pre-service and post-service measurements. These problems did not appear to be systematic, and do not affect the analysis. For PY3 we assume that participants with incomplete data are similar to those with complete data and we apply average per-unit savings estimates to those participants.

Assessment: In general, Navigant Consulting found the database adequate to the evaluation task. We have a one recommendation to facilitate more effective evaluation in the future.

1. Consider including geographic identifiers in the base data. Our impact analysis determined saving by geographic (weather) zone. In order to do this we had to request supplemental data from ComEd to associate participants among weather zones. If a

region field were included in the base database (most appropriately the UnitDataFile table), these associations would be faster.

3.1.3 Gross Program Impact Parameter Estimates

The following sections describe the results of our comparison of observed participant equipment parameters versus the tracking database

Diagnostic and Tune-Up

The key parameters for estimating gross impacts for each consumer are rated efficiency and capacity and *in situ* efficiency adjustments. The Navigant Team examined program data and performed on-site verification of program data for a sample of 45 participants to verify each of these parameters.

Unit Efficiency and Capacity

In the *Commonwealth Edison Company's 2008-2010 Energy Efficiency and Demand Response Plan*, the planners assumed that the efficiency of the equipment that qualified for incentive was SEER 8.0 as operating and the efficiency of the tuned-up units would be SEER 10.16. These values are a combination of the rated efficiency and degradation from the rated efficiency or Efficiency Index (EI) in terminology of the Service Assistant, SA.

Independent participating contractors recorded equipment data for rated efficiency, capacity and other physical unit parameters in their SA for all qualifying customers. Performance data including EI are saved on the SA following successful tests and all participant data are uploaded to a database managed by FDSI. For a sample of participants, the evaluation team performed site inspections, confirmed nameplate information and independently measured EI and other operating parameters with our own SA. We also verified rated capacity and efficiency against the Preston's Guide. Table 3-2 compares the parameters from the evaluation sample to the program participant population as a whole.

Table 3-2. Diagnostic and Tune-Up Efficiency and Capacity Parameters

Average Rated Efficiency	Post-Installation		Program Population
	Contractor Reported	Evaluator Verification	Post-Test
Average Rated Efficiency (SEER)	10.8	11.1	10.86
Average Efficiency Index (EI)	95.7	98.8	98.0
Average Rated Capacity (tons)	2.8	2.8	2.9
N	43	43	14,550

The Evaluation Team concludes that the contractor field estimates are adequate for all of these parameters. Differences are not endemic and can simply reflect minor differences in operating conditions at the time of measurements and/or calibration differences among different tools used.

Figure 3-1 is a histogram of installed rated unit efficiencies recorded among all participants during this evaluation. The figure shows that SEER 10 machines that met recently-superseded minimum efficiency dominate the population. Newer machines that meet the current federal minimum efficiency of SEER 13 have significant market penetration that will grow as older machines are retired[12]. Figure 3-2 shows the distribution of equipment size among program participants. The average machine is 2.87 tons capacity.

[12] Units SEER 10 and less than SEER 10 comprised 56% and 17% of PY2 participants or 73% combined. The same efficiency units comprise 70% of the PY3 participants.

Figure 3-1. Distribution of AC Unit Efficiency among All Participant Consumers

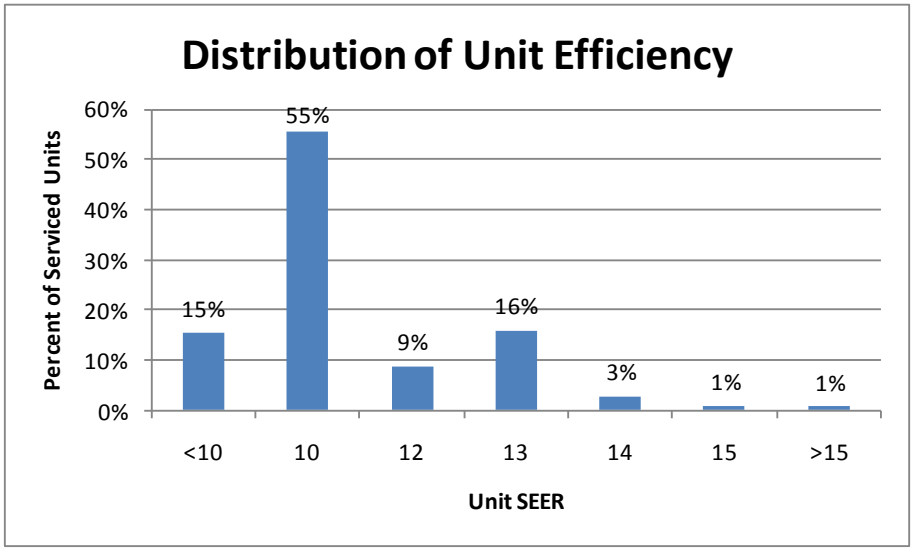
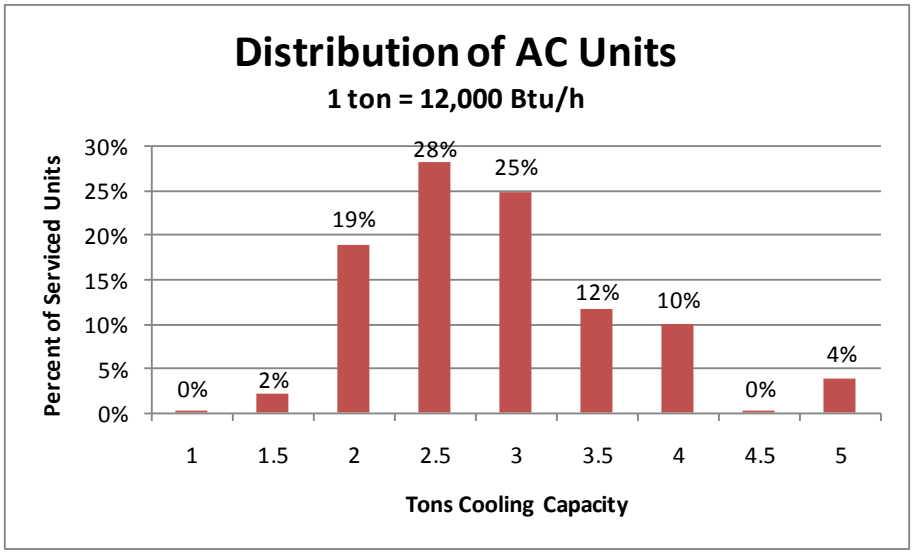


Figure 3-2. Distribution of AC Unit Capacity among All Participant Consumers

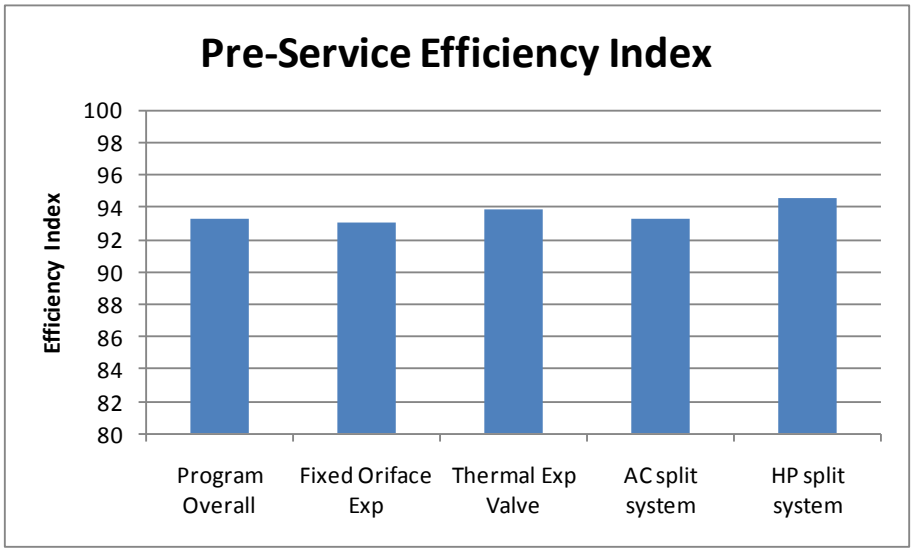


The efficiency index, EI, is the target parameter of the diagnostic program. A quality tune-up will increase the EI from a low value toward a target of 100. In the program planning stages, the assumed efficiency index on units before service was about 80 based on an operating SEER of 8.0 for machines rated at SEER 10.0. Incentives are generally earned for increasing the EI to above 90[13]. Field data on *pre-service* units show an average EI of 93.85. After service the average EI was 98.0. The increase in the EI is significant at the 90/10 confidence and precision level; however, it is not the magnitude expected. Figure 3-3 shows pre-service EIs for different

[13] See Table 1-3 and program incentives discussion.

groupings of participants. Post-service EIs were not different among groups of customers at statistical significance, indicating relatively uniform post tune-up performance among these groups.

Figure 3-3. Pre-Service Efficiency Index – Select participant groupings



Run Hours of Operation

The *Energy Efficiency and Demand Response Plan* based savings estimates on simulations of typical single-family attached and detached homes and multifamily residential units using weather data from the Typical Meteorological Year 2 (TMY2) dataset. The simulations do not explicitly list the run hours of air conditioning equipment, but during training sessions for the Service Assistant, Honeywell and ComEd staff recommended using 742 hours.[14] .

Ideally, measured run-time would be the basis of program runtime estimates. A runtime study for the PY2 CACES Program evaluation yielded uncertain results due to extra-ordinary weather and economic conditions. Similar concerns preceded the PY3 evaluation cycle, thus further end-use monitoring was not implemented. Instead Navigant analyzed a data set of about 2100 residential load research customers for 2008-2010. The analysis had several steps.

1. Each customer's data was examined to determine whether summer daily average consumption was at least 6% higher than individually determined baseline periods[15] as an indication of AC operation.
2. Customers with an indication of AC were further filtered to eliminate those with outlier data, such as total consumption less than 100 kWh per month or anomalously high individual hourly consumption data.

[14] 742 hours is the average of Rockford, Moline and Chicago as provided by an Energy Star Savings Calculator: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls.
[15] Typically in April and May when neither heating nor cooling was expected.

3. Customers were assigned to one of three representative weather stations based on location.
4. Consumption of load research data was pooled by weather station and we performed a linear regression with daily Cooling Degree Days CDDd.
5. Energy use above the baseline was assumed to be cooling related, and cooling energy was converted to hours of use per customer using average unit efficiency and size from the prior analysis.
6. Runtime estimates were normalized to TMY2 data for an entire cooling season.

Table 3-3. Weather Normalized Run-Time Hours Estimated with Load Research Data

Weather Station	Single Family[a]	Multi-Family
Chicago	561 hours	500 hours
Rockford	519 hours	474 hours
Moline	620 hours	610 hours

[a] *load research data did not distinguish between single-family attached and detached dwelling types.*

Quality Installation

Table 3-4 provides billing analysis estimates of seasonal savings under the QI program for single family dwellings. Results shown are weather-normalized to NOAA 1981-2010 Climate Normals data(Typical Meteorological Year). Participants for SEER 13 units installed at single family detached residences saved an estimated 387 kWh, weather-normalized (5% of seasonal total). Participants for SEER 13 units installed at multi family residences saved an estimated 339 kWh, weather-normalized (12.5% of seasonal total). SEER 14+ units save somewhat more energy among each housing segment, as we would expect. Tables 3-4, 3-5 and 3-5 show the billing analysis results for single family detached, single-family attached and multi-family, respectively.

Table 3-4. Predicted Cooling Season[15] Energy Savings per Single Family Detached Residence

	TMY
Predicted baseline (KWh)	7804
SEER 13 Savings (KWh)	387
Percent savings	4.96%
90% Confidence Interval Low (KWh)	304
90% Confidence Interval High (KWh)	470
SEER 14+ Savings (KWh)	600
Percent savings	7.69%
90% Confidence Interval Low (KWh)	429
90% Confidence Interval High (KWh)	602

Table 3-5. Predicted Cooling Season[16] Energy Savings per Single Family Attached Residence

	TMY
Predicted baseline (KWh)	5189
SEER 13 Savings (KWh)	279
Percent savings	5.38%
90% Confidence Interval Low (KWh)	126
90% Confidence Interval High (KWh)	432
SEER 14+ Savings (KWh)	513
Percent savings	9.89%
90% Confidence Interval Low (KWh)	157
90% Confidence Interval High (KWh)	563

Among multi-family participants the percent savings are high because baseline consumption is relatively lower.

[16] Season is defined as May 15 through September 15

Table 3-6. Predicted Cooling Season[15] Energy Savings per Multi-Family Residence

	TMY
Predicted baseline (KWh)	2720
SEER 13 Savings (KWh)	339
Percent savings	12.46%
90% Confidence Interval Low (KWh)	225
90% Confidence Interval High (KWh)	453
SEER 14+ Savings (KWh)	604
Percent savings	22.21%
90% Confidence Interval Low (KWh)	264
90% Confidence Interval High (KWh)	717

Results are attended by three important caveats:

Overall, the total number of records is 11,467, and the number of post-installation records is 6,297, which is an average of more than 2.6 post-installation records per residence.

Finally, there exists the possibility that estimates are confounded by exogenous temporally-correlated factors, in particular, the economic recession that began in December 2007 and persists. This creates possibly serious estimation issues and could be resolved in subsequent analyses by including in the data billing records for residential customers who *did not* install a new AC unit.

