Con Edison EEPS Programs - Impact Evaluation of Residential Room Air Conditioner Program

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energy & resource solutions

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1 Executive Summary

Consolidated Edison Company of New York (CECONY) requisitioned an impact evaluation of its Residential Room Air Conditioner Program. This document contains the results of that evaluation.

1.1 Program Background and Objectives

CECONY designed its Residential Room Air Conditioner program for rapid deployment of energy efficiency measures to existing Residential customers. The program is open to Residential customers who contribute to the System Benefit Charge (SBC) on their utility bill. The program provides a $30[1] (per unit) cash rebate to customers for the purchase of an ENERGY STAR-rated room air conditioner (AC).

Participants of the program must purchase a qualifying residential room air conditioner (AC) unit and mail in a rebate form and proof of purchase to receive the rebate. CECONY has contracted with Honeywell to implement the program.

The program had approximately 60,000 participants in 2010 and 2011. The vast majority (90%) of the program's savings comes from window ACs and only a fraction (10%) of program savings comes from through-the-wall units.[2]

1.2 Research Approach

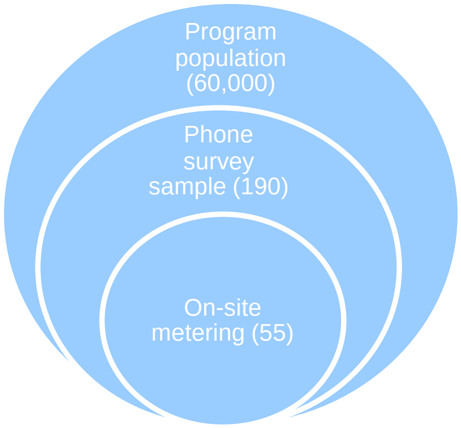
Program net energy savings and net peak demand reduction were determined through a nested sample of 190 telephone surveys that determined gross program savings and attribution and from which a sub-sample of 55 sites was selected for nearly 3 months of on-site metering. Attribution was based on self-reported responses from the same telephone survey.

The evaluation team calculated gross impacts by leveraging the program tracking data, program participants' billing data, data collected using the phone survey, and on-site metered data as well as other data collected on-site. The use of a double-ratio estimation method for combining these various data sets ensured a high-quality result at a reasonable cost. The use of double-ratio estimation reduces uncertainty at a reasonable cost by leveraging the results of the low-cost, medium-accuracy phone surveys with the results from the high-rigor, higher-cost, on-site metering. By nesting the on-site sample within the phone survey sample, the evaluators were able to achieve a more accurate estimate of the frequency of some outliers, which may include extremely high air conditioning usage participants or extremely low air conditioning usage participants. A schematic of the sampling plan is shown below in Figure 1-1.

[1] This amount has since been changed to $25 as of 2012

[2] Data from the CECONY Program Tracking Database.

Figure 1-1
Nested Sampling Schematic



The program-induced savings, indicated as a net-to-gross ratio (NTGR), is made up of free ridership (FR) and spillover (SO) and is calculated as $(1 - FR + SO)$. These components are derived from self-reported information from telephone interviews with program participants. The evaluation team relied on the self-report method to derive both FR and SO estimates. Program participants were interviewed and asked a series of structured and open-ended questions about the influence of the program and its various components and on the decision to purchase or install energy efficient cooling and heating equipment.

1.3 Results

The evaluation team calculated gross and net energy and demand savings which are presented in the following section.

1.3.1 Gross Impacts

The program acquired a total of 2,575 MWh gross energy savings and 1,612 kW peak gross demand savings over the evaluation period. The realization rates for energy and peak demand savings are 1.08 and 0.40, respectively. A discussion of the peak demand savings values is included below and in Section 4.1.3 on Coincident Factor. Savings were calculated for each of two strata – one comprising participants living in high-density areas (i.e., Manhattan, Brooklyn, and the Bronx) and one comprising participants living in medium-density areas (Queens, Westchester, and Staten Island). The total verified gross energy savings and total verified gross peak demand savings are shown by stratum in Table 1-1 and Table 1-2, respectively.

Table 1-1
Program Gross Energy Impacts

Stratum	Measure Installations	Ex Ante Gross Energy Savings (MWh)	Ex Post Gross Energy Savings (MWh)	Gross Energy Realization Rate	Energy Relative Precision
High density	31,526	1,248	1,535	1.23	19%
Medium density	27,667	1,130	1,040	0.92	26%
Total	**59,193**	**2,378**	**2,575**	**1.08**	**15%**[3]

Table 1-2
Program Gross Peak Demand Impacts

Stratum	Measure Installations	Ex Ante Gross Peak Demand Savings (kW)	Ex Post Gross Peak Demand Savings (kW)	Gross Peak Demand Realization Rate	Peak Demand Relative Precision
High density	31,526	2,137	886	0.41	34%
Medium density	27,667	1,890	726	0.38	36%
Total	**59,193**	**4,027**	**1,612**	**0.40**	**25%**

The primary driver of the high energy realization rate is that the room air conditioners' run time is longer (more hours) than expected, which increases energy usage and savings per unit. The primary driver of the low peak demand realization rate is a lower coincidence factor than expected because fewer of the air conditioners were running during the peak period than originally assumed.[4]

Unit Run-Time Results

The run-time results derived from combining phone survey data, billing data, and on-site metering for the room AC program are shown in Table 1-3. Room ACs were found to run for significantly more time in the more densely populated areas than in the less-dense areas. The additional run time in the high density stratum can be attributed to the thermal mass effects of the very large buildings in high-density areas and heat islanding[5]. People may also be less able or less willing to use open windows for effective passive cooling in higher-density areas.

[3] The two-tailed confidence and precision on the energy result for this study is 90/15. While this relative precision value is higher than the goal of 10%, a confidence and precision of 90/15 is a very good result for a rigorous evaluation using equipment metering for a very small program, such as this one.
[4] The high relative precision on the peak demand impact is partially driven by the lower realization rates. The demand realization rate is 0.40 +/- 0.10. If the realization rate had been 1.00 +/- 0.10 (same absolute precision with a higher realization rate), then the relative precision would have been 10% instead of 30%.
[5] Additional run time in high-density geographies in shoulder months can also be attributed to the fact that many high-occupancy buildings are centrally controlled, introducing a possibility that the participants are using air conditioning to offset building heating.

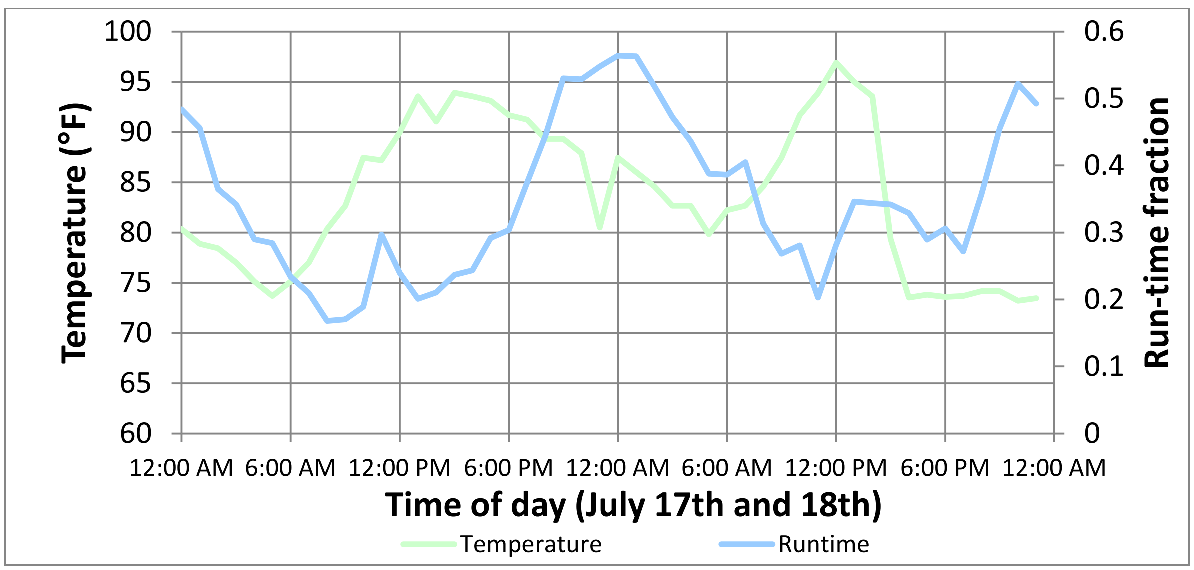
Table 1-3
Energy Consumption and Equivalent Full-Load Hours (EFLH) Results by Stratum