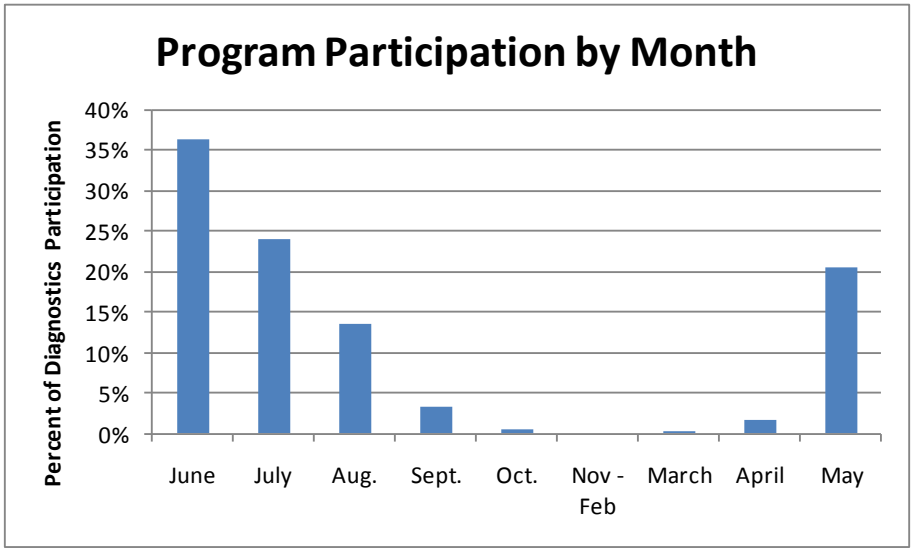
3.1.4 Gross Program Impact Results

Diagnostic and Tune-Up

Navigant Consulting reviewed the participation data from the tracking system, and we determined that there were 14,550 documented participants in the database. The criteria for participation were a check date prior to June 30, 2011 and an incentive paid greater than $10. The late June cut-off date extends beyond the program year which ended on May 31, 2011. The extra time permitted ComEd to fully process payments for units serviced prior to May 31, 2011. The incentive threshold eliminated a few test records that had carried through the database.

Figure 3-4 shows program participation by month. Note again that the program year is June 2010 through May 2011. About 22% of program participation is attributed to the spring, usually the busiest season for tune-up work. Furthermore, the number of Service Assistants in the field grows with contractor participation. April and May 2011 are, therefore, also the months with the *greatest capacity* to perform tune-ups.

Figure 3-4. Diagnostics Program Participation by Month



Savings from the tune-up program are the result of improved effective efficiency of the equipment and equipment run-hours. For each participant, we used inputs for equipment capacity, unit EER[17], pre-service and post-service efficiency adjustments to estimate unit power savings. Energy savings is the product of average unit power savings[18] and runtime. Normalized run hours were determined with the most appropriate of the three weather stations for each participant.

Table 3-7 presents planned savings for each segment compared to the evaluated savings estimates for the three residential segments, averaged among all three weather stations. Savings among all market segments is lower than the plan estimates because that equipment was in better shape than anticipated.

Table 3-7. Average Diagnostic and Tune-up Savings for Different Customer Types

	Planned *(Ex Ante)* kWh/participant	*Ex Post* kWh/participant
Multi-Family	68	76
Single Family Attached	99	89
Single-Family Detached	106	106

[17] Residential air-conditioners are generally rated in SEER (Seasonal Energy Efficiency Ratio) which accounts for operating conditions both during the most oppressive outdoor heat and during more typical non-peak demands. Unit demand savings is a function of EER which is the efficiency at peak only. Navigant applied correlations (California Energy Commission 2005) of unit SEER and EER to determine EER values given rated SEER.
[18] SEER values are used to calculate seasonal average power savings.

Table 3-8. Customer Participation by Building Type

	Participation
Multi-Family	1,325
Single Family Attached	1,857
Single-Family Detached	11,368

Table 3-9. *Ex Post* Program Savings – Diagnostic & Tune-Up

	PY3 Goal	PY3 *Ex Ante* Saving	Evaluated PY3 Gross	Realization Rate
Participants (#customers)	29,450	14,550	14,550	100%
Energy Savings (MWh)	6,067	1,479 *	1,476	99.8%
Demand Savings (MW)	NA	NA	1.99	NA

** Ex Ante adjusted gross after applying a realization rate.*

Per participant *ex ante* demand and energy savings were adjusted downward based on the PY2 evaluation and they remain low for the program – roughly equaling the PY2 numbers. PY3 per participant savings remain low as a result of better baseline performance of customer AC units (average SEER 10.1 performing in the field) than anticipated in the program plan (SEER 8.0). Lower power savings is the main factor in lower energy savings

Quality Installation

Navigant Consulting reviewed the participation data from the tracking system, and we determined that there were 1,687 documented complete PY3 participants in the database. Among those PY3 participants, more than 95% had sufficient data to perform a billing analysis to determine energy savings when we include billing records through September 2011.

Table 3-10 presents planned savings for each segment compared to the evaluated savings estimates for three residential segments and the two types of Quality Installation criteria. All segments but High SEER single-family detached participants have a realization rate greater than 100%, but that one segment comprises 30% of all participants.

Table 3-10. Average Quality Installation kWh Savings for Different Customer Types

	Plan kWh	Evaluated kWh	Realization Rate
Quality Installation SEER 13			
Multi-Family	63	339	538%
Single attached	180	279	155%
Single detached	312	387	124%
Quality Installation SEER 14+			
Multi-Family	154	604	392%
Single attached	428	513	120%
Single detached	754	600	80%

Table 3-11. PY3 Quality Installation Customer Participation

	SEER 13 Participants	SEER 14+ Participants	Total Participants
Multi-Family	212	23	235
Single-Family Attached	134	58	192
Single-Family Detached	748	512	1260
Total	1094	593	1687

Table 3-12. Ex Post Program Savings – Quality Installation

	PY3 Goal	PY3 *Ex Ante*	Evaluated PY3 Gross	Realization Rate
Participants (#customers)	1550	1687	1687	100%
Energy Savings (MWh)	649	685	750	109.4%
Demand Savings (MW)	NA	NA	1.01	NA

3.1.5 Net Program Impact Results

The Evaluation Team conducted 55 interviews with independent participating contractors to learn about current and prior maintenance and installation practices. Feedback from the contractors during the in-depth interviews qualitatively addresses the NTG issues:
The following findings indicate contractors were not inclined to use a tool like the Service Assistant prior to the program.

- A common contractor complaint was that the Service Assistant protocol took longer than prior practices. A few noted performing fewer tune ups per day.
- The cost of the Service Assistant is a significant barrier to using an integrated tool such as the Service Assistant.

Contractors indicated that their scope of rigor applied to installations and service increased above baseline practices:

- Questions about prior service and installation practices show that the program has changed contractor practices for the better. Manual J was used by fewer than 50% of contractors prior to participating in the program, duct sealing is much more widely done and with more diligence compared to prior practices.
- None of the contractors interviewed were using similar diagnostic tools in the field prior to the program.
- Comments made during training sessions attended by the evaluators also tend to support the opinion that the contractors gained diagnostic knowledge and ability through the program that could be applied in the field.

Feedback such as these comments from contractors leads the Evaluation Team to conclude that a NTG ratio of 1.0 is appropriate at this time. The PY4 evaluation will include questions for quantification of the NTG ratio.

Furthermore, there are indications of some market transformation. Many contractor are using the service assistant in their tune-up and installation business outside of the ComEd service territory, and they are using the more rigorous practices required by CACES such as Manual J and duct sealing outside of the ComEd service territory

Interviews with customers do allude to some free-ridership potential. Fifty-seven percent of participating customers decided to install a high-efficiency central air conditioning system before selecting their contractor. Before finding the contractor, participants believed installing a high-efficiency air conditioning system instead of a standard efficiency system was important and rate this importance with a mean of 7.9 on a scale of 0 to 10. However, since customers do not receive a direct financial incentive, their attitudes are not subject to free-ridership attribution.

3.2 *Process Evaluation Results*

The process evaluation of the CACES program focuses on the following researchable questions:

1. What are key barriers to participation for eligible ComEd customers? What are key barriers to participation for eligible independent participating contractors? How can they be addressed by the program?
2. How did customers become aware of the program? How did eligible independent participating contractors become aware of the program? What marketing strategies could be used to boost program awareness and participation, if needed?
3. How efficiently is the program being administered? What methods could be implemented to improve the efficiency of program delivery?

We based satisfaction ratings on a scale of 0 to 10, with 0 meaning "very dissatisfied" and 10 meaning "very satisfied." We grouped responses with ratings of 0 to 3 as "dissatisfied," ratings of 4 to 6 as "neutral," and ratings of 7 to 10 as "satisfied."

3.2.1 Process Themes

There are many themes to explore during a process evaluation. Because of the number of contacts we needed to determine themes of inquiry prior to fielding the survey. The themes we explored included: air conditioning installation and service practices, program administration and barriers to program participation

3.2.2 Program Processes

Installation Practices

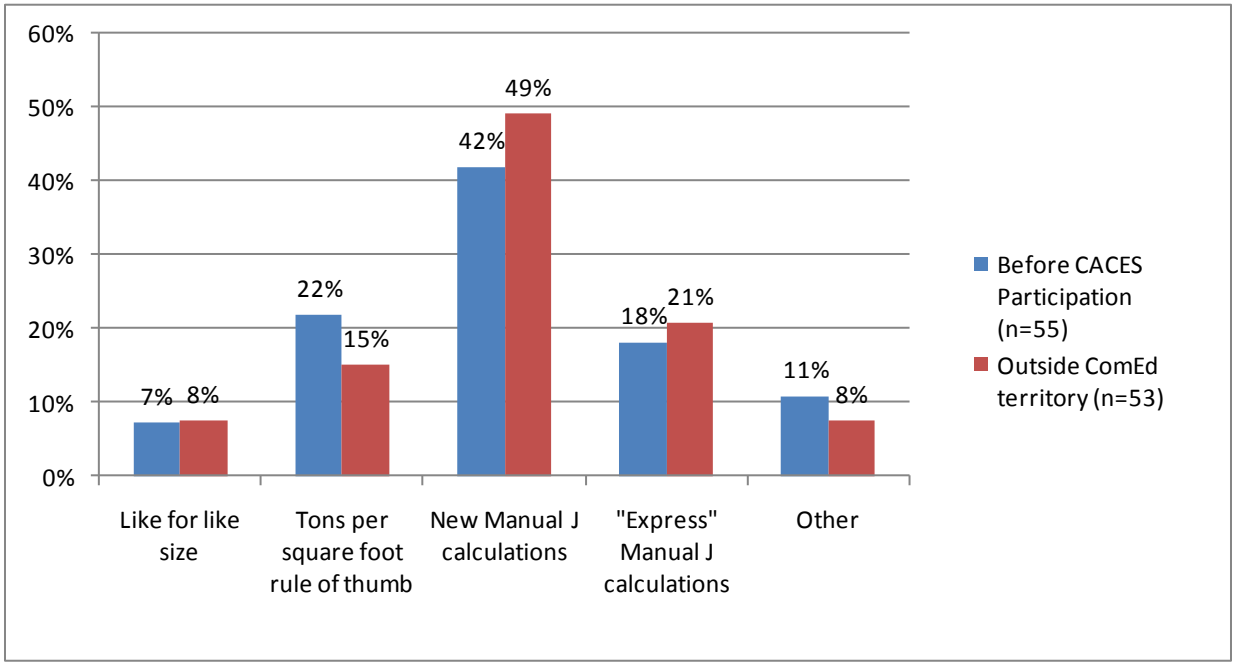
The evaluation team asked contractors participating in the CACES program to identify their current and past A/C system installation practices, including sizing, duct sealing, and air balancing.

As shown in the figure below, before participating in ComEd's CACES program, more than half of contractors used either a full (42%) or express (18%) Manual J calculation. The remaining contractors typically used a less effective method such as replacing the existing unit with the same size or using a "tons per square foot" rule of thumb. To participate in the program and earn the incentive, the contractor must adhere to ComEd's Quality Installation and Right-Sizing criteria, which includes documented use of Manual J procedures and calculations to select the capacity of the equipment. Assuming that participating contractors meet this requirement, the new systems installed by nearly half of the contractors will be sized more accurately than without the program.

Contractors also indicate that they currently use the Manual J software in 70% of installations performed outside of ComEd's service territory. While this is an improvement over baseline

practices, and while the less effective methods are used less frequently, this means that contractors may still not use Manual J if it is not required. Notably, before participating, a greater share of small contractors (49%) than large contractors (30%) report that they used full Manual J calculations to size new equipment.

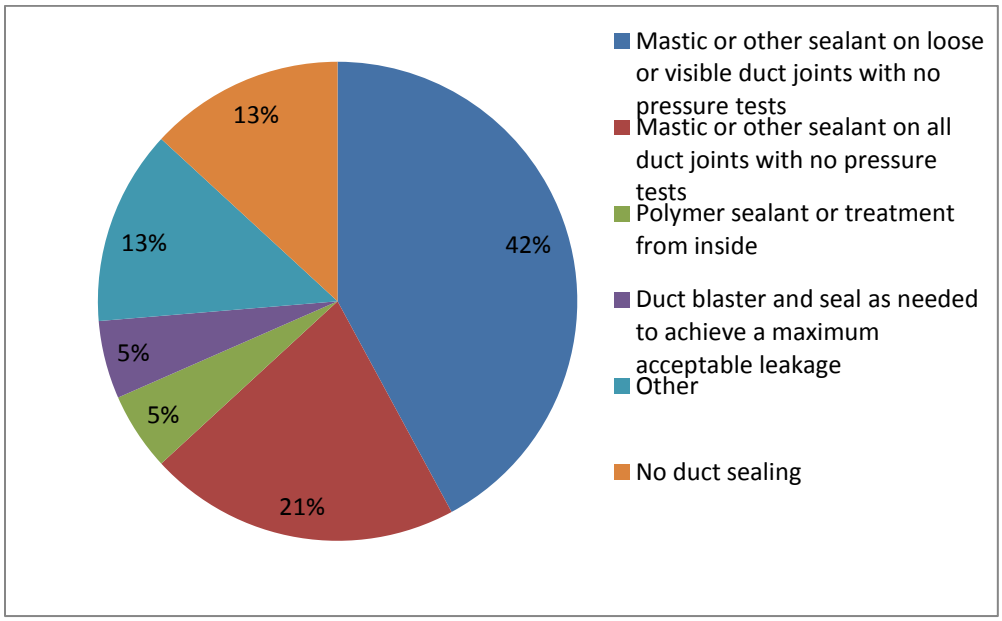
Figure 3-5. Sizing Techniques Used Prior to Participation and Outside of ComEd Service Territory



Of the non-participating contractors interviewed, most use some level of calculations to size equipment for new construction and replacement systems. Almost half use Manual J (seven out of sixteen contractors interviewed indicate that they use either full detailed or express Manual J calculations). Of the contractors who take measurements but do not use Manual J (four of the contractors interviewed), some have their own general calculations they have developed over time, which incorporate measurements such as square footage, exterior walls, insulation, and number of windows. One contractor specifically mentioned that he submits measurements to the distributor for them to do calculations to size the system.

Nearly half (42%) of participating contractors identify their primary duct sealing method as using mastic or another sealant on loose or visible joints with no pressure tests. An additional 21% use mastic or another sealant on all joints with no pressure tests. Five of the 38 respondents (13%) report that they do not do any duct sealing.

Figure 3-6. Current Duct Sealing Practices (n=38)*

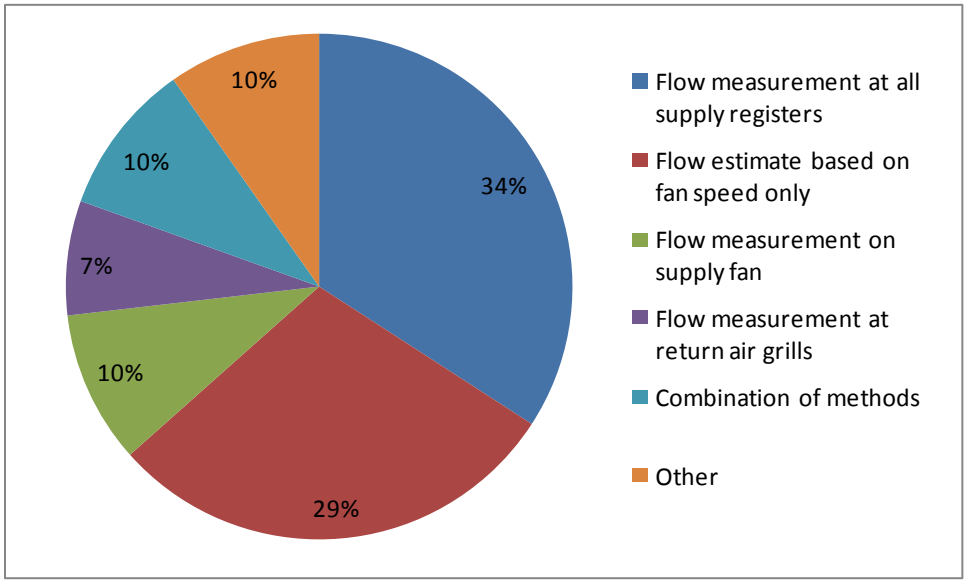


**Excluding "Don't Know" responses*

Sixteen percent of contractors say duct-sealing practices have changed since their participation in the program. Nearly all of these report increasing the amount of duct sealing they do rather than changing the type of sealing. The vast majority (88%) of respondents indicate that their duct sealing practices are the same inside ComEd's service territory and in other areas, while 2% report they are different.

Contractors most often describe their current practices for air balancing as either flow measurement at all supply registers (34%) or flow estimate based on fan speed only (21%). Ten percent describe their method as a combination of two or more of the methods in Figure 3-7

Figure 3-7. Current Air Balancing Practices (n=41)



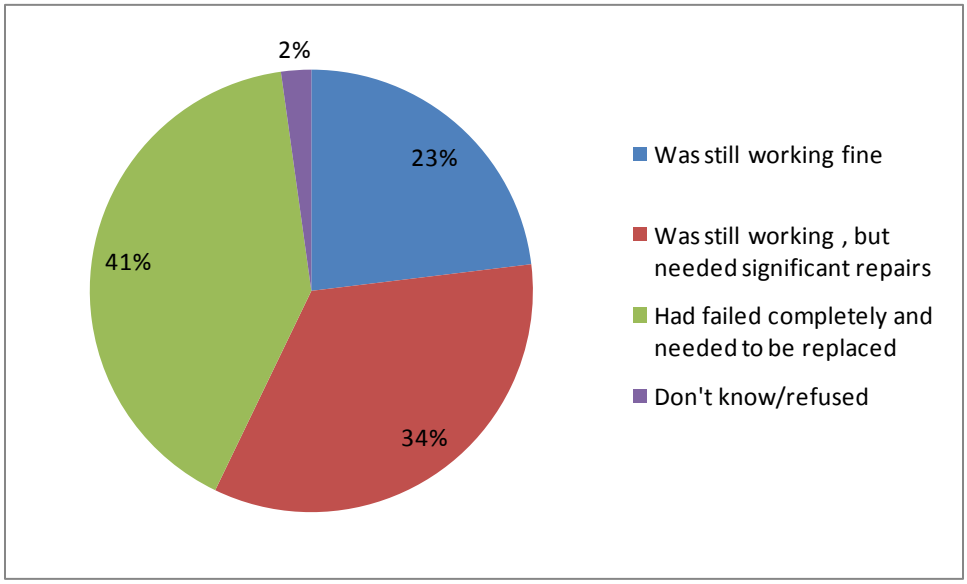
Only 13% of respondents changed their air balancing practices since participating in ComEd's CACES program. As with the duct sealing practices, contractors report that the primary change in practice is being aware of the need for air balancing and performing it more often. Virtually all (95%) of respondents use the same air balancing practices inside and outside of ComEd's service territory.

More than half of the non-participating contractors interviewed do duct sealing. Among these contractors, the most mentioned methods were mastic or other sealant on loose or visible duct joints with no pressure tests or mastic or other sealant on all duct joints with no pressure tests. Similarly, more than half of non-participating contractors interviewed currently do air balancing, and most do so through flow measurement at the supply fan, supply registers, return air grills, and flow estimates based on fan speed.

Operating Condition of Replaced Systems

Nearly all (91%) of participating customers indicate that their new central air conditioning system or heat pump replaced an existing central A/C system (89%) or heat pump (2%). Of those, 75% report that the replaced system either had failed completely and needed to be replaced (41%) or was still working but needed significant repairs (34%). Twenty-three percent of respondents that replaced an existing system report that they retired their unit early. The CACES program may consider offering an incentive for early retirements due to the additional energy savings typical of these replacements.

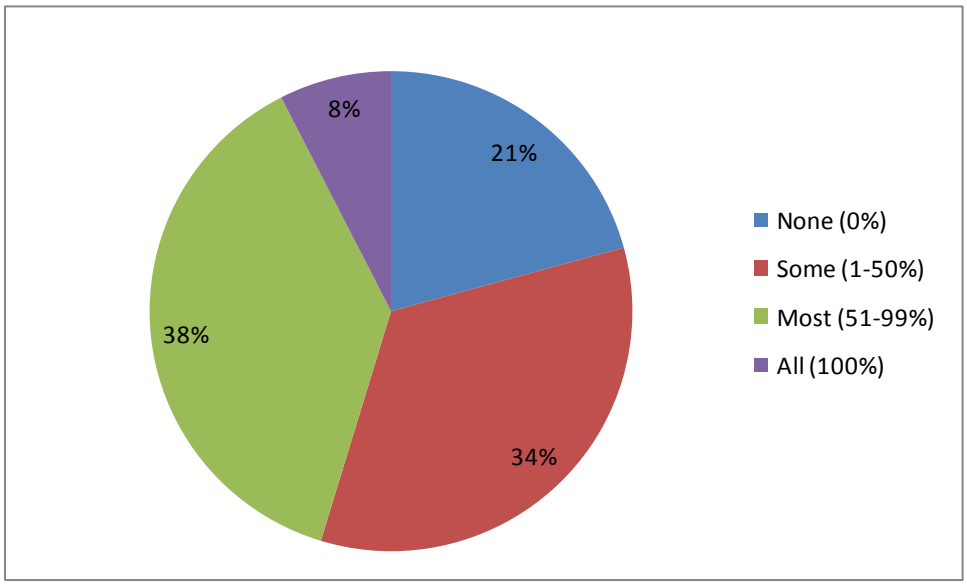
Figure 3-8. Operating Condition of Replaced Central A/C Systems



Installation Rebates

Figure 3-9 shows the share of contractors' installations of central A/C systems and heat pumps that submitted an application for rebate through the ComEd CACES program. On average, contractors report that they submit applications for a rebate on 45% of their applicable installations. Small companies (with less than 10 employees) are more likely to submit a rebate than large companies (50% compared to 33%, respectively). Although this difference is noticeable, it is not statistically significant. Interestingly, 21% of contractors report that they did not submit a rebate application for any of their 2010 projects (PY3), meaning that they only participated in the tune up portion of the program.

Figure 3-9. Share of Contractors' Central A/C and Heat Pump Installations Receiving Rebate through CACES Program (n=52)



Of the participating customers that installed high efficiency units (14 SEER or higher), 65% also received the federal tax credit.

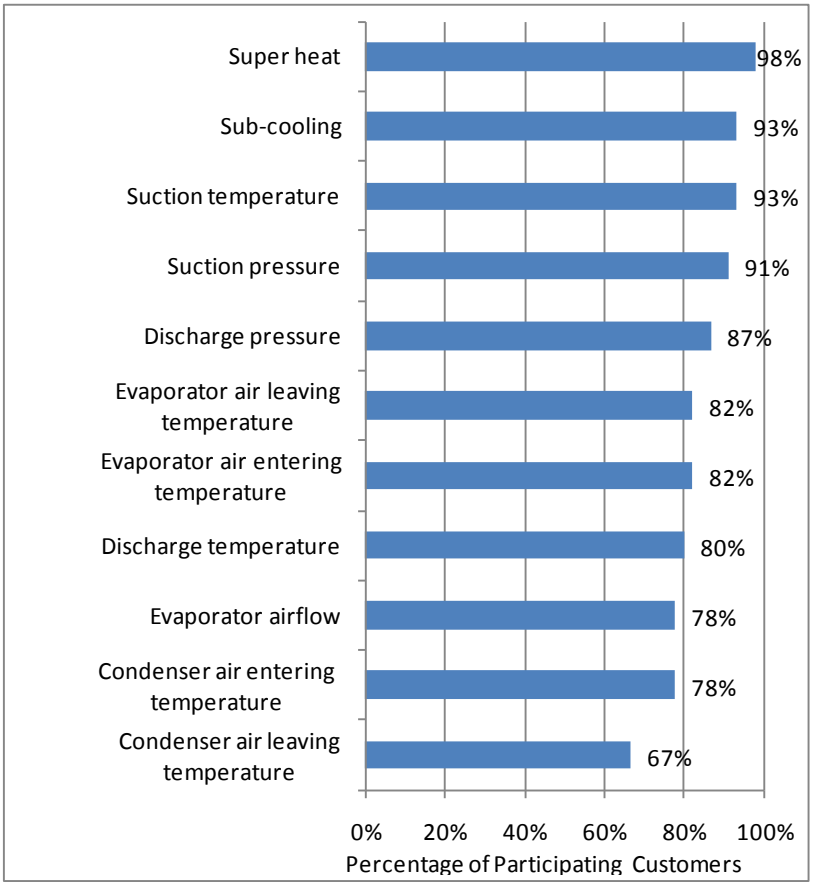
In addition to changing the installation practices of contractors, the program touches on other parts of contractors' business. Most noteworthy is that 63% of contractors use the Service Assistant Tool for central A/C installations performed outside of ComEd's service territory, with 45% of participating contractors reporting that they use it for a majority (over 90%) of the installations outside of the service territory.

Participating contractors state that very few, if any, of their installation jobs are referred through the program. Forty-eight percent of contractors claim that they received no referrals and 41% claim that they received between only 1% and 10% of their jobs through the program.

Tune-Up Practices

Figure 3-10 shows the parameters typically measured during a tune-up. The large majority of participating contractors measure most parameters. The most commonly measured parameters are super heat, sub-cooling, suction temperature, and suction pressure, as over 90% of respondents identify each of these parameters. Condenser air leaving temperature is the least commonly measured parameter, identified by only 67% of respondents.

Figure 3-10. Parameters Typically Measured During Tune-Up (Multiple Response) (n=45)

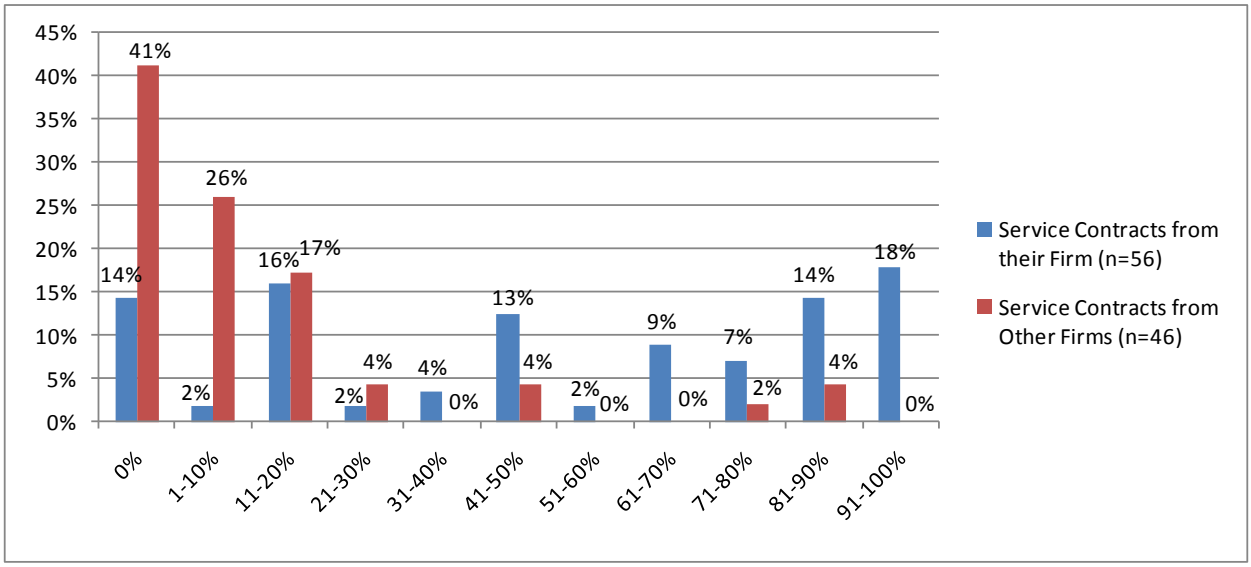


In general, contractors believe that the number of tune-ups their company performs would be the same if the program did not exist. Eighty-four percent of respondents state that the number of tune-ups would be about the same, while 13% say the number would be lower and 4% say the number would be higher. Respondents who report that there would be no difference in the number of tune-ups performed if the program did not exist claim that either the majority of their tune-up work is from existing service agreements or that ComEd does not provide them with referrals to increase their number of tune-ups. Contractors cite that that the reasons for the increase in tune-ups are 1) because the program includes the ability to offer a discount due to the rebate, 2) because of the perceived accuracy of the tool, and 3) because of the use of the ComEd name. The contractors who believe the program reduces the number of tune-ups performed say that it is due to the extra time and effort required of each tune-up.