Stratum	Normalized Energy Consumption (kWh-EER/ton)	EFLH[6]
High density	6,623	552
Medium density	5,073	423
Weighted average for CECONY territory	**5,997**	**500**

Coincidence Factor Results

Profiles of temperature and hourly run-time fraction (the average fraction of an hour that all participating units are cycling, or running) are shown in Figure 1-2. The 2 days shown in Figure 1-2 were the hottest days of 2012 in New York City. While the outside air temperature peaks just after noon on the days shown, the metered room AC usage peaks at approximately midnight with a run-time fraction of approximately 0.55. The AC usage is significantly lower during CECONY's peak period of 4–5 p.m. The run-time fraction of approximately 0.3 during the 4–5 p.m. period is essentially analogous to coincidence factor. Survey evidence indicates the most likely explanation for the offset peak is that 50% of the rebated room ACs are installed in a bedroom, where hours of use differ from other areas of a residence. [7]

Figure 1-2
Run-Time Fraction and Temperature Profile Over Two Hottest Days in Summer 2012



[6] The EFLH listed in the tables already accounts for various unit efficiencies found within the program, and does not need to be further adjusted based on unit efficiency.

[7] Con Edison is currently exploring options to add a controllability function/device to allow customers who purchase a qualifying Room AC unit through the Residential Room AC Program, to be able to program those units remotely.

The coincidence factors by stratum are shown in Table 1-4.

Table 1-4
Coincidence Factor Results by Stratum

Stratum	Coincidence Factor
High density	0.32
Medium density	0.30
Weighted average for CECONY territory	**0.31**

1.3.2 Attribution and Program Net Impacts

Based on the participant self-report method, the evaluation team estimated an overall FR rate for the Residential Room Air Conditioner Program of 0.53. The precision around the estimate is 9% at 90% confidence. The evaluation team found no participant SO savings that could be attributed to the program activity. As part of the evaluation, the presence of nonparticipant SO (NPSO) was investigated through the interviews with retailers. The results of retailer interviews show evidence that CECONY's Room Air Conditioner Program, along with other utility-administered energy efficiency programs nationwide impact retailer stocking and sales practices, thus aiding in market transformation and likely resulting in NPSO. Quantifying savings from the NPSO is a challenging task, and it was outside of the scope of this evaluation effort. As the result, the overall NTGR for the program captures FR and participant SO and is 0.47.

The net program results are calculated by multiplying the gross program results by the net-to-gross ratio (NTGR). The total program net energy impacts and total program net peak demand impacts are shown in Table 1-5 and Table 1-6, respectively.

Table 1-5
Program Net Energy Impacts

Stratum	Measure Installations	Ex Post Gross Energy Savings (MWh)	NTGR	Ex Post Net Energy Savings[8] (MWh)	Energy Relative Precision
High density	31,526	1,535	0.47	721	21%
Medium density	27,667	1,040	0.47	489	28%
Total	**59,193**	**2,575**	**0.47**	**1,210**	**17%**

[8] The net savings and precision for net energy and demand are provided for information purposes. The workplan for this evaluation was submitted to the DPS in May 2012 and approved in June 2012 prior to inclusion of 90/10 precision on net savings as a target in DPS guidelines. This evaluation targeted 90/10 precision on gross savings and NTGR. CECONY's position is that the NTG results should be used prospectively.

Table 1-6
Program Net Peak Demand Impacts

Stratum	Measure Installations	Ex Post Gross Peak Demand Savings (kW)	NTGR	Ex Post Net Peak Demand Savings (kW)[8]	Demand Relative Precision
High density	31,526	886	0.47	416	35%
Medium density	27,667	726	0.47	341	37%
Total	**59,193**	**1,612**	**0.47**	**758**	**26%**

1.3.3 Implications for the New York Technical Manual

The New York Technical Manual (NYTM) should adopt the verified hours of use for both CECONY and Orange & Rockland (O&R) territories, as shown in Tables 1-7and 1-8, for use with the existing algorithm in the NYTM. If possible, the program should offer deemed hours of use for participants based on their population-density based stratum. If this is not possible, it is recommended that the program use the weighted average of 500 for the entire CECONY program population. The evaluation team recommends that O&R use an average of the Newburgh, NY results and the medium density CECONY results – equal to 415 hours.

Table 1-7
Meter-based EFLH for Use in NYTM - CECONY

Location	Meter-based EFLH
High density CECONY	552
Medium density CECONY	423
Weighted average CECONY	**500**

Table 1-8
Meter-based EFLH for Use in NYTM – O&R

Location	Meter-based EFLH
Medium density CECONY	423
Newburgh, NY	407
Average O&R	**415**

For comparison, the previously used EFLH values are shown in Table 1-9.

Table 1-9
NYTM Previous EFLH Values

Timeframe	EFLH
Prior to 2011 NYTM	630
2011 NYTM	233
Jan 2011 commission order	382

1.4 Conclusions and Recommendations

The evaluation team makes several conclusions and recommendations as a result of the evaluation, which are contained in the following section.

1.4.1 Conclusions

The results of this study show three main conclusions. These conclusions are listed below and discussed in detail in the Results section.

1. Usage is higher in high-density population areas than in medium-density population areas within CECONY territory.
2. Hours of use are higher than specified by the January 2011 commission order or the latest NYTM.
3. Usage peaks later in the day than expected, resulting in a lowered coincidence factor.

In addition, the evaluation team notes that FR for this program is driven, at least in part, by transformational changes in the market. That is, the program's relatively high FR rate likely is due to some extent to a transformation of the room AC market in New York and across the country. ENERGY STAR products regularly go through a cycle of market transformation, in which their incremental costs decrease and perceived benefits increase over time, resulting in increased sales. This increase in sales results in a parallel increase in self-reported FR in utility incentive programs. Eventually, when the market is almost entirely transformed, the ENERGY STAR requirements are updated to qualify only higher efficiency models. The next ENERGY STAR requirement update for room ACs will be on October 1, 2013. At that point, the market targeted by the program will shift, and FR for programs based on incentivizing ENERGY STAR units will decrease. The update to ENERGY STAR requirements indicates that the market has been transformed.

The evaluation team suggests that CECONY, along with other utilities that have sponsored ENERGY STAR room AC programs in recent years, had a role in this market transformation, including NPSO that has occurred in New York through changes in stocking practices of major retailers.[9] This phenomenon should be taken into account when assessing the cost-effectiveness of the program and deciding about its future. Future years of this program should not have the high FR that the program of the past few years has experienced, due to the revised (more stringent) ENERGY STAR requirements.

1.4.2 Recommendations

The recommendations for the program and the NYTM resulting from the results and conclusions of this evaluation are shown in the following sections.

Program Recommendations

The evaluation team offers four recommendations that may help to increase program cost-effectiveness. These are listed below and then discussed in detail. The evaluation team's recommendations focus either

[9] Arizona Public Service has claimed savings for market transformation. For more information, see *SEER is Overrated – Capturing Savings from Residential HVAC Market Effects* (from ACEEE Summer Study 2012).

on driving participation toward higher energy savings per transaction or on lowering the cost of achieving savings.