Fifty-seven percent of participating contractors use the Service Assistant Tool for tune-ups performed outside of ComEd's service territory. Of the contractors that did use the tool in other areas, 38% (21% of contractors overall) use it on virtually all (91-100%) of tune-ups and another 38% use it only rarely (on 1-10% of tune-ups). The primary reasons for not using the tool in non-ComEd areas are the time and hassle required to use the tool and the lack of tools assigned to

technicians in those areas. Virtually all (95%) of participating contractors charge the same price for a tune-up that uses the Service Assistant Tool as one that does not.
On average, contractors report that more than half (54%) of the tune-up work they perform is on equipment with existing annual or biennial service contracts with their firm. An average of 14% of tune-ups is on equipment that appears to have received annual or biennial service from other firms. Figure 3-11 shows the share of tune-ups from existing service contracts.

Figure 3-11. Share of Tune-Ups from Existing Service Contracts



Nearly three-quarters (73%) of participating customers report that they had their previous central air conditioning system regularly tuned up prior to installing their new equipment. Not unexpectedly, respondents in the highest income stratum (household income of $100,000 or more) are significantly more likely to have regularly tuned up their previous equipment than those with lower income levels. Although a large share of customers state that they regularly serviced their central air conditioning equipment, only 45% report that these tune-ups were part of an annual or biennial service plan. Although only half of participants (50%) currently have an annual or biennial service plan for their new central air conditioning system, this is a notable increase from the 32% of customers that had their equipment tuned up as part of a service plan before participating.

Similar to equipment installations, the vast majority of tune-ups are not referred to the contractor by ComEd: 40% of contractors report that they receive no tune-up referrals from ComEd, while 56% state that only 1 to 10% of tune-ups are referred through the program.

Program Requirements

In general, participation requirements were not overly burdensome for contractors. However, nearly half of respondents report some trouble using the online contractor portal. Users most

often indicate that the portal is difficult to figure out, did not work with every system, and had errors. Other issues include the account numbers not matching properly, problems accessing information, problems with registration and setup, and the general amount of time required for the data entry.

Table 3-13 Difficulties of Contractors Meeting Program Requirements

Requirement	Share Reporting Difficulty
Using the online contractor portal	43%
Purchasing the Service Assistant Tool	13%
Attending the program's trainings	9%

The primary issues reported regarding purchasing the Service Assistant Tool revolve around its expense for contractors. Those contractors identifying trouble with the training requirement state that the sessions are inconvenient to attend and are too far away. Most contractors were able to overcome the issues they had with the requirements with help from Honeywell staff or by receiving general technical support from ComEd.

Reasons for Non-Participation

Only half of the non-participating contractors interviewed were aware of the program, and half (among both aware and unaware respondents) expressed an interest in participating in the program in the future. Some of these contractors said they had tried to contact ComEd about the program and participation but were unable to get information or actually sign up for the program.

While most non-participating contractors did not participate due to lack of awareness, the program requirements did limit some. Several non-participating contractors stated that they would be more likely to participate in the program if the cost of the equipment required to participate was lower (closer to $1,000-$1,200). Another non-participating contractor claimed that he would be more likely to participate if he could do so during downtimes so that enrollment and training in the program would not detract so much from paying work during peak times of the year.

Non-participating contractors who were aware of the program indicated that their reasons for not participating primarily include the high initial cost of the equipment, lack of information available or difficulty of enrollment, or a perception of little potential benefit for their company or customers.

Marketing & Outreach

More than half (57%) of participating contractors first learned about the program through a vendor or distributor. Other common methods include being contacted by Honeywell and through friends/colleagues/word of mouth.

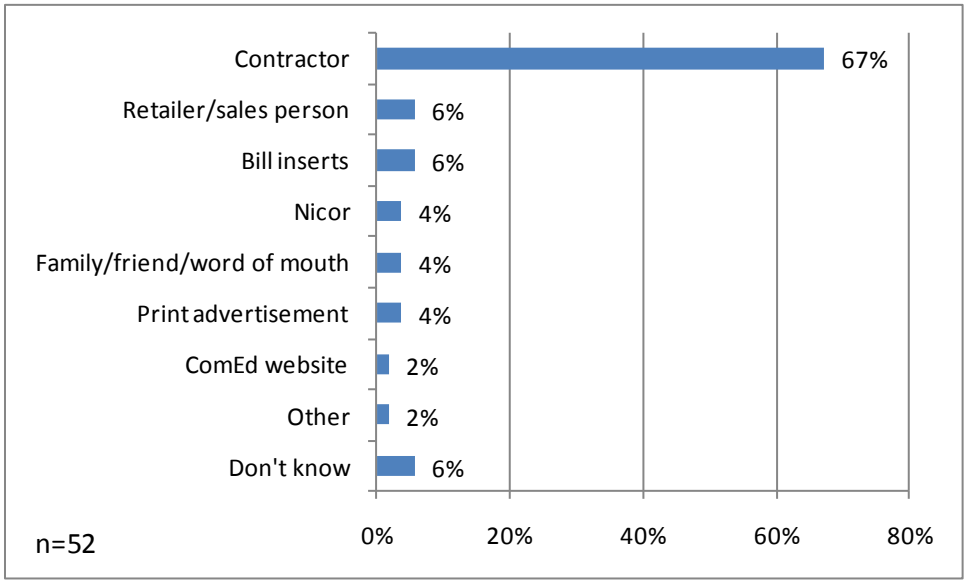
Overall, non-participating contractors indicated that their customers are not aware of the program (the majority indicated "not at all aware" while several indicated "somewhat or not very aware"), and as such, almost no customers actually ask them about the program. In contrast, customers are relatively aware of the Federal Tax credits and oftentimes ask the contractor about the requirements to receive the credits.

When promoting the program to customers, 52% of contractors use marketing tools or support offered by the program or by ComEd. Contractors who use the Service Assistant Tool on tune-ups and installations outside of the ComEd territory are significantly more likely to use ComEd materials, as they have embraced the program more. The most common marketing tools or support from ComEd that contractors used in PY3 were flyers, vehicle stickers/magnets, and the directory on the ComEd website, with brochures and bill inserts used less. Forty-five percent of contractors rate ComEd's marketing materials as useful (7 or greater on a 0 to 10 point scale) in providing information about the program to potential customers. Contractors suggest providing more detailed information about the program, including where to get additional information, as a way of making the materials more useful.

Most non-participating contractors do promote high-efficiency equipment to their customers, at the very least by explaining to customers the advantages of high-efficiency systems. Key selling points they emphasize include cost savings on their monthly bills, rebates and incentives, and energy conservation. Specific marketing measures that some contractors have taken to promote high-efficiency equipment include sending out brochures and flyers, some of which include coupons for discounts on high-efficiency equipment, posting information on their own company websites, and directing customers to some of the distributors' websites for information and education on specific systems.

Approximately half (52%) of respondents state that they were aware of their contractor's participation in the ComEd CACES program when their equipment was installed. Two-thirds of those (35% of total respondents) first learned about the program from their contractor. An additional 15% (8% of total) learned about the program through marketing or advertisements from their utility (either ComEd or Nicor). Of the participants that did not first learn about the ComEd CACES program from their contractor, 35% of participants report that their contractor explained the details of the program.

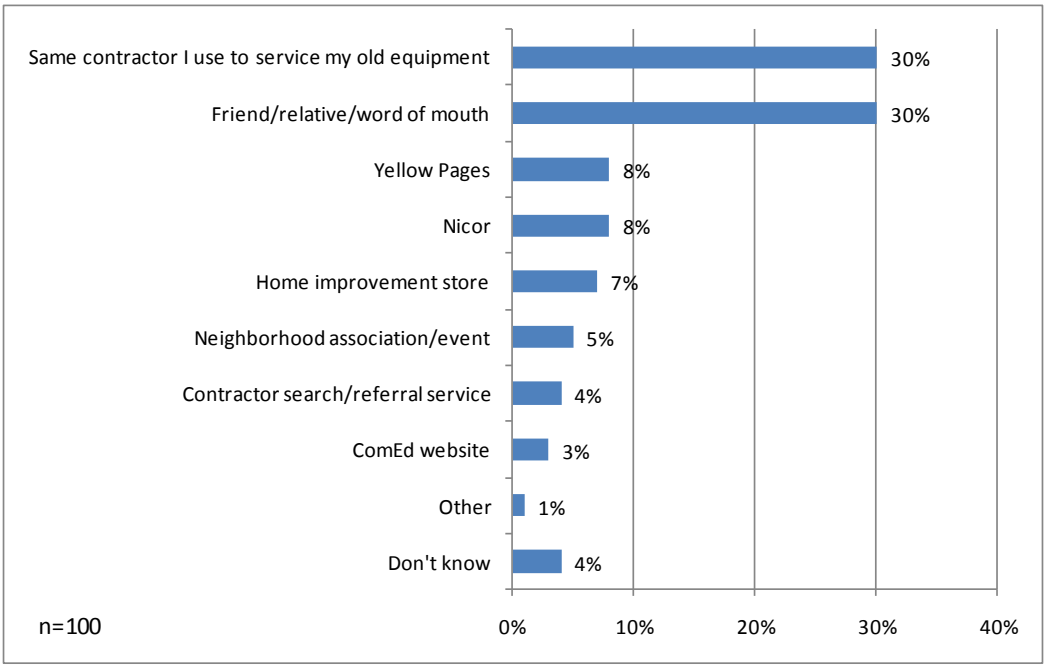
Figure 3-12. How Participants *First* Learned about the ComEd CACES Program



Customers place low importance in their contactor's participation in the CACES program. When asked to rate this importance on a scale of 0 to 10, with 0 meaning not at all important and 10 meaning extremely important, participating customers give a mean rating of 5.1. One quarter of respondents rate the importance as 0, not at all important.

The low level of importance given to contractors' participation in the program is primarily due to the CACES program's focus on contractors as well as how customers find their contractor. As shown in Figure 3-13. , more than half of participants (60%) found their contractor either through past experience or through friend and family. Given these sources, it is unlikely that the contractor's program participation would be a deciding factor.

Figure 3-13. Sources of Finding Contractor



About half (48%) of participating customers contacted more than one contractor, and a significantly smaller share of the participants that installed high-efficiency equipment (SEER 14+) contacted more than one contractor than those that installed lower efficiency systems. This suggests that customers installing lower efficiency systems may be more price sensitive and possibly shopped around for the lowest price. Among all respondents, the most cited reasons for selecting their contractor included previous experience (27% of respondents), cost effectiveness (16%), quality of work (10%), and knowledge about the products/services involved (10%).

Of those participating customers that installed high efficiency (14 SEER or greater) central A/C systems, 88% report that they were aware of the benefits of installing high-efficiency central air conditioning equipment compared to regular efficiency equipment. Respondents identified newspapers or magazines (35%) and their contractor or sales person (26%) as where they first learned about these benefits. In addition to those participants that first learned from contractors, 89% state that their contractor also discussed the benefits of installing high-efficiency air conditioning equipment.

Eighty percent of participating customers report that they were aware of the benefits of the proper sizing and installation of central air conditioning equipment. Notably, the share of respondents with homes less than 2,000 square feet is significantly larger than the share of those with larger homes (97% vs. 75%). The most commonly cited sources of information about these benefits include contractors (35%), friends and relatives (10%), and non-print media (10%).

Contractors overwhelmingly prefer email as the way to learn about energy efficiency programs such as ComEd's CACES program, as shown in Table 3-14. This is true for both large and small companies. However, preferences of other methods differ by the size of the contractor. A significantly larger share of small contractors prefers to learn about energy efficient programs from their distributors, and small firms also favor flyers, ads and mailings. Large contractors are more likely to prefer gathering information from ComEd's website. ComEd may consider these preferences when tailoring marketing and outreach to contractors of different sizes.

Table 3-14. Contractors' Preferred Methods of Learning about Energy Efficiency Programs

Requirement	Total (n=56)	Large (n=21)	Small (n=35)
Email	73%	86%	66%
Distributors/wholesalers	23%	5%	34%*
Flyers/ads/mailings	18%	14%	20%
ComEd website	16%	24%	11%
Telephone	11%	5%	14%
Trade magazines	9%	--	14%
Professional colleagues	4%	--	6%
Trade/professional organizations	2%	5%	--

**Significantly greater than large contractors*

Contractors believe that they are influential in their customers' selection of a high-efficiency central A/C system over a standard efficiency system. On a scale of 0 to 10, with 0 meaning not at all influential and 10 meaning extremely influential, 68% of contractors rate their level of influence as 7 or greater. This is in line with the program's design and expectation of the contractor as the primary driver of the program.

Contractors generally believe that their affiliation with the CACES program is not of high importance to customers. Using a scale of 0 to 10, 69% of contractors rate the importance to the customer that their contractor is affiliated with the program as neutral or not important (a rating of 6 or lower).

According to contractors, the primary reason customers install high efficiency HVAC equipment is to save money on energy bills (identified by 66% of contractors). The principal

reason they do not install this equipment (identified by 96% of contractors) is due to its high cost. Similarly, participating customers most often (77%) cite high cost as the mean reason why some homeowners install standard efficiency central A/C systems instead of high efficiency systems.

Importance of Incentives and Reasonable Incentive Level

Almost all non-participating contractors interviewed indicated that incentives are very important in their customer's decision-making process when buying new HVAC equipment. Some noted that they had seen an increase in demand for high-efficiency equipment when the Federal Tax credits were available and noticed a decline in demand once the rebates were reduced. Several contractors also explained that while incentives tend to be especially important to lower income customers, they could also have a negative effect if the incentive is offered in the form of a rebate or tax credit. Customers that have a limited amount to spend on the initial purchase of equipment sometimes cannot afford to make the upfront purchase and wait for the payback, and therefore will buy standard equipment rather than upgrading to high efficiency equipment.

Non-participating contractors estimated that a reasonable rebate/incentive level to influence customers to purchase high-efficiency equipment rather than standard equipment would be in the range of $500 to $1,000 (as a general starting point depending on the requirements). However, based on their experiences with the Federal Tax credits available, a few contractors had seen that even a $1,000-$1,500 rebate/incentive was not enough to influence some customers. Of the customers that installed high efficiency units (14 SEER or higher), 65% received the federal tax credit, indicating that, while most customers take advantage of available rebates and credits, a sizeable share do not.

One non-participating contractor described that the cost savings for furnaces make the decision to purchase high efficiency equipment easy, which they communicate to their customers. However, the key selling points for A/C units tend to be more difficult because the energy and cost savings are not as obvious, and specifically in the Chicago area, where most customers do not use A/C for enough of the year to make it worthwhile. Oftentimes he sees the main reasons for customers to buy efficient A/C units is because of non-energy benefits (e.g., they are quieter, better at de-humidifying, and better for customers with allergies).

Installations and Demand for High-Efficiency Equipment

Participating contractors report a general increase in their number of total installations from 2009 to 2010. On average, contractors increased their total installations by about 40% as the economy recovered from its low in 2009. In that time, the average share of high efficiency systems (14+ SEER) installed increased from 24% to 34% for participating contractors.

In comparison, the total volume of HVAC equipment (high-efficiency and standard equipment) installed by non-participating contractors has been relatively stable over the last few years, although some contractors indicated that the total number of installations they have done have declined since the recession started. These contractors indicated that customers are more inclined to make their systems last as long as possible, preferring to make repairs to their existing systems rather than replacing them.

The difference in increase in volume between contractors participating in the program and those that do not is notable and may be related to their participation in the CACES program and the promotion of high-efficiency equipment. However, other factors, such as size of the firms and customer bases, may also influence these differences.

Most non-participating contractors indicated that the demand for high-efficiency equipment has also consistently increased over time, due to customers wanting to save on their energy bill as well as incentives and rebates available (particularly the Federal Tax credits). However, similar to overall installations, some contractors indicated that the demand for high-efficiency equipment has also declined in the last several years with the economic conditions. For example, one contractor said that before the downturn, when customers needed to install a new system, they typically wanted to upgrade to a higher-efficiency system, but are now more content with a 13 SEER system, or trying to fix what they have, so they have lower up-front costs. Another reason given for the slight decline in high-efficiency equipment more recently (in 2011), is possibly due to the decline in the availability of tax credits.

However, some non-participating contractors provided other reasons they feel demand for high-efficiency equipment has increased. One contractor indicated that while people are holding on to what they have as long as possible because of the economy, once they do need to replace something, they seem to be tending more towards high-efficiency equipment because of the available rebates and incentives and ultimately cost savings in the long run. Another contractor indicated that the increase in demand may also be related to the real estate market, in that with houses not selling or being "flipped" as quickly, owners tend to be focusing more on long-term solutions and consequently installing higher-end units to increase their return on investment.

Training

Virtually all responding participating contractors (93%) report attending the technical training offered by ComEd. Because this is a requirement of the program, it is likely that the few respondents who did not report attending the training had colleagues who did attend outside of the respondents' knowledge. Of the technical training attendees, more than half (56%) report that the training changed their standard operating procedures for central A/C tune-ups and installations. When asked specifically how the training changed their practices, the most commonly reported changes included the general use of the Service Assistant tool, gathering better and more accurate information, and performing more testing. The technical training did

not cause contractors to increase their promotion and installation of high-efficiency A/C systems, however, as only 23% claim an increase in marketing the program following the training.

Overall, contractor satisfaction with the technical training is high, as 66% rate their satisfaction at 7 or greater on a scale of 0 to 10. Contractors provide a mean rating of 7.3. Contractors offering low (0-3) ratings state that their dissatisfaction is driven by the program not increasing their technical knowledge to their expectations.
Most non-participating contractors indicated that they do attend professional training sessions on a regular basis; however, some attend more frequently than others. Distributors and manufacturers of HVAC equipment conducted the majority of the training sessions mentioned by contractors. Some contractors specifically named Carrier as one distributor who conducts a wide variety of training sessions.

Contractor Satisfaction

As shown in Table 3-15, participating contractors indicate high overall satisfaction with the program, as 70% provide a rating of 7 or greater on a scale of 0 to 10, with a mean rating of 6.8. Respondents also report that they are very satisfied with Honeywell (73%). Large shares of contractors also give high satisfaction ratings to both the tune-up (68%) and quality installation (67%) requirements of the program.

Table 3-15. Contractor Satisfaction with Select Elements of ComEd's CACES Program (0=Not at all satisfied, 10=Extremely satisfied)

Program Element	Satisfied (7-10)	Neutral (4-6)	Dissatisfied (0-3)	Mean
ComEd CACES program overall (n=56)	70%	16%	14%	6.8
The program implementer (Honeywell) (n=56)	73%	13%	14%	7.3
Tune-up requirements (n=56)	68%	25%	7%	7.0
Quality installation requirements (n=54)	67%	33%	--	7.4
Training received (technical and business) (n=55)	64%	31%	5%	7.1
Data entry process, including contractor portal (n=56)	61%	27%	13%	6.6
Incentive process (n=56)	55%	25%	20%	6.3
Wait time to receive rebate (n=55)	53%	35%	13%	6.4

Contractors give lower satisfaction ratings to the incentive process and the wait time to receive the rebate. For most elements of the program, the large majority of contractors who are not satisfied (giving a rating under 7) with the wait time of the program give a neutral rating (4 to 6) instead of a low satisfaction rating (0 to 3). The outlier of this pattern is contractors' satisfaction with the incentive process. This includes uploading data from the Service Assistant Tool and using the Contractor Portal, for which 25% provide a neutral rating and 20% provide a dissatisfied rating of 0 to 3, suggesting that this may be an area of improvement for ComEd. There are no significant differences between large and small contractor firms for all satisfaction questions.

We asked contractors providing a satisfaction rating of less than 5 for their satisfaction with the overall ComEd CACES program to explain their reasoning for the low rating. Among the 10

contractors who provide a low overall rating, reasons for dissatisfaction include the incentive not being cost effective, the tool or portal not working properly, and poor communication from the program.

Additionally, 36% of contractors report experiencing a problem while participating in the program. Of those, nearly half had a technical problem with the Service Assistant Tool.

Customer Satisfaction

Overall, participating customers express high satisfaction with the ComEd CACES program, on a scale of 0 to 10, with 0 meaning very dissatisfied and 10 meaning extremely satisfied, participants provide a mean overall satisfaction rating of 8.0. One quarter of participants rate their satisfaction as a 10, or extremely satisfied. Participants providing the lowest satisfaction ratings state that they did so because they did not fully understand the benefits of the program or because the program did not directly benefit them.

Table 3-16. Customer Satisfaction with Elements of ComEd's CACES Program (0=Not at all satisfied, 10=Extremely satisfied)

Program Element	Satisfied (7-10)	Neutral (4-6)	Dissatisfied (0-3)	Mean
CACES program overall* (n=49)	80%	20%	--	8.0
Work quality of the installation (n=99)	98%	1=%	1%	9.3
The installed central A/C system (n=98)	97%	2%	1%	9.2
The contractor who installed the system (n=99)	94%	3%	3%	8.9

**Customers familiar with the CACES program*

Participants also give very high satisfaction ratings to other elements of the program, including the work quality of the installation (mean of 9.3), the installed equipment (9.2), and the contractor who installed their central air conditioning system (8.9).

Benefits and Drawbacks

Contractors identify a number of benefits to participating in the program. Many cite the Service Assistant Tool as the primary benefit. Contractors find that the tool helps them test systems

more consistently and accurately and show the results to customers, increasing their perceived value and making their job easier. Other benefits include leveraging the ComEd name and advertising to increasing income and the number of customers.

The most commonly cited drawbacks to participating in the CACES program are that it is time consuming, the cost of the equipment is high, the paperwork and training are too burdensome, and the incentives are not high enough to be worth the effort of participation.

One quarter (25%) of contractors report experiencing an issue that prevented them from promoting or implementing the CACES program as expected. The most commonly cited issues are needing additional time to complete the tune-up and the tool not working properly. Notably, 25% of respondents state that there are no drawbacks to participation.

Despite the drawbacks and issues reported, nearly all contractors (88%) plan to continue participating in the program again in the future (should the program continue to be offered).

3.3 Cost Effectiveness Review

This section addresses the cost effectiveness of the CACES program. Cost effectiveness is assessed through the use of the Illinois Total Resource Cost (TRC) test. The Illinois TRC test is defined in the Illinois Power Agency Act SB1592 as follows:

> *Total resource cost test' or 'TRC test' means a standard that is met if, for an investment in energy efficiency or demand-response measures, the benefit-cost ratio is greater than one. The benefit-cost ratio is the ratio of the net present value of the total benefits of the program to the net present value of the total costs as calculated over the lifetime of the measures. A total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures, to the sum of all incremental costs of end-use measures that are implemented due to the program (including both utility and participant contributions), plus costs to administer, deliver, and evaluate each demand-side program, to quantify the net savings obtained by substituting the demand-side program for supply resources. In calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases.*[19]

ComEd uses DSMore™ software for the calculation of the Illinois TRC test.[20] The DSMore model accepts information on program parameters such as number of participants, gross savings, free ridership, program costs and CO_2 reductions. It then calculates a TRC that fits the requirements of the Illinois Legislation.

[19] Illinois Power Agency Act SB1592, pages 7-8.
[20] Demand Side Management Option Risk Evaluator (DSMore) software is developed by Integral Analytics.

One important feature of the DSMore model is that it performs a probabilistic estimation of future avoided energy costs. It looks at the historical relationship between weather, electric use and prices in the PJM Northern Illinois region and forecasts a range of potential future electric energy prices. The range of future prices is correlated to the range of weather conditions that could occur, and the range of weather is based on weather patterns seen over the historical record. This method captures the impact that extreme weather has on electricity prices. Extreme weather generally results in electricity price spikes and creates a skewed price distribution. High prices are going to be much higher than the average price while low prices are going to be only moderately lower than the average. DSMore is able to quantify the weighted benefits of avoiding energy use across years which have this skewed price distribution.

Results

Table 3-17 summarizes the unique inputs used in the DSMore model to assess the TRC ratio for the CACES program in PY3. Most of the unique inputs come directly from the evaluation results presented previously in this report. Measure life estimates and program costs come directly from ComEd. All other inputs to the model, such as avoided costs, come from ComEd and are the same for this program and all programs in the ComEd portfolio.

Table 3-17. Inputs to DSMore Model for CACES Program

Item	Value Used
Measure Life	15
Utility Administration and Implementation Costs	$1,043,560
Utility Incentive Costs	$1,073,874
Net Participant Costs	$0

Based on these inputs, the Illinois societal TRC for this program is 0.52 and the program does not pass the Illinois TRC test.

Section 4. Conclusions and Recommendations

The CACES Program has completed its second full year of operation. While it has fostered some good results as far as the delivery of quality HVAC services, there are still challenges to achieve anticipated savings. Participation goals and subsequent savings goal have been scaled back from the original 3-year plan. Even these revisions are proving a challenge to attain.

4.1 Program Impacts Conclusions and Recommendations

The Diagnostic and Tune Up program is not achieving program goals. This is primarily a function of not meeting participation goals that were raised following PY2. Savings per site remains relatively low compared to planning estimates. The primary drivers for the Diagnostics and Tune up Program impact results are (1) improvement potential in unit efficiency and (2) the hours of equipment operation. The Quality Installation program met its revised goals, but these are very modest among the large potential customer base.

For both years of operation the program consistently enrolls consumers with equipment that is operating relatively well. Average efficiency indices, EI, above 92 (100 = rated performance) do not leave much room for improvement. Even after this issue was flagged during the summer of 2010, the program mostly continued to serve customers with well performing equipment. Spring 2011 participants had an average efficiency index of more than 94. Part of the cause of high initial EI is attributed to many of the serviced equipment received annual or biennial service. More than 70% of PY3 participants also participated in PY2. Analysis of their test data shows that a 1 year service interval tends to maintain fairly high performance year-to-year. It may also be that economic conditions lead owners of more distressed machines to postpone service so the program has not had a chance to benefit the most needy equipment.

> ***Recommendation.*** Consider targeting the program to equipment that does not receive annual service. Perhaps pay a premium incentive for participants with poor initial EI or basing the incentive on EI improvement. Conversely, consider limiting incentives for annually serviced equipment.

The challenge for improving program impacts is finding the customers that will benefit the most from the program. This may entail more outreach directly to customers rather than contractors, but there must also be a value proposition for the customers. Some program dissatisfaction among customers is that they do not get an incentive directly.

> ***Recommendation.*** Consider marketing the program to consumers with tips to determining if their equipment operates poorly – ice on suction lines, dirty condensers, poor air flow, inadequately cool supply air, for example.

Runtime hours are also affecting realization rates for both programs. Our second year of analyzing load research data leads Navigant to conclude that initial runtime estimates were over-estimated. Residential air-conditioning use is not as predictable as commercial space cooling. Homes are vacant and un-conditioned during hours of peak cooling loads. Individuals have control over thermostats and on/off switches to control cooling.

> ***Recommendation.*** Consider conducting more research into the hours of operation question. Use a broader and larger sample or sample from among load research customers to more accurately mine load research data for AC operation.

4.2 Program Processes Conclusions and Recommendations

The process evaluation revealed that the Program, as designed and delivered, is accomplishing some significant results.

- Contractors are embracing more rigorous testing, service techniques and equipment sizing.
- Improved service is spilling over into areas outside of the ComEd service territory, hinting at some market transformation.
- Customers and participating contractors are satisfied with the program overall.
- Non-participating contractors are still interested in the program, though they are less convinced in the value to their company

Nonetheless, there are still areas for improvement. Participating contractors would like to see more referrals from ComEd – increasing the value of participating and enhancing the visibility of the participating contractors.

> ***Recommendation.*** Consider marketing the program more aggressively to consumers with a more prominent referral service for participating independent contractors.

There are still some problems cited with timely incentive payment. Complaints about problems with uploading data may allude to database problems or inadequate training.

> ***Recommendation.*** Consider offering brief refresher courses just prior to the beginning of spring tune up season.