1. **Consider targeted marketing focused on higher population density areas.** Because the results of this study show that higher savings are achieved in higher population density areas of New York, the evaluation team suggests using targeted marketing focused on Manhattan, Brooklyn, and the Bronx to drive participation in higher population density areas. This would achieve higher savings per unit with equal costs.
2. **Consider redesigning the program to utilize an upstream or midstream approach to implementation.** In order to decrease administrative costs and increase program participation, CECONY should consider implementing an upstream or midstream program. Instead of offering the customer rebates, consider providing incentives to product suppliers or retailers to ensure that store shelves are stocked only with ENERGY STAR-rated room ACs at an already-incentivized price. This should drive increased participation with lower administrative costs and has the potential for a large market influence.
3. **Consider implementing higher efficiency tiers to drive participation for higher-savings units.** In addition to leveraging the ENERGY STAR requirement update, CECONY should consider implementing more rigorous program participation requirements by efficiency level or offering higher incentives for higher savings tiers. This should increase participation for higher efficiency units and increase overall savings.
4. **Consider bundling room ACs with additional measures.** To increase savings per transaction with minimal incremental cost to CECONY, consider offering participants the option of bundling their room AC with other ENERGY STAR appliances or measures. One possibility for increasing savings is to add an opt-in low-cost measure to the rebate application. For example, participants could check a box to receive a heavily discounted smart strip, in lieu of part of their rebate. This is a way to drive higher savings per participant at minimal cost to the program.[10] Con Edison is currently exploring options to add a controllability function/device to allow customers who purchase a qualifying Room AC unit through the Residential Room AC Program, to be able to program those units remotely. This option has the potential to enhance the program's value in the future.

Recommendations for New York Technical Manual

The NYTM should adopt the verified hours of use for both CECONY and O&R territories, as shown in Table 1-10 and Table 1-11, respectively, for use with the existing algorithm in the NYTM. If possible, the CECONY program should offer deemed hours of use for participants based on their population-density based stratum. If this is not possible, it is recommended that the program use the weighted average of 500 for the entire CECONY program population. The evaluation team recommends that O&R program use an average of Newburgh, NY and medium density CECONY for the deemed hours of use.

[10] A recent opt-in giveaway program in Maryland showed surprisingly high installation rates, as shown in a forthcoming EmPOWER Maryland evaluation report.

Table 1-10
EFLH for Use in NYTM - CECONY

Stratum	CECONY Boroughs	EFLH
High density CECONY	Manhattan, Brooklyn, Bronx	552
Medium density CECONY	Queens, Westchester County, Staten Island	423
Weighted average CECONY		**500**

Table 1-11
EFLH for Use in NYTM – O&R

Stratum	CECONY Boroughs	EFLH
Medium density CECONY	Queens, Westchester County, Staten Island	423
Newburgh, NY		407
O&R Average		**415**

Evaluation Recommendations

The two-tailed confidence and precision on the energy result for this study is 90/15. While this relative precision value is higher than the goal of 10%, a confidence and precision of 90/15 is a very good result for a rigorous evaluation using equipment metering, such as this one.

Future evaluations of this program should continue to use the double ratio estimation method with some slight changes to the sampling method described in Section 3.1.2. In addition, for rigorous evaluation of smaller programs such as this one, a 90/20 two-tailed confidence and precision is a reasonable target. Evaluation recommendations are detailed thoroughly in the body of this report.

2 INTRODUCTION

Consolidated Edison Company of New York (CECONY) and Orange & Rockland Utilities (O&R), collectively "the Companies," have completed the delivery of the first cycle (2009 – 2011) of a portfolio of Energy Efficiency Portfolio Standard (EEPS) Utility Administered programs, as ordered by the New York Public Service Commission. This document presents a detailed impact evaluation of the CECONY Residential Room AC program.

2.1 Program Background and Objectives

CECONY designed its Residential Room AC program for rapid deployment of energy efficiency measures to existing Residential customers. The program is open to customers in residential dwellings with one to four units as well as to customers who reside in multi-family dwellings that are subject to the system benefits charge (SBC), i.e., they pay the SBC charge on their electric utility bill. The program provides a $30[11] (per unit) cash rebate to customers for the purchase of an ENERGY STAR-rated room AC.

The program requires that purchasers of a qualifying residential room AC unit mail in a rebate form and proof of purchase to receive the rebate. CECONY has contracted with Honeywell to implement the program.

The program had roughly 60,000 participants in 2010 and 2011, with 90% of the savings coming from window ACs and 10% of the savings coming from through-the-wall units.[12]

2.2 Evaluation Objectives

The intent of the evaluation of the Residential Room AC Program was twofold. First, the evaluation team is providing a general assessment of the Residential Room AC Program's performance in total during the 2009 to 2011 period. Second, the evaluation team is providing a focused and more robust assessment of the room AC measures based on primary data collection, including telephone surveys, customer bills, and on-site measurement and verification (M&V), and providing actionable recommendations for improving the program's implementation as a result of these assessments.

The evaluation team used a focused approach with on-site M&V for the window AC measure, because it contributes the overwhelming majority of program savings. The results should better inform program and implementation staff about actual field performance and also provide input for revisions to the NYTM savings algorithms and factors.[13] Additionally, the evaluation team has provided forward-looking revised savings estimates and parameters for improvement of deemed savings for this program. The overall evaluation scope and objectives are identified in Table 2-1, as represented in the evaluation plan submitted for this program. These objectives were reviewed and approved by New York Department of Public Service (DPS) staff.

[11] This amount has since been changed to $25 as of 2012.
[12] Data from the CECONY Program Tracking Database.
[13] New York Department of Public Service's *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, October 10, 2010, (a.k.a., the New York Technical Manual or NYTM).

Table 2-1
Evaluation Scope and Objectives

Objective	Definition
Evaluation scope	Primary data collection activities will be focused on window ACs, which account for 90% of the program's savings.
Gross energy impacts	Report annual first-year gross electric (kWh) at the customer meter (gross savings) using tracking data inputs to a model developed from primary data collection. Results will be weather normalized to a typical year using TMY3 (typical meteorological year) weather data.
Gross demand impacts	Report the electrical demand impact at the customer meter, defined as the energy reduction during the hottest day of the year between 4 p.m. and 5 p.m., using tracking data inputs to a model developed from primary data collection.
Program attribution	Estimate free ridership (FR) and participant spillover (SO) using self-reported responses from telephone surveys. In addition, nonparticipant SO (NPSO) will be researched qualitatively through channel partners.
Precision	The sample designs will target 10% precision at the 90% confidence level for program energy savings as directed by the DPS Evaluation Guidelines. Subsector precisions will be less precise.