Section 5. Appendices

5.1 Data Collection Instruments

ComEd CACES Program Participant Survey

Draft 5/11/2011

This is a phone survey that will target customers that installed a new central air conditioning system as part of the ComEd CACES program in Late Summer/Fall 2010 and Early Spring 2011. The goal of the survey is to understand participant awareness of the program and to identify areas of improvement. The survey will also capture persistence of the installed measures, awareness of the energy efficiency and overall satisfaction with the ComEd CACES Program.

Introduction

Hi, May I please speak with (NAME FROM DATABASE)?

My name is ____ and I'm calling from Opinion Dynamics on behalf of ComEd. According to our records you recently installed a high efficiency central air conditioning system. We're talking to ComEd customers who recently installed new equipment as part of ComEd's Central Air Conditioning Efficiency Services program. The information you provide will help ComEd better understand how the program may be improved. The questions that I have will only take about 15 minutes and your responses will be kept anonymous.

Were you involved in the decision to purchase your new air conditioning system?

(CONTINUE WITH CORRECT CONTACT)

Verification

V1. Just to verify, our records show that you recently installed a new central air conditioning system or heat pump. Is this correct?

1. Yes
2. No
98. (Don't know)
99. (Refused)

[IF V1 <> 1, THANK AND TERMINATE,]

[ASK IF V1=1]
V2a. Is the central air conditioning system or heat pump you installed still in use?

1. Yes
2. No

98. (Don't know)
99. (Refused)

[ASK IF V2a=2, then terminate]
V2b. Why is it not in use?
1. (Under repair)
2. (Being replaced)
3. (Still waiting to receive)
00. (Other, specify)
98. (Don't know)
99. (Refused)

V3. Did this new central air conditioning system or heat pump replace an existing central air conditioning system or heat pump or is it new?
1. It replaced an existing central A/C system
2. It replaced an existing heat pump
3. It is new and I did not have central A/C before
4. It is new for a new home.
98. (Don't know)
99. (Refused)

[ASK IF V3=1 or 2]
V4. When it was replaced, would you say your previous central A/C system or heat pump… (Read List)
1. Was still working fine
2. Was still working, but needed significant repairs
3. Had failed completely and needed to be replaced
98. (Don't know)
99. (Refused)

QFT1. Did you receive a tax credit from the government for the high efficiency central A/C system or heat pump you installed?
1. Yes
2. No
8. (Don't know)
9. (Refused)

For the rest of my questions, I will be referring to your central air conditioning system or heat pump as your central A/C system or equipment.

Program Awareness and Experience with Contractor

Contractors that participate in ComEd's Central A/C program are trained to install new air conditioning systems using advanced diagnostic tools in accordance with industry standards to properly size and install the air conditioning system. This process is called "Quality Installation."

A1. Were you aware that your contractor was participating in the ComEd Central A/C program when you had your equipment installed?

1. Yes
2. No
3. (Don't know)
4. (Refused)

[ASK IF A1=1]
A2. How did you learn about the ComEd Central A/C program?

1. (Contractor)
2. (Bill inserts)
3. (ComEd Web site)
4. (Family/friends/word-of-mouth)
00. (Other, specify)
98. (Don't know)
99. (Refused)

[ASK IF A1=1]
A3. On a scale of 0 to 10, where 0 is not at all important and 10 is extremely important, how important was your contractors' participation in the ComEd Central A/C program in your decision to choose a contractor?

[RECORD RATING 0-10]
98. (Don't know)
99. (Refused)

A4. Where did you find your contractor?

1. (ComEd website)
2. (Friend/relative/neighbor/word of mouth)
3. (Contractor search/referral service)
4. (Yellow pages)
5. (Same contractor I use to service my old equipment)
00. (Other, specify)
98. (Don't know)
99. (Refused)

A5. Before you installed the air conditioning system, did you contact more than one contractor?

1. Yes
2. No
98. (Don't know)
99. (Refused)

A6. What was the MAIN reason for selecting the contractor you hired?

1. (Cost effectiveness/least expensive)
2. (Positive references/highly recommended)
3. (Hired contractor before)

4. (Family/friend recommended)
5. (Participation in ComEd program for Quality Installation)
0. (Other, please specify)
98. (Don't know)
99. (Refused)

[skip if A2=contractor]
A7. Did your contractor explain to you the details of the ComEd Central A/C program?
1. Yes
2. No
3. (Don't know)
4. (Refused)

A8. Prior to the installation of your central A/C equipment, were you aware of the benefits of installing high efficiency central air conditioning equipment compared to regular efficiency equipment?
1. Yes
2. No
3. (Don't know)
4. (Refused)

A9. How did you <u>first</u> learn about the benefits of installing high efficiency central air conditioning equipment?
1. (Contractor/Sales Person)
2. (ComEd website)
3. (ComEd newsletter)
4. (ComEd bill insert)
5. (Friend/relative/neighbor/word of mouth)
6. (Newspapers/magazines/print)
7. (Do not know of the benefits of installing high efficiency A/C equipment)
00. (Other, specify)
98. (Don't know)
99. (Refused)

[SKIP IF A9=1]
A10. Did your contractor also talk to you about the benefits of installing high efficiency air conditioning equipment?
1. Yes
2. No
98. (Don't know)
99. (Refused)

A11. Prior to the installation of your central A/C equipment, were you aware of the benefits of the proper sizing and installation of central air conditioning equipment?
1. Yes
2. No
3. (Don't know)

4. (Refused)

[ASK IF A11=1]
A12. How did you first learn about the benefits of the proper sizing and installation of central air conditioning equipment?

1. (Contractor/Sales Person)
2. (ComEd website)
3. (ComEd newsletter)
4. (ComEd bill insert)
5. (Friend/relative/neighbor/word of mouth)
6. (Newspapers/magazines/print)
00. (Other, specify)
98. (Don't know)
99. (Refused)

[SKIP IF A12=1]
A13. Did your contractor also talk to you about the benefits of properly sizing and installing central air conditioning equipment?

1. Yes
2. No
98. (Don't know)
99. (Refused)

[ASK IF V3 =1 OR 2]
AS1. Prior to installing your new central A/C equipment, did you have your previous central A/C system regularly tuned up or serviced?

1. Yes
2. No
3. (No, did not have central AC previously.)
98. (Don't know)
99. (Refused)

[ASK IF AS1=1]
AS1b. Were these tune ups part of an annual service plan?

1. Yes
2. No
3. (Yes, but it was a biannual service plan)
98. (Don't know)
99. (Refused)

AS2. Do you currently have an annual service plan to tune up or service your new central A/C system?

1. Yes
2. (Yes, but service plan is every two years instead of annually)
3. No
98. (Don't know)

99. (Refused)

Program and Contractor Satisfaction

[ASK IF A1=1, ELSE SKIP TO CS1a]
PS1. On a scale of 0 to 10 where 0 is extremely dissatisfied and 10 is extremely satisfied, how satisfied are you with the ComEd Central A/C program overall?
[RECORD RATING 0-10]
98. (Don't know)
99. (Refused)

[IF PS1=98,99, SKIP TO CS1a]
PS1a. Why did you give it that rating?
00. (OPEN END)
98. (Don't know)
99. (Refused)

CS1a. On a scale of 0 to 10, where 0 is extremely dissatisfied and 10 is extremely satisfied, how would you rate your satisfaction with the contractor who installed your air conditioning system?
[RECORD RATING 0-10]
98. (Don't know)
99. (Refused)

[ASK IF CS1a<4]
CS1b. Why do you give it that rating?
00. (OPEN END)
98. (Don't know)
99. (Refused)

CS2. On a scale of 0 to 10 where 0 is extremely dissatisfied and 10 is extremely satisfied, how would you rate your satisfaction with the contractor on: [RECORD 0-10, 98=DK, 99=Refused)
a. The central air conditioning system that was installed
b. Work quality of the installation

[ASK IF CS2a<4]
CS3a. Why do you give your central air conditioning system that rating?
00. (OPEN END)
98. (Don't know)
99. (Refused)

[ASK IF CS2b<4]
CS3b. Why do you give the quality of the installation that rating?
00. (OPEN END)
98. (Don't know)

99. (Refused)

Free Ridership Questions

[ASK IF HE Flag=1 and A8=1]
FR1. Did you decide to install a **high efficiency** central A/C system before or after you selected a contractor?

1. Before selecting contractor
2. After selecting contractor
98. (Don't know)
99. (Refused)

[ASK IF HE Flag=1 and A8=1]
FR2. Before you found your contractor, how important was it to you install a high efficiency air conditioning system instead of a standard efficiency air conditioning system? Please use a scale that ranges from 0 to 10 where 0 indicates not at all important and 10 indicates extremely important.
[RECORD 0-10; 98=Don't Know; 99=Refused]

Barriers

B1. What do you think are the main reasons why some home owners install a standard efficiency air conditioning system instead of a high efficiency air conditioning system?
[MULTIPLE RESPONSE: SELECT UP TO 3]

1. (Cost is too high)
2. (Not aware of where to get information)
3. (Not aware of types energy efficiency equipment)
3. (Not aware of the savings possible from high efficiency equipment)
4. (Existing system not in need of replacement)
00. (Other, specify)
98. (Don't know)
99. (Refused)

Demographics

I just have a few demographic questions left. This information will be used for analytical purposes only, and will be kept anonymous.

D1. What type of residence do you live in? (READ CATEGORIES)

1. Single-family
2. Duplex or two-family
3. Apartment/condo in a 2-4 unit building
4. Apartment/condo in a >4 unit building
5. Townhouse or row house (adjacent walls to another house)
6. Mobile home, house trailer
7. (Other, please specify)
98. (Don't know)
99. (Refused)

D2. What is the approximate square footage of your home?

[NUMERIC OPEN END]
99998. (Don't Know)

D3. Including yourself, how many people currently live in your home year round?

[RECORD NUMBER PEOPLE]
98 (Don't know)
99 (Refused)

D4. What type of fuel do you use to heat your home? (MULTIPLE RESPONSE)

01. Natural gas
02. Bottled, tank or LP gas
03. Electric
04. Oil, kerosene
05. Coal (coke)
06. Wood
07. Solar
00. Other (specify)
96. No fuel
98. (Don't know)
99. (Refused)

D5. In what year was your home or apartment built? (READ CATEGORIES, IF NECESSARY)

01. Built in 2006-2009 (NEW HOME)
02. Built 2000-2005 (NEW HOME)
03. Built 1990-1999
04. Built 1980 to 1989
05. Built 1970 to 1979
06. Built 1960 to 1969
07. Built 1950 to 1959
08. Built 1949 or earlier
98. (Don't know)
99. (Refused)

D6. What is the highest level of education that you have completed so far? (READ CATEGORIES, IF NECESSARY)

1. Grade school or less (1-8)
2. Some high school (9-11)
3. Graduated high school (12)
4. Vocational/technical school
5. Some college (1-3 years)
6. Graduated college (4 years)
7. Post graduate education
8. (Don't know)
9. . (Refused)

D7. In what year were you born?

00. [NUMERIC OPEN END; 1890-19991]
9998. (Refused)

D8. Which of the following best represents your annual household income from all sources in 2010, before taxes? Was it . . . .?

1 $14,999 or less
2 $15,000 to $19,999
3 $20,000 to $29,999
4 $30,000 to $39,999
5 $40,000 to $49,999
6 $50,000 to $74,999
7 $75,000 to $99,999
8 $100,000 to $149,999
9 $150,000 or more
98 (Don't know)
99 (Refused)

This completes the survey. ComEd appreciates your participation. Thank you for your time.

ComEd CACES Program
Interview Guide
Non-Participating Contractors

Introduction

Hi, may I please speak with [name from list]?
[If no name, ask for person most knowledgeable about central AC installations in ComEd territory.]

My name is ___ and I'm calling from Opinion Dynamics, a market research company, on behalf of ComEd. We're talking to HVAC contractors who do not currently participate in ComEd's Residential HVAC Program.

I would like to ask you some questions about your experience with high efficiency residential HVAC equipment that will help ComEd improve the program. The questions that I have will only take about 15 minutes and your responses will be kept strictly confidential.

Is this a good time to talk? [IF NO, SCHEDULE A CALL BACK.]

INSTALLATION PRACTICES

1. Approximately how many residential AC and/or heat pump units did your company install in 2010? How did this change (e.g. increase or decrease) from 2009? Approximately what share of the equipment you installed were 14 SEER or greater for each year?

2. Thinking about 2010 compared to 2009, did you notice a change (increase or decrease) in customer demand for high efficiency HVAC equipment? [Note increase or decrease] What factors do you think are responsible for this change? (e.g., rebates, incentives, programs, older equipment that needed upgrading)?

3. How important are incentives (both from utility programs and federal tax credits) in getting customers to purchase high efficiency HVAC equipment as opposed to a standard efficiency unit? In your opinion, what percentage of your customers would have installed a higher efficiency unit without the discount/incentive? What amount of rebate/incentive do you feel is a reasonable amount to get influence customer to purchase a high-efficiency unit? [Probe for differences between early retirement and replacement on failure]

4. How do you promote higher efficiency systems to your customers? How do you communicate/message the benefits of higher efficiency units? In otherwords, what are the key selling points to customers (e.g., energy savings, savings money on monthly bill, rebates on equipment)? Do you feel utilities do an effective good job at communicating the key benefits of high-efficiency HVAC equipment to customers through their programs?

These next 3 questions address your current technical practices. Your responses will help establish the baseline practices for the region.

5. How do you typically size new equipment for customers? Do methods differ for new construction versus replacement equipment? How? Which of the following techniques best applies for each situation?
    a. Like for like size
    b. Like+ (a little larger) for like size
    c. Tons per square foot rule of thumb (Describe)
    d. New Manual J calculations with full details
    e. "Express" Manual J calculations
    f. Other, specify

6. Which of the following best describes your current practices for duct sealing?
    a. Mastic or other sealant on loose or visible duct joints with no pressure tests
    b. Mastic or other sealant on all duct joints with no pressure tests
    c. Duct blaster and seal as needed to achieve a maximum acceptable leakage
    d. Polymer sealant or treatment inside the duct
    e. Other, specify

7. Which of the following best describes your current practices for air balancing? [Multiple Response]
    a. Flow measurement at supply fan
    b. Flow measurement at all supply registers
    c. Flow measurement at return air grills
    d. Flow estimate based on fan speed only
    e. Other, specify

8. How often do you attend professional training sessions about issues related to HVAC equipment? Who typically sponsors these trainings?

9. Are you aware of ComEd's Residential HVAC program? How did you become aware of it?

10. Why have you not participated in the program yet? [Probe: Lack of customer demand? Trouble meeting requirements?] Do you expect to participate in the program in the future? What is keeping you from participating in the future?

11. Are there any changes that ComEd can make to the program that would make you more likely to participate? Please describe.

12. How would you describe your customers' level of awareness of the ComEd Residential HVAC program? (e.g., Very Aware, Somewhat Aware, Not at All Aware, DK). Are your customers aware of the federal tax credits for the purchase of high-efficiency HVAC equipment? Do any of your customers ask about the program incentive? What about the federal tax credits?

Wrapping up

I have just a few more questions…

13. How many employees do you have?

14. How long have you been in business?

15. What geographical area(s) do you serve?
    1. City of Chicago and Cook County
    2. Chicago collar counties.
    3. Bordering Wisconsin East
    4. Rockford area
    5. Bordering WI west
    6. NW IL
    7. Moline (Quad Cities) area
    8. Central IL ComEd (Dekalb and South)
    9. South of Chicago metro (Joliet area)

ComEd

PARTICIPATING TRADE ALLY SURVEY – CACES PROGRAM

PY3 Draft 1/4/2010

Introduction

[READ IF CONTACT=1]
Hello, this is _____ from Opinion Dynamics calling on behalf of ComEd. This is not a sales call. May I please speak with <PROGRAM CONTACT>?

We are calling HVAC contractors who have participated in ComEd's Central Air Conditioning Efficiency Services (CACES) program to learn about their experiences with the program and to gain a better understanding of how the program could be improved.

I would like to ask you some questions about your experience so far with the CACES program. The questions will only take about 20 minutes and your responses will be kept strictly confidential. Is now a good time? [If no, schedule call-back]

[READ IF CONTACT=0]
Hello, this is _____ from Opinion Dynamics calling on behalf of ComEd. I would like to speak with the person most knowledgeable about your company's participation in ComEd's residential HVAC incentive program.

We are calling HVAC contractors who have participated in ComEd's Central Air Conditioning Efficiency Services (CACES) program to learn about their experiences with the program and to gain a better understanding of how the program could be improved.

I would like to ask you some questions about your experience so far with the CACES program. The questions will only take about 20 minutes and your responses will be kept strictly confidential. Is now a good time? [If no, schedule call-back]

Screening

A1. Just to confirm, our records show that <COMPANY> is a participating contractor in ComEd's Central Air Conditioning Efficiencies Services (CACES) program. Is this correct? (IF NEEDED: This is the residential HVAC program where ComEd pays contractors incentives to perform and document quality installation practices and upsell high-efficiency central A/C units.)

1 (Yes, company is currently participating in program)
2 (No, company is NOT participating in program)
98 (Don't know)
99 (Refused)

[IF A1=2,98,99: Thank and terminate. Record as "Could not confirm participation".]

Equipment Selection, Sizing, and Installation

First, I would like to ask you some questions about your current equipment installation history.

E1. Approximately how many total residential central A/C systems and/or heat pumps did your company install in 2010?
[NUMERIC OPEN END; 98= Don't know; 99 =Refused]

E1b. Approximately what share of the installed units in 2010 were 14 SEER or greater ?
[Percentage: 0-100; 98= Don't know; 99 =Refused]

E2. And approximately how many total residential A/C systems and/or heat pumps did your company install in 2009?
[NUMERIC OPEN END; 98= Don't know; 99 =Refused]

E2b. What share of the installed units in 2009 were 14 SEER or greater
[Percentage: 0-100; 98= Don't know; 99 =Refused]

Installation Practices

Now I would like to ask about installation and tune up practices for new and replacement equipment **prior to your participation** in the CACES program and outside of the ComEd service territory. Your answers will help establish the baseline against which we compare practices required by the CACES program.

IP1. Thinking about the central A/C installations you did before participating in ComEd's CACES program, how did you typically size new equipment for customers? Please indicate which of the following techniques best applies.

1. Like for like size
2. Like+ (a little larger) for like size
3. Tons per square foot rule of thumb
4. New Manual J calculations with full details
5. "Express" Manual J calculations
0. (Other, specify)
8. (Don't know)
9. (Refused)

IP2. And how do you currently size new central A/C equipment for customers outside of ComEd's service territory? [IF NECESSARY: Those installations that do not qualify for quality installation incentives]

1. Like for like size
2. Like+ (a little larger) for like size
3. Tons per square foot rule of thumb
4. New Manual J calculations with full details
5. "Express" Manual J calculations
0. (Other, specify)
8. (Don't know)
9. (Refused)

IP3. Thinking about your new central A/C installations as part of ComEd's CACES program, which of the following best describes your current practices for duct sealing?

1. Mastic or other sealant on loose or visible duct joints with no pressure tests
2. Mastic or other sealant on all duct joints with no pressure tests
3. Duct blaster and seal as needed to achieve a maximum acceptable leakage
4. Polymer sealant or treatment from inside
0. (Other, specify)
8. (Don't know)
9. (Refused)

IP4. Have your duct sealing practices changed since participating in the ComEd CACES program?

1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK IF IP4=1]
IP5. How have your duct sealing practices changed since participating in the program?
[OPEN END; 98= Don't know; 99 =Refused]

IP6. Are your duct sealing practices the same inside ComEd's service territory and in other areas?

1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK IF IP6=2]
IP7. How are your duct sealing practices different in other areas compared to ComEd's service territory?
[OPEN END; 98= Don't know; 99 =Refused]

IP8. Thinking about your new installations as part of ComEd's CACES program, which of the following best describes your current practices for air balancing? [Multiple Response]

1. Flow measurement at supply fan
2. Flow measurement at all supply registers
3. Flow measurement at return air grills
4. Flow estimate based on fan speed only
0. (Other, specify)
8. (Don't know)
9. (Refused)

IP9. Have your air balancing practices changed since participating in the ComEd CACES program?

1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK IF IP9=1]
IP10. How have your air balancing practices changed since participating in the program?
[OPEN END; 98= Don't know; 99 =Refused]

IP11. Are your air balancing practices the same inside ComEd's service territory and in other areas?

1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK IF IP11=2]
IP12. How are your air balancing practices different in other areas compared to ComEd's service territory?

[OPEN END; 98= Don't know; 99 =Refused]

T1. Prior to participating in the CACES Program which of the following parameters did you typically measure during a tune up? [Multiple Response]

1. Suction temperature
2. Suction pressure
3. Discharge temperature
4. Discharge pressure
5. Evaporator air entering temperature
6. Evaporator air leaving temperature
7. Condenser air entering temperature (outdoor ambient temperature)
8. Condenser air leaving temperature
9. Super heat
10. Sub-cooling
11. Evaporator airflow
98. (Don't know)
99. (Refused)

Thank you. For the rest of my questions, I will only be asking about those units installed in 2010.

E1. Approximately what percentage of your 2010 central A/C systems and/or heat pumps installations did you submit an application for rebates from ComEd's HVAC program? [Percentage: 0-100; 998= Don't know; 999 =Refused]

E2. If the program did not exist, approximately what percentage of the central A/C systems and/or heat pumps systems that you installed do you believe would be 14 SEER or greater? [Percentage: 0-100; 998= Don't know; 999 =Refused]

E3. Thinking about your total number of installations of central A/C systems and/or heat pumps in 2010, approximately what percentage do you believe were installed to residential customers outside of the ComEd service territory? [Percentage: 0-100; 98= Don't know; 99 =Refused]

[ASK IF E3>0%, ELSE SKIP TO E9]
E4. Do you use the Service Assistant Tool for central A/C installations you perform outside of ComEd's service territory?

1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK IF E4=1, ELSE SKIP TO E9]
E5. On approximately what percentage of central A/C installations that are done outside of ComEd's territory do you use the Service Assistant Tool? [Percentage: 0-100; 998= Don't know; 999 =Refused]

[ASK IF E5=0%]
E6. Why don't you use the Service Assistant Tool outside of ComEd's service territory?

1. (It takes too long to use/not profitable)
2. (It is too difficult to use)
3. (It is not required)
8. (Don't know)
9. (Refused)

E7. Approximately what percentage of your installations that go through the program are referred to you by ComEd? [Percentage: 0-100; 998= Don't know; 999 =Refused

Tune Ups

Now I have some questions about your company's central A/C tune up practices.

T1. Approximately how many total tune ups of central A/C systems and/or heat pump units did your company perform in 2010?
[NUMERIC OPEN END; 98= Don't know; 99 =Refused]

T2. Of those, approximately what percentage received incentives from ComEd's CACES program? [Percentage: 0-100; 998= Don't know; 999 =Refused]

T3. If the CACES program did not exist do you think the number of tune ups your company performs would be different?

1. (Yes, it would be higher)
2. (Yes, it would be lower)
3. (No, it would be about the same)
8. (Don't know)
9. (Refused)

[ASK IF T3=1]
T4. Without the program, approximately how many more tune ups do you think your company would have performed in 2010? [NUMERIC OPEN END; 998= Don't know; 999 =Refused]

[ASK IF T3=1]
T5. Why do you think your company would have performed more tune ups without the program?
[OPEN END, DK, REF]

[ASK IF T3=2]
T6. Without the program, approximately how many fewer tune ups do you think your company would have performed in 2010? [NUMERIC OPEN END; 98= Don't know; 99 =Refused]

[ASK IF T3=2]
T7. Why do you think your company would have performed fewer tune ups without the program?
[OPEN END, DK, REF]

[ASK IF T3=3]
T8. Why do you think there would be no difference in the number of tune ups your company performs if the program did not exist? [OPEN END, DK, REF]

T9. Do you use the Service Assistant Tool for tune ups you perform outside of ComEd's service territory?

1. (Yes)
2. (No)
8. (Don't know)
9. (Refused)

[ASK IF T9=1, ELSE SKIP TO T12]
T10. On approximately what percentage of tune ups that are performed outside of ComEd's territory do you use the Service Assistant Tool? [Percentage: 0-100; 98= Don't know; 99 =Refused]

[ASK IF T10=0%]
T11. Why don't you use the Service Assistant Tool for tune ups outside of ComEd's service territory?

T12. Do you charge the same price for a tune up that uses the Service Assistant Tool as one that doesn't?

1. (Yes)
2. (No)
3. (Not applicable, I use the tool for all tune ups)
8. (Don't know)
9. (Refused)

T13a. What percent of your central A/C tune up work is from annual or biennial service contracts with your firm?
[Percentage: 0-100; 98= Don't know; 99 =Refused]

T13b. What percent of your central A/C tune up work is on equipment that appears to receive annual or biennial service from your firm or others?
[Percentage: 0-100; 98= Don't know; 99 =Refused]

T14. Approximately what percentage of your tune ups that go through the program are referred to you by ComEd? [Percentage: 0-100; 998= Don't know; 999 =Refused

Program Process/Participation

PP1. The CACES program has a number of requirements for contractors to participate in the program. Did you have any difficulty meeting any of the following program requirements? [1=Yes, 2=No, 8=DK, 9=REF]

a. Purchasing the service assistant tool
b. Attending the program's trainings
c. Using the online contractor portal

[ASK IF PP1a or PP1b or PP1c=1, ELSE SKIP TO MO1]
PP2. Can you describe the difficulty you had in meeting the requirement for [INSERT PP1a or PP1b or PP1c]? [ASK FOR EACH ONE]

1. (Open End)
8. (Don't know)
9. (Refused)

PP3. How were you able to overcome this difficulty?
1. (Was not able to overcome the difficulty)
0. (Open End)
8. (Don't know)
9. (Refused)

Marketing and Outreach

MO1. How did you first hear about the ComEd CACES program?
1. (ComEd Website)
2. (Friend/colleague/word of mouth)
3. (Speaker/Presentation at an event)
4. (Newsletter)
5. (Vendor/Distributor)
6. (Contacted by program implementer – Honeywell)
00. (Other, specify)
98. (Don't know)
99. (Refused)

MO2. When promoting the CACES program to your customers, do you utilize any of the marketing tools or support offered by the program or ComEd?
1. Yes
2. No
98. (Don't know)
99. (Refused)

[ASK IF MO2=1]
MO3. Which marketing tools or support do you use to promote the CACES program to customers?
1. (Directory on ComEd website)
2. (Other, specify)
98. (Don't know)
99. (Refused)

[ASK IF MO2=1]
MO4. On a scale of 0 to 10, with 0 meaning "not at all useful" and 10 meaning "extremely useful," how useful are the program's marketing materials in providing information about the program to potential customers? [0-10, 98=DON'T KNOW, 99=REFUSED]

[ASK IF MO4<5]
MO5. What would have made the materials more useful? [MULTIPLE RESPONSE, UP TO 3]
1. (More detailed information about program)
2. (More detailed information about how to sign-up)
3. (Where to get additional information)
00. (Other, specify)
98. (Don't know)

99. (Refused)

MO6. In general, how do you prefer to learn about energy efficiency programs such as ComEd's CACES program? [MULTIPLE RESPONSE, UP TO 3]

1. (Flyers/ads/mailings)
2. (E-mail)
3. (Telephone)
4. (Through trade or professional associations)
5. (Distributors/wholesalers)
6. (Website)
7. (Trade magazines)
8. (Industry events)
9. (Professional colleagues)
00. (Other, specify)
98. (Don't know)

Customer Experience

CP1. On a scale of 0 to 10 where 0 is "not at all influential " and 10 is "extremely influential", how would you rate the overall influence that you/your staff have on a customer's selection of a high efficiency central A/C system over a standard efficiency system?
[0-10, 98=DON'T KNOW, 99=REFUSED]

CP2. In your opinion, what are the main reasons your customers decide to install high efficiency HVAC systems?

1. (Save money on their energy bills)
2. (Help protect the environment)
3. (Utilize rebate/incentive)
00. (Other, specify)
98. (Don't know)
99. (Refused)

CP3. And what are the main reasons customers decide NOT to install high efficiency HVAC systems?