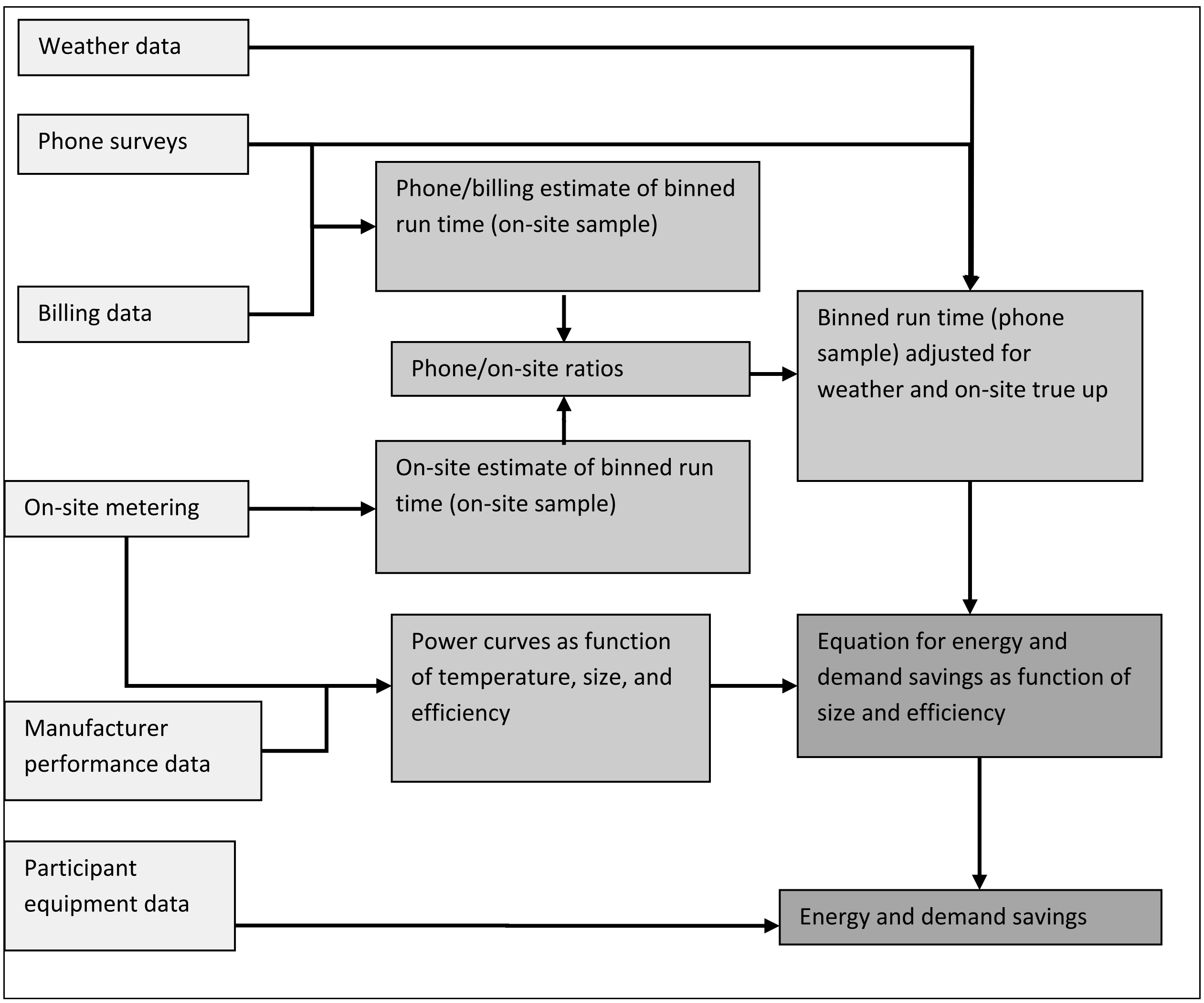
3 Evaluation Methodology

The evaluation methodology is presented in the following section.

3.1 Gross Savings Evaluation Methods

The evaluation team calculated gross impacts by leveraging the program tracking data, program participants' billing data, data collected using the phone survey, and on-site metered data as well as other data collected on-site. The use of a double-ratio estimation method for combining these various data sets ensured a high quality result at a reasonable cost. Each segment of the evaluation method is discussed below briefly and more thoroughly in Appendix A. A schematic illustrating the general approach to the room AC impact evaluation is summarized in Figure 3-1.

Figure 3-1
General Room AC Impact Evaluation Approach



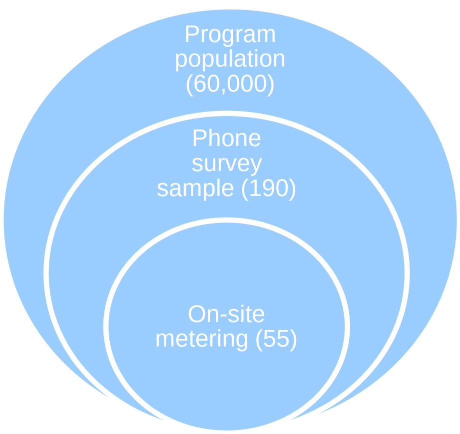
3.1.1 Baseline

The program design for the Room AC program assumes a replace-on-burnout baseline. This means that each piece of equipment is compared to a similar piece of equipment with code-minimum efficiency to derive savings. This approach is reasonable for this measure and is used for the evaluation of this program. The baseline EER used to estimate energy and demand savings for ENERGY STAR room ACs is the federal minimum EER listed in the ENERGY STAR database[14] corresponding to each specific unit. The baseline EER differs by unit depending on size and configuration.

3.1.2 Approach to Data Collection

The evaluation used a combination of phone surveys, billing data, and on-site metering to estimate equipment usage. The evaluation team used these combined data collection efforts to determine run-time hours, energy savings, and peak demand savings for a representative sample of program participants, utilizing the double-ratio estimation method.[15] The use of double-ratio estimation reduces uncertainty at a reasonable cost by leveraging the results of the low-cost, medium-accuracy phone surveys with the results from the high-rigor, higher-cost on-site metering. By nesting the on-site sample within the phone survey sample, the evaluators were able to achieve a more accurate estimate of the frequency of some outliers, which may include extremely high air-conditioning usage participants or extremely low air-conditioning usage participants. A schematic of the sampling strategy is shown in Figure 3-2.

Figure 3-2
Nested Sampling Schematic



[14] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=AC
[15] Wright, Double Ratio Analysis: A New Tool for Cost-Effective Monitoring, 1994

Sample Design Approach

The evaluation team designed the phone survey and on-site samples to meet a target of 90% confidence with 10% precision on program gross energy impacts per the evaluation guidelines[16]. The sample designed for this study was stratified by the population density of the participant's location. The high population density stratum included those participants residing in Manhattan, the Bronx, and Brooklyn, while the medium population density stratum included participants residing in the less-densely populated boroughs of Queens and Staten Island as well as Westchester County. The sampled strata are shown in Table 3-1. A more detailed description of the sampling approach along with details on the targeted and achieved samples can be found in the Sample Design and Final Sample Disposition section of Appendix A.

Table 3-1
Sampled Strata

Stratum	Program Population	Target Phone Sample	Achieved Phone Sample	Target On-Site Sample	Achieved[17] On-Site Sample
High population density	31,526	100	95	30	29
Medium population density	27,667	90	90	25	25
Total	**59,193**	**190**	**185**	**55**	**54**

Data Collection Methods Overview

The general data collection effort consisted of the following steps. The process is highlighted in the following sections and thoroughly detailed in corresponding sections in Appendix A.

1. The evaluation team conducted a phone survey to determine how customers report using their heating and cooling equipment on weekdays and weekends during varying outdoor conditions.
2. The evaluation team disaggregated survey participant billing data in order to calibrate phone survey data.
3. Field technicians performed rigorous data collection and metering at a sample of phone survey participant sites. The technicians metered actual equipment energy consumption and indoor temperatures.

Phone Survey Approach

[16] August 7, 2008 (updated November 2012) Evaluation Guidelines issued by the DPS through the NYS Evaluation Advisory Group (EAG), http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/766a83dce56eca35852576da006d79a7/$FILE/EVALGUIDE.11.12.pdf

[17] The achieved on-site sample reflects the number of sites with good data. The target for completed sites with good data was 50, and the on-site sample target included a 10% oversample.

The evaluation team designed the phone survey with the primary intention of determining how the participant operated his or her rebated room AC. Other goals of the survey were to determine where the room AC was located within the participant's home, the type of space being conditioned, and when and if the room AC was removed for winter and re-installed for the summer. The evaluation team asked each participant to provide a schedule of AC use depending on the forecasted high temperature for the day. For each of the three day types, the participants provided a schedule, temperature setpoint, and operating mode for the room AC. The evaluation team used the phone survey responses to predict run time during the period in which the meters were installed and adjustment factors were calculated based on the metered run time. The complete phone survey instrument can be found in Appendix C, the Residential HVAC and Room AC Program Participant Phone Survey.

On-Site Measurement and Verification Approach

The fifty-five sites included in the on-site metering sample were metered from July 15th through October 1st. At each site, the field technicians gathered data relating to site and building characteristics and equipment specifications. Field technicians used plug-in meters to monitor the direct power usage from the room AC.[18] The indoor temperature was also metered for calibration purposes and to confirm run-time accuracy. Details about the meters used on-site can be found in the Metering Equipment Details of Appendix A. A list of information gathered at each metered site can be found in the On-Site Survey section of Appendix A.