1. (High cost)
2. (Lack of information about how to participate)
3. (Rebate amount is not enough)
00. (Other, specify)
98. (Don't know)
99. (Refused)

CP4. In your opinion, how important do you think it is to your customers that their HVAC contractor is affiliated with the CACES Program? Please use a scale from 0 to 10, where 0 is "not at all important" and 10 is "very important"? [SCALE 0-10; 98=Don't know, 99=Refused]

Training

T1. Did you and/or your co-workers receive free technical training as part of the CACES program?

1. Yes

2. No
98. (Don't know)
99. (Refused)

[SKIP IF T1>1]
T2. Did the CACES program technical training change your standard operating procedures for central A/C tune-ups and installations?

1. Yes
2. No
98. (Don't know)
99. (Refused)

[ASK IF T2=1]
T3. Specifically, how did the technical training change your standard operating procedures for tune-ups and installations?
[OPEN END; 98=Don't know; 99=Refused]

T4. Did the technical training cause you to promote the purchase and installation of high efficiency A/C systems?

1. Yes
2. No
98. (Don't know)
99. (Refused)

T5. On a scale from 0 to 10 where 0 is "extremely dissatisfied" and 10 is "extremely satisfied", how would you rate your overall satisfaction with the technical training that you received for participating in the ComEd CACES program? [0-10, 98=DON'T KNOW, 99=REFUSED]

[ASK IF T5<5]
T6. Why did you rate your satisfaction with the training this way?
[OPEN END, DK, REF]

Contractor Satisfaction

I now have a few questions about your satisfaction with elements of the CACES program. Please try to limit your feedback to only your experiences in 2010.

C1. On a scale from 0 to 10 where 0 is "extremely dissatisfied" and 10 is "extremely satisfied", how would you rate your overall satisfaction with the following aspects of the CACES Program…
[MULTIPLE RESPONSES, 0-10, 98=DON'T KNOW, 99=REFUSED]

a. The training received (both technical and business)
b. The data entry process, including contractor portal
c. The incentive process
d. The wait time to receive your incentive
e. The tune-up requirements
f. The quality installation requirements

g. The program implementer (Honeywell)

C2. On a scale from 0 to 10 where 0 is "extremely dissatisfied" and 10 is "extremely satisfied", how would you rate your overall satisfaction with the ComEd CACES Program? [0-10, 98=DON'T KNOW, 99=REFUSED]

[ASK IF C2<5]
C3. Why did you give the program this rating?
1. [OPEN END]
98. (Don't know)
99. (Refused)

C4. Did you experience any problems while participating in the program? (IF NEEDED: Other than what we have already talked about)
1. Yes
2. No
98. (Don't know)
99. (Refused)

[ASK IF C4=1]
C5. What problems did you experience?
1. (Process takes too long)
2. (Inconsistent information)
3. (Customer complaints)
4. (Difficult to submit applications)
00. (Other, specify)
98. (Don't know)
99. (Refused)

Benefits and Barriers

B1. What do you see as the benefits to your business for participating in the CACES Program? [MULTIPLE RESPONSE, UP TO 3]
1. (Technical training)
2. (Additional business)
3. (Lower Maintenance Costs)
4. (Better Quality/New Equipment)
5. (Rebate/Incentive)
6. (Improved Safety/Morale)
7. (Set Example/Industry Leader)
9. (Able to make improvements sooner)
9. (Saves money on utility bill)
00. (Other, Specify)
98. (Don't know)
99. (Refused)

B2. What do you see as the drawbacks to participating in the program? [MULTIPLE RESPONSE, UP TO 3]

1. (Paperwork and Training too burdensome)
2. (Incentives not high enough/not worth the effort)
3. (Program is too complicated)
4. (Cost of equipment)
5. (Poor Communication)
6. (Time Consuming)
7. (No drawbacks)
00. (Other, specify)
98. (Don't know)
99. (Refused)

B3. Have you experienced any issues that have prevented you from promoting or implementing the CACES program as expected? [MULTIPLE RESPONSE, UP TO 3]

1. (Financial reasons)
2. (Lack of program understanding)
3. (Difficulty of Application/Paperwork)
4. (Availability of high efficiency units)
5. (Availability of units that meet program requirements)
6. (Issues with Proper sizing/installation)
7. (Need for additional time to complete tune-up tests or service assistant customer setup)
8. (Issues with testing the unit and uploading test results)
9. (None/no issues)
00. (Other, specify)
98. (Don't know)
99. (Refused)

B7. Have you had any difficulties with receiving payments in a timely manner from ComEd?

1. Yes
2. No
98. (Don't know)
99. (Refused)

Feedback and Recommendations

R1. Do you plan to participate in the CACES program again in the future?

1. Yes
2. No
3. Maybe
98. (Don't know)
99. (Refused)

C6. What changes can be made to the program to make it more valuable to you?

0. [OPEN END]
1. No changes
98. (Don't know)
99. (Refused)

Firmographics

I only have a few general questions left.

F1. How long have you been in business?

1. Less than 2 years
2. 2-4 years
3. 5-9 years
4. 10-19 years
5. 20-29 years
6. 30 years or more years
98. (Don't know)
99. (Refused)

F2. Do you know the approximate number of employees at your company? Would you say it is…

1. Less than 10
2. 10-49
3. 50-99
4. 100-249
5. 250 or more
98. (Don't know)
99. (Refused)

F3. Which of the following best describes the facility? This facility is…

1. <COMPANY>'s only location
2. One of several locations owned by <COMPANY>
3. The headquarters location of <COMPANY> with several locations

5.2 *Billing Analysis Details*

Billing Analysis: Model

We estimated a linear fixed effects model for air conditioning energy use. Such a model essentially creates a separate dummy variable for each residence in the analysis that captures all household-level effects. In particular, we begin with the linear model:

Equation 5-1

$$Kwhd_{kt} = \alpha_{k0} + \alpha_1 CDDd_t + \alpha_2 Post_{kt} \cdot CDDd_t + \alpha_3 Post_{kt} \cdot CDDd_t \cdot D_k + \boldsymbol{\beta}_1 \mathbf{X}_k + \varepsilon_k + \phi_{kt}$$

where $Kwhd_{kt}$ is the kWh per day consumed by household *k* in billing period *t*; $CDDd_t$ is the average cooling degree days (CDD per day) during the billing period; $Post_{kt}$ is a dummy variable denoting whether the billing period is before ($Post_{kt} = 0$) or after ($Post_{kt} = 1$) the installation of the new AC unit; D_k is a dummy variable taking a value of one if the new unit's SEER rating is 14+ and zero if the unit is SEER 13; $\mathbf{X}_k$ is a vector of other household/residence characteristics that may affect kWh usage, such as the size of the residence and the number of household members; ε_k is a term accounting for household-level unobservable variables; and ϕ_{kt} is a term accounting for other unobservable effects.

The fixed effects model defines the household-specific constant $\gamma_k = \boldsymbol{\beta}_1 \mathbf{X}_k + \varepsilon_k$ as a deviation from the mean constant α_{k0}. This deviation is treated as a parameter to be estimated, in which case we can rewrite Equation 1 as the fixed effects model:

Equation 5-2

$$Kwhd_{kt} = \alpha_{k0} + \gamma_k + \alpha_1 CDDd_t + \alpha_2 Post_{kt} \cdot CDDd_t + \alpha_3 Post_{kt} \cdot CDDd_t \cdot D_k + \varphi_{kt}$$

In the absence of a new installation, predicted kWh consumption per day for the average household is $Kwhd_{kt} = \alpha_0 + \gamma_k + \alpha_1 CDDd_t$. For a household with a new installation with an efficiency rating of SEER 13, the predicted consumption per day is:

$$Kwhd_{kt} = \alpha_{k0} + \gamma_k + \alpha_1 CDDd_t + \alpha_2 CDDd_t$$

and for a household with a new installation with an efficiency rating equal to or greater than SEER 14 it is:

$$Kwhd_{kt} = \alpha_{k0} + \gamma_k + \alpha_1 CDDd_t + \alpha_2 CDDd_t + \alpha_3 CDDd_t \cdot D_k .$$

The result of this specification is that the kWh savings from a cooling degree day is $-\alpha_2$ for the installation of a SEER 13 unit, and $-\alpha_2 + \alpha_3$ for the installation of a SEER 14+ unit.

Separate models were estimated for single family and multi-family residences. Estimation results are presented in Table 5-1 and Table 5-2. In both models, the null hypothesis of no fixed effects (no savings) is strongly rejected.

Table 5-1. Results for the Fixed Effects Regression Model: Single Family Dwelling

Variable	Parameter Estimate	Standard Error	T-statistic
$CDDd_t$	2.642	0.099	26.71
$Post_{kt} \cdot CDDd_t$	-0.478	0.058	-8.24
$Post_{kt} \cdot CDDd_t \cdot D_k$	-0.273	0.062	-4.42
Intercept	19.312	0.79	24.47

R-sq = 0.149; 9753 observations, 2007 households

Table 5-2. Results for the Fixed Effects Regression Model: Multi- Family Dwelling

Variable	Parameter Estimate	Standard Error	T-statistic
$CDDd_t$	1.782	0.181	9.84
$Post_{kt} \cdot CDDd_t$	-0.432	0.089	-4.9
$Post_{kt} \cdot CDDd_t \cdot D_k$	-0.34	0.176	-1.93
Intercept	4.759	1.397	3.41

R-sq: within = 0.146, between = 0.081, overall = 0.066; 1713 observations , 385 households

Key results are the following:

- For single family residences, the coefficient estimate for $CDDd_t$ estimate indicates that under baseline conditions, an additional $CDDd_t$ increases kWh usage by 2.64.

- For multi-family residences, the coefficient estimate for $CDDd_t$ estimate indicates that under baseline conditions, an additional $CDDd_t$ increases kWh usage by 1.78.

- The billing analysis cannot estimate demand (kW) savings directly, since billing data are monthly rather than hourly. Demand savings for the program are estimated using energy estimates from the billing analysis and runtime hours estimates from the Diagnostics and Tune-Up program.

Billing Analysis Inputs

The billing data included 2399 residences with 34,500 summer season billing records Several criteria for inclusion in the analysis reduced these counts:

- The analysis omitted the billing period in which the AC unit was installed.
- The analysis included only those billing periods for which the cooling degree days per day (CDDd) was at least 5.0. This was done to better isolate the effect of AC efficiency gains. The cooling degree day data are presented in Figure 2-1 and

- The analysis excluded all installations for which there was not at least one feasible billing period before installation (i.e., a billing period with CDDd>5.0), and one feasible period after installation.

Because *ex ante* savings are based on dwelling type, Navigant Consulting conducted separate regression analyses for single-family and multi-family dwellings. After applying the inclusion criteria to the billing data, the PY3 pre-installation data set of single family residences consists of 2007 residences and 9753 billing record observations, the multi-family data consists of 385 residences and 1713 billing observations. The combined 11,467 observations and 2392 households provide on average 4,8billing record observations per household.

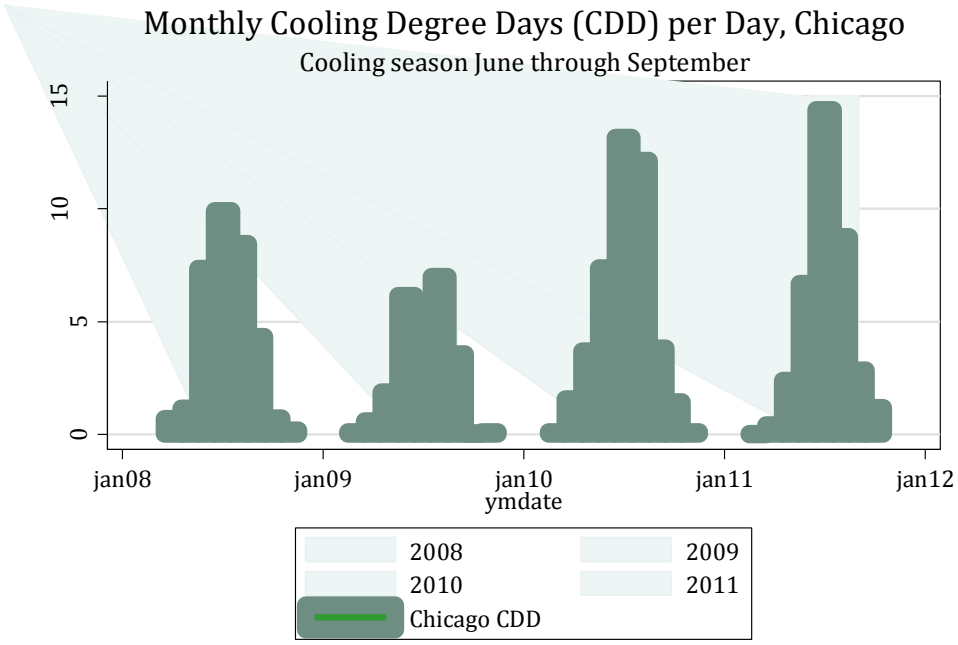
There were 6297 post installation observations for 2392 households, an average of 2.62 post installation billing records per household. Of these, there were 5128 post installation observations for 2007single households, an average of 2.56 post installation billing records per household. There were 1169 post installation observations for 385 of multi-family households, an average of 3.04 post installation billing records per household.

Table 5-3. Summary of the Data PY3 cooling season

Data Category	Number of sample *residences*	Number of sample *residences* w/ SEER 14+ installations	Number of *records*	Number of *records* w/ SEER 14+ installations	Number of post-installation *records*	Number of post-installation *records* with SEER 14+ installations	Post-installation *records* per Participant
Single-Family	2007	761	9754	3770	5128	1870	2.56
Single-Family Detached	1754	681	8520	3381	4471	1655	2.55
Single-Family Attached	253	80	1233	389	657	215	2.60
Multi-Family	385	35	1713	166	1169	97	3.04
Total	2,392	796	11,467	3,936	6,297	1,967	2.63

Figure 5-1 presents cooling degree days over the study period 2008-2010 at the Chicago O'Hare weather station. While the summer of 2009 was unusually cool, the 2010 cooling season was slightly warmer than long-term averages. In the typical meteorological year, the number of cooling degree days at O'Hare is 773; in the summer of 2009 it was 587. In 2010 the total was 1064

Figure 5-1. Daily Cooling Degree Days – Chicago O'Hare Airport 2007 - 2010



Source: http://www.degreeday.net