3.1.3 Approach to Data Analysis

The analysis for this evaluation included a combination of the phone survey results, billing data, and metered data. The high-level data analysis steps are listed below. A list of the analysis methods also appears below, and a brief description of the tasks follows the list. A more detailed explanation of each of the analysis methods' steps can be found in Appendix B. The data analysis steps include:

1. Billing data disaggregation for each survey participant
    a. Determine monthly consumption for each site.
    b. Estimate lighting and domestic hot water (DHW) usage.
    c. Calculate the remaining consumption (HVAC and miscellaneous equipment).
    d. Calculate miscellaneous equipment consumption.
    e. Calculate HVAC consumption by subtracting lighting, DHW, and miscellaneous equipment consumption from the monthly total.
    f. Split HVAC consumption into heating and cooling.
2. Phone survey processing for each survey participant

[18] A PMI Eagle 120 plug-in power meter was used for this purpose. The Eagle 120 plugs into the wall outlet and the room air conditioner plugs into the Eagle 120. The Eagle 120 has a self-powered clock used to time-stamp the data as it is collected, so it is resilient to any power outages. This meter only handles units up to 120V and 15A, nominally a 1-ton unit. However, larger units only represent 8.5% of the program participants and there is no reason to believe that run time varies as a function of unit size.

   a. Create a setpoint schedule for each of these day types.
   b. Create an hourly setpoint schedule for each participant for the monitored period.
   c. Determine whether or not the room AC is capable of fully meeting the cooling load when it is in use for extended periods.
   d. Generate a normalized power adjustment curve as a function of outside air temperature to predict hourly energy consumption.
   e. Model actual year cooling energy consumption using EnergyPlus.
   f. Average actual year modeled monthly cooling energy with the corresponding billing-derived cooling energy consumption estimate to determine billing adjustment factors, to be used to determine actual logged runtime over a typical year.
   g. Model a typical meteorological year (TMY) using a TMY3 in EnergyPlus.
   h. Apply the monthly billing adjustment factors to each hourly energy consumption value to generate billing-adjusted hourly run-time and energy consumption values for each participant for the actual year and for a typical year.
   i. Stratify participants in each population density stratum into substrata based on phone-predicted run times.
   j. For each of the five phone-predicted runtime based substrata, bin the billing-adjusted actual year results for the metering period and the billing-adjusted TMY results for the full year by time of day, outdoor air temperature (OAT), and high temperature.

3. Logger data processing
   a. Assign each minute-long data point an operational mode.
   b. Calculate total run time for each unit using the operational modes assigned and categorize run time by the OAT, the hour of the day, and whether the high temperature for the day was above or below 80°F.
   c. Summarize the data at the hourly level and average across all sites by stratum (high population density and medium population density).
   d. Determine the entering wet-bulb value used in the equipment models from metered indoor temperatures and humidity.
   e. Convert data points into instantaneous power values normalized by efficiency and size.
   f. Run a linear regression on the averaged normalized power data to get energy efficient power as a function of OAT.

4. Ratio analysis
   a. For each bin in each stratum, calculate the adjustment factor of billing-adjusted modeled run time for the metered period to the actual metered run time.
   b. Apply the bin and stratum-specific adjustment factors to the hourly TMY results to get a typical cooling season hourly run-time shape for each stratum.

5. Equipment modeling
    a. Start with the typical cooling season hourly run-time shape for each stratum from 4.b.
    b. Determine adjusted normalized unit power for each hour from the adjusted power benchmark curve using OAT for each hour.
    c. Calculate normalized energy consumption (in kWh-EER/ton) for each hour by multiplying adjusted run time by adjusted power for each stratum.
    d. Calculate normalized peak demand during the hour from 4 to 5 p.m. on the single hottest day of the year.
    e. Sum the hourly values of energy consumption over the entire cooling season to produce total normalized consumption for a typical year (in kWh-EER/ton).
    f. Combine normalized total consumption and peak demand with baseline assumptions to derive energy and demand savings equations.

3.1.4 Tracking System Review

A tracking system review was performed to understand how well the information in the tracking system is collected, checked for quality, and maintained by CECONY. The evaluation team initially reviewed the tracking system as a stand-alone document for understandability. The evaluators also reviewed it in conjunction with the data collected on-site for accuracy.

3.2 Attribution

Program attribution accounts for the portion of the gross energy savings associated with a program-supported measure or behavior change that would not have been realized in the absence of the program. The program-induced savings, indicated as a net-to-gross ratio (NTGR), is made up of free ridership (FR) and spillover (SO) and is calculated as $(1 - FR + SO)$.

As part of this evaluation, the evaluation team derived FR and participant SO components from self-reported information from telephone interviews with program participants and explored the presence of NPSO through the interviews with retailers. The final NTGR includes FR and participant SO rate and represents the percentage of gross program savings that can reliably be attributed to the program.

The evaluation team relied on the self-report method to derive both FR and participant SO estimates. Using the survey instrument developed by Opinion Dynamics and approved by DPS staff for this evaluation, program participants were interviewed and asked a series of structured and open-ended questions about the influence of the program and its various components and on the decision to purchase or install energy efficient cooling and heating equipment. The survey instrument can be found in Appendix D. Algorithms for estimation of the net-to-gross ratio based on the participant survey can be found in Appendix B.

3.2.1 Free Ridership

Free riders are program participants who would have implemented the incented energy efficient measure(s) even without the program. In other words, FR represents the percent of savings that would have been achieved in the absence of the program. FR estimates are based on a series of questions that explore the influence of the program in making the energy efficient installations, as well as likely actions had the incentive not been available.

The FR participant survey instrument included a series of questions designed to gather data on the customer's preexisting plans to implement the program measure, willingness to have bought the measure even if there was no program incentive (i.e., to pay full cost), and likelihood of taking the same action in the absence of the program. In most cases, methodologies account for participants that were partially influenced by the program in either the timing or number or size of units purchased and installed.

The survey measures and the FR algorithm included the following areas of program influence:

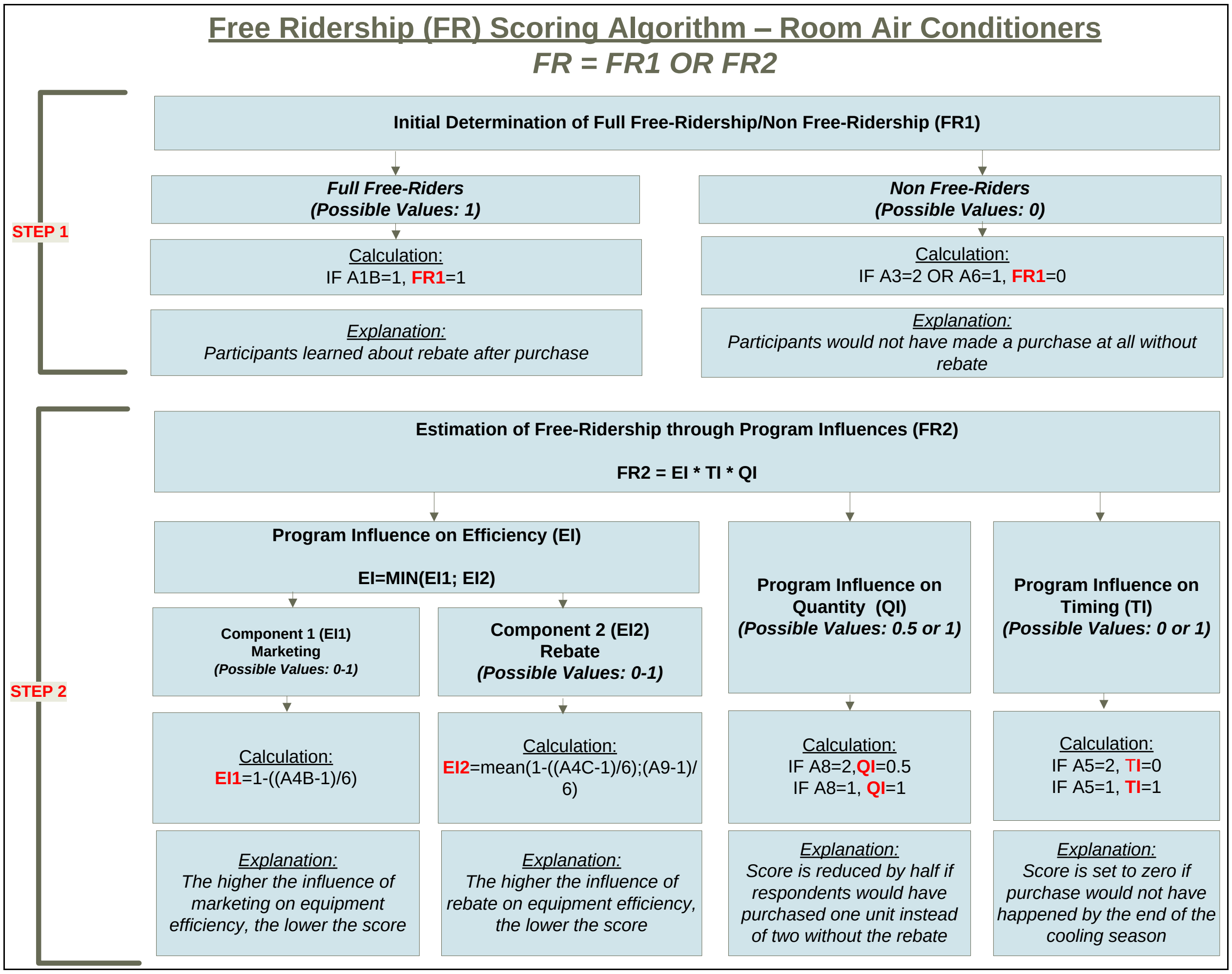
- Influence on the mere decision to purchase/install new equipment
- Influence on the efficiency level of the purchased equipment
- Influence on the quantity of the high efficiency equipment purchased
- Influence on the timing of the purchase of high efficiency equipment

The FR algorithm used in this evaluation is illustrated in Figure 3-3. As can be seen from the diagram, the final FR rate is based on three concepts that the program can influence that are then multiplicatively combined. These concepts are efficiency (EI), timing (TI), and quantity (QI). This method follows the proposed and approved approach to calculating FR for this program.[19]

It should be noted that following the approval and implementation of the Residential Room AC evaluation effort, the FR algorithm that multiplies the three program influence scores (EI, TI, and QI) has been questioned by the DPS as possibly being inadequate in estimating FR. There is an ongoing discussion occurring among the New York Department of Public Service (DPS), CECONY, O&R, evaluators, and other stakeholders regarding an alternative calculation of the FR rate. To-date, agreement has been reached to combine the efficiency and the quantity score multiplicatively. Since the discussions around alternative ways of calculating FR started after the NTG approach for the Residential Air Conditioner Program was finalized, approved, and executed, we followed the FR estimation approach that we initially proposed and did not estimate free ridership using an alternative method for this program.[20]

[19] The algorithm was approved by the DPS in May 2012.
[20] For informational purposes, we calculated the FR estimate using the alternative algorithm as 56% (instead of 53%) with a relative precision of 8% at 90% confidence (as compared to 9% with the multiplicative approach).

Figure 3-3
Free Ridership Algorithm



Spillover

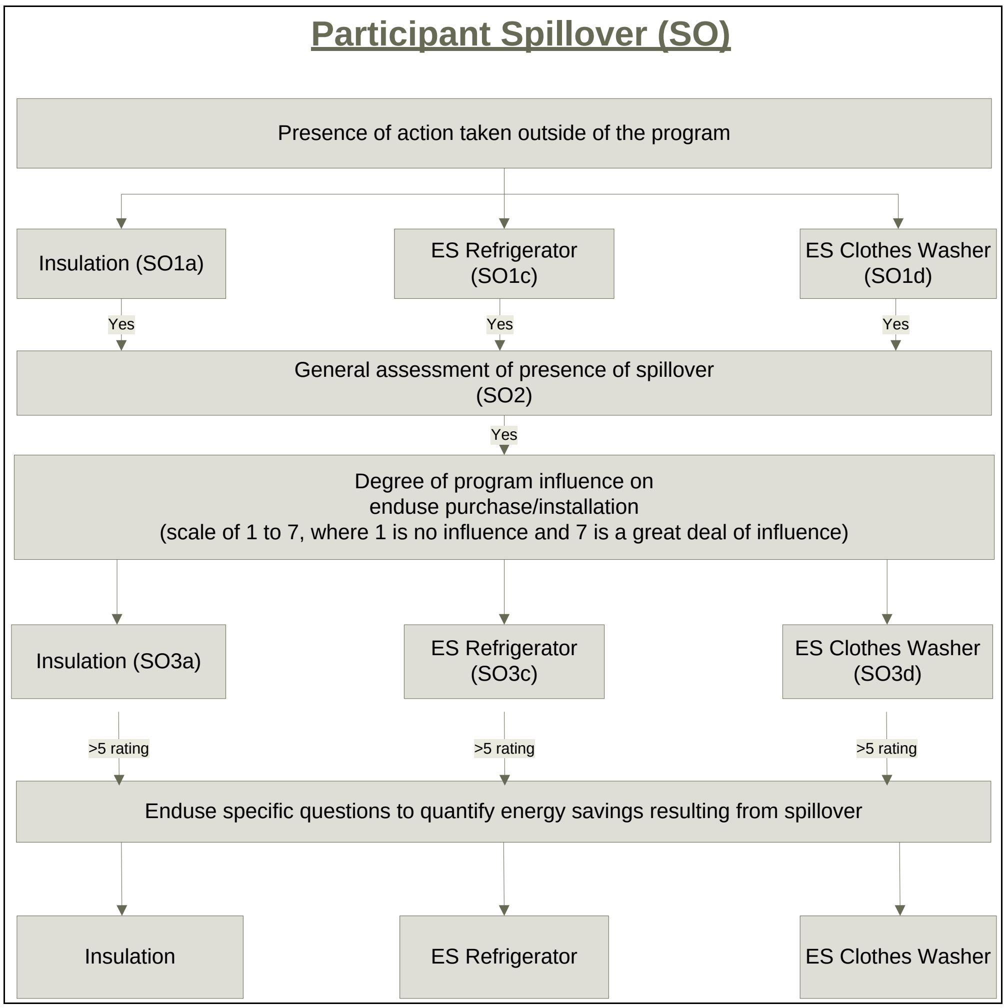
SO represents additional savings (expressed as a percent of total program savings) that were achieved without program rebates but would not have happened in the absence of the program. Through this evaluation, the evaluation team assessed participant SO through interviews with participating customers by asking about efficiency actions they took as a result of participating in the program but did not receive program support. The survey instrument contained checks to ensure consistency of response. NPSO in the market was investigated through retailer interviews.

The program has not had a substantial marketing component that would promote energy efficiency in general or the installation of other measures aside from those rebated through the program. However, past experience suggests that, for some, the experience of using one type of energy efficiency equipment can lead to looking for other ways to make one's home more energy efficient. If those additional improvements are program-induced, they can result in the SO savings that the program could claim. As part of the participant survey the evaluation team attempted to determine if participant SO existed and to quantify it.

While participant SO can result from a variety of measures, survey length did not allow for estimation of SO across all possible scenarios. To avoid overburdening participants, the survey could only ask about a limited number of actions that might be taken outside the program. The evaluation team included measures that could be reasonably expected to be influenced by program participation and are more likely to have been implemented without program support. Participant SO was measured for attic insulation, ENERGY STAR clothes washers, and ENERGY STAR refrigerators.

Participants were asked if they made any of the above-listed improvements. Those who did were asked if the CECONY program was of any influence and, if so, what the degree of influence was. Respondents were also asked to explain in their own words exactly how the program influenced their decision to make specific additional improvements. Figure 3-4 provides graphical depiction of the SO algorithm.

Figure 3-4
Spillover Algorithm



3.2.2 Retailer Interviews

The evaluation team supplemented participant research with retailer interviews. The goal of these interviews was to understand the influence of CECONY's Residential Room Air Conditioner

Program on market trends in terms of stocking and sales of room ACs. Then, the evaluation team researched if and how the CECONY program may have influenced the market shift toward higher efficiency.

The program tracking database contained names of more than 500 retailers from whom participants purchased program-rebated room ACs. The analysis of the program tracking data revealed that six retailers sold more than 80% of rebated units between 2009 and 2011, with one of those retailers having sold more than half of rebated units. All retailers were regional or national chains.

The evaluation team attempted to contact the six corporate level retailer representatives with the most program sales. Out of these six contacts, the evaluators were able to reach and complete five interviews with retailers who were responsible for nearly 80% of all program savings. The interviews were completed between November 11, 2012, and January 8, 2013.

4 RESULTS

The gross and net results of the program evaluation are shown in the sections below.

4.1 Gross Savings Results

The following section presents the program level savings results, the run-time results, the peak coincidence factor results, and the tracking system results.

4.1.1 Program Level Savings Results

The program achieved a total of 2,575 MWh energy savings and 1,612 kW peak demand savings over the evaluation period. The realization rates for energy and peak demand savings are 1.08 and 0.40, respectively. A discussion of the peak demand savings values is included in Section 4.1.3 on coincident factor. The total verified gross energy savings and realization rates are shown by stratum in Table 4-1. The total verified gross peak demand savings and realization rates are shown by stratum in Table 4-2.

Table 4-1
Program Gross Energy Impacts

Stratum	Measure Installations	Ex Ante Gross Energy Savings (MWh)	Ex Post Gross Energy Savings (MWh)	Gross Energy Realization Rate	Relative Precision[21]
High density	31,526	1,248	1,535	1.23	19%
Medium density	27,667	1,130	1,040	0.92	26%
Total	**59,193**	**2,378**	**2,575**	**1.08**	**15%**[22]

Table 4-2
Program Gross Peak Demand Impacts

Stratum	Measure Installations	Ex Ante Gross Peak Demand Savings (kW)	Ex Post Gross Peak Demand Savings (kW)	Gross Peak Demand Realization Rate	Relative Precision[21]
High density	31,526	2,137	886	0.41	34%
Medium density	27,667	1,890	726	0.38	36%
Total	**59,193**	**4,027**	**1,612**	**0.40**	**25%**

[21] Relative precision is provided for a two-tailed, 90% confidence interval.
[22] As discussed in the evaluation recommendations section, 15% relative precision is very good in this case because the program is relatively small and the evaluation methods for this study were highly rigorous.

The primary driver of the energy realization rate is that the run time is longer than expected, which increases energy usage and savings per unit. The primary driver of the peak demand realization rate is the lower coincidence factor than expected. These specific findings are discussed in more detail below.

4.1.2 Run-Time Results

The run-time results derived from combining phone survey data, billing data, and on-site metering for the room AC program are shown in Table 4-3. Room ACs were found to run for significantly more time in the more densely populated areas than in the less-dense areas. The additional run time in the high-density stratum can be attributed to the thermal mass effects of the very large buildings in high-density areas and heat islanding[23].

Table 4-3
Energy Consumption and EFLH Results by Stratum

Stratum	Normalized Energy Consumption (kWh-EER/ton)	EFLH
High density	6,623	552
Medium density	5,073	423
Weighted average for CECONY territory	**5,997**	**500**

The run-time hours for Newburgh, NY, were derived using the same method as that of the medium population density CECONY territory, except for replacing the Central Park, NY, TMY3 weather file with a Newburgh, NY, TMY3 weather file. The results are shown in Table 4-4. Newburgh is at the northern edge of O&R territory. The evaluation team recommends using either Newburgh results (407 EFLH) or averaged Newburgh and medium-density New York City results (415 EFLH) for O&R territory as shown in Table 1-11 on page 9.

Table 4-4
Energy Consumption and EFLH Results for Newburgh, NY

Stratum	Normalized Energy Consumption (kWh-EER/ton)	EFLH
Newburgh, NY	4,889	407

The suggested run-time hours for CECONY and O&R are shown in Table 4-5 in comparison with the previously used EFLH for both utilities.

[23] Additional run time in high-density geographies in shoulder months can also be attributed to the fact that many high-occupancy buildings have centrally controlled heating, introducing a possibility that the participants are using air conditioning to offset building heating.

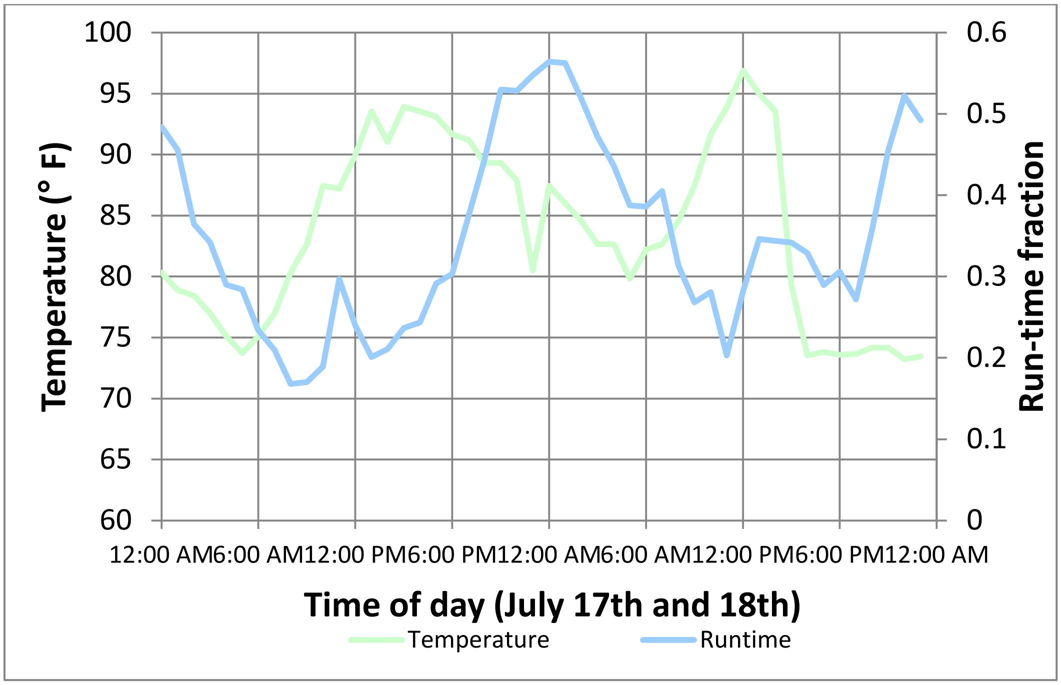
Table 4-5
Comparison of New Full-Load Run-Time Hours with Previously Used Hours

Timeframe and Stratum	EFLH
Prior to 2011 NYTM	630
2011 NYTM	233
Jan 2011 commission order	382
Medium density CECONY territory	423
High density CECONY territory	552
Newburgh, NY	407

4.1.3 Peak Demand Coincidence Factor

Profiles of temperature and hourly run-time fraction (the average fraction of an hour that all participating units are cycling, or running) are shown in Figure 4-1. The two days shown in Figure 4-1 were the hottest days of 2012 in New York. While the OAT peaks just after noon on the days shown, the metered room-AC usage peaks at approximately midnight with a run-time fraction of approximately 0.55. The metered usage is significantly lower during CECONY's peak period of 4–5 p.m. The run-time fraction of approximately 0.3 during the 4–5 p.m. period is essentially analogous to coincidence factor. The most likely explanation for the offset peak is that 50% of the rebated room ACs are installed in a bedroom, where hours of use are likely different from other areas of a residence.

Figure 4-1
Run-Time Fraction and Temperature Profile Over Two Hottest Days in Summer 2012



The coincidence factors by stratum are shown in Table 4-6.

Table 4-6
Coincidence Factor Results by Stratum

Stratum	Coincidence Factor
High density	0.32
Medium density	0.30
Weighted average for CECONY territory	**0.31**

4.1.4 Tracking System Results

From the tracking system review, the evaluation team observed a 99.8% installation verification rate. Of the fifty-four visually verified units, one was found to not actually qualify for the program, resulting in 0 savings for the site. There were additional units that had higher efficiencies (and savings) than were claimed.

4.2 Attribution

Based on the participant self-report method, the evaluation team estimated an overall FR rate for the Residential Room Air Conditioner Program of 0.53. This estimate is based on interviews with 192 program participants out of the population of more than 50,000 participants, with the results from each participant weighted by the savings contribution of that participant.[24] The precision around the estimate is 9% at 90% confidence. Given the confidence interval of 0.05, the upper bound of the FR estimate reaches 0.58 and the lower bound reaches 0.48. The values needed to determine relative precision are shown in Table 4-7.

Table 4-7
Relative Precision and Confidence Intervals

Value	Residential Room Air Conditioner Program
FR rate	0.53
Sample size	192
Participant population size	50,208
Variance	0.00088
Standard error	0.03
T-value	1.645
Relative precision at 90% confidence	0.09
Confidence interval	0.05

The program had a somewhat high FR rate indicating that many participants would have purchased their appliance in the absence of the program. Close to a third of participants (32%) had a FR rating of 0.75 and higher, and almost a quarter (23%) had a FR rating of 1.0. A third of participants (34%), however, were complete non-free riders, and 38% had a FR rating of 25% and lower.

4.2.1 Spillover

We asked survey respondents about spillover (SO) associated with installing insulation, ENERGY STAR refrigerators, and ENERGY STAR clothes washers. After a careful analysis of the participant SO using related responses from the telephone survey of participants, the evaluation team found no SO savings that could be attributed to program activity.

A total of twelve survey respondents indicated that they installed either insulation, or ENERGY STAR refrigerators, or ENERGY STAR clothes washers after participation in the Room Air Conditioner Program. Of those, only six gave the program an influence rating of 6 or 7, indicating that the program influenced their actions.[25] When probed further to explain how the program influenced the decision to make those additional improvements outside of the program, none of the six respondents provided a response that indicated the program influenced the additional projects in a manner consistent with SO.

The evaluation team explored the presence of NPSO through interviews with retailers. The results of retailer interviews show evidence that CECONY's Room Air Conditioner Program, along with other utility-administered energy efficiency programs nationwide, impact retailer stocking and sales practices, thus aiding

[24] One participant was dropped from the analysis because of the overwhelming presence of "Don't know" responses, which made the results from that specific survey unusable.
[25] On a scale of 1 to 7, where 1 means no influence and 7 means a great deal of influence.

in market transformation and resulting in NPSO. Quantifying savings from the NPSO, however, is a challenging task and was outside of the scope of this evaluation effort. Detailed findings from retailer interviews are provided in the section below.

4.2.2 Retailer Interviews

The following sections discuss the approach and results from interviews with retailers as additional input to the assessment of attribution.

State of the Room Air Conditioner Market

The room-AC market is nearly transformed. Almost all retailers we interviewed reported that ENERGY STAR room ACs comprised a large percentage of all room ACs stocked in 2011 – between 55% and 90% – with most retailers reporting the share of ENERGY STAR room ACs at 75% and higher. None of the retailers, however, had a room-AC inventory that is completely comprised of ENERGY STAR units. Furthermore, depending on the unit size and type, retailers tend to stock both ENERGY STAR and non-ENERGY STAR units in order to offer their customers variety and choice.

Most retailers noted that the share of ENERGY STAR room ACs increased between 2009 and 2011, and most of them predict further increase in 2013 and beyond. Only one retailer was able to provide an estimate for an increase in the share of ENERGY STAR room ACs between 2009 and 2011, estimating the share to have risen by approximately 15%.

Room Air Conditioner Stocking and Sales

All retailers we interviewed confirmed that the decisions about what residential room AC models to stock are made at the corporate level. Three national retailers mentioned that stocking decisions are made nationally across all of the stores. One retailer mentioned that their leadership team works with merchants when making stocking decisions. Yet another retailer said that they are a part of the buying group that collectively makes stocking decisions.

The decision to stock ENERGY STAR room ACs is driven by a variety of factors, including equipment availability, size, cost, and rebates available from utility programs and other sources (e.g., manufacturing). The primary driver of the stocking decisions is cost and quality. When reviewing the products on the market and choosing what to stock for the upcoming cooling season, retailers try to strike a balance between quality and price.

As for sales, room ACs are a “heat-driven” product category and their sales are seasonal and are highly dependent on weather patterns during the cooling season. While most retailers mentioned that they carefully plan and forecast their sales to come as close as possible to selling through the stocked inventory, some inventory might carry over to the next year if the summer is cooler than expected. In general, however, retailers said that room-AC sales mimic stocked equipment inventory.

Influence of Utility Programs on Room Air Conditioner Stocking and Sales

With the decisions being made at the corporate level, it was difficult, if not impossible, for the retailers to parse out the influence of an individual utility rebate program on stocking and sales practices. All of the retailers interviewed, however, acknowledged that utility rebates are an important factor that influences the manufacturing, stocking and sales of ENERGY STAR room ACs. Every retailer stressed that the upfront cost of room ACs continues to be the most important factor driving customer purchasing decisions, and the availability of the rebate brings the price point of the ENERGY STAR and non-ENERGY STAR units to parity. Retailers specifically mentioned seeing lower sales patterns of ENERGY STAR room ACs in markets with no utility programs.

Retailers also acknowledged that utility rebates shifted manufacturing of room ACs toward higher efficiency. Manufacturers, recognizing the increased demand for ENERGY STAR room ACs that rebates bring about, adjusted their production systems to accommodate the change and brought more ENERGY STAR models to the market.

While all of the retailers recognized the importance of utility rebates in shifting the market, they also mentioned a key challenge that prevents retailers from taking full advantage of the programs – the timing of the decision-making processes between retailers and utilities. All of the retailers mentioned that they make stocking decisions well in advance of the cooling season. Most make their selections and commit to buying those models in the fall or even earlier for the next year's cooling season. The presence of a program and the line-up of room AC models eligible for rebates, however, is usually not announced by the program administrators until the following spring, right before the cooling season, which is after the stocking decisions are made. Most retailers mentioned that if this challenge is overcome, they would be willing to customize their inventory to match the rebated models. Con Edison reports that Con Edison and Honeywell have worked closely with retailers to understand their needs.

Rebates aside, retailers also mentioned that program marketing and educational efforts are an important program feature that helps emphasize ENERGY STAR units at the store, as well as educate consumers about and showcase the benefits of ENERGY STAR units.

Expected Impact of Changing ENERGY STAR Standards

As part of the interview, we also explored the expected impact of new ENERGY STAR specifications for room ACs that are set to come in to effect in October 2013 on the stocking practices and sales. Most retailers said they were not yet sure of the impact because they have not seen the final product line-up from manufacturers. One retailer did not anticipate a lot of change.

4.2.3 Net-to-Gross Ratio

Using the NTG formula below, we derived an overall NTGR of 0.47 for the program.

$$NTG = 1 - FR + SO$$

$$NTG = 1 - 0.53 + 0$$

4.3 Net Program Level Results

Net program level results, calculated using the verified gross impacts and the NTGR, are presented in the following section.

4.3.1 Evaluated Net Impacts

With a net-to-gross ratio of 0.47, the verified program level net impacts are 1,210 MWh and 758 kW. These results are shown in comparison with the gross verified program impacts in Tables 4-8 and Table 4-9.

Table 4-8
Evaluated Net Program Level Energy Impacts

Stratum	Measure Installations	Ex Post Gross Energy Savings (MWh)	NTGR	Ex Post Net Energy Savings[26] (MWh)	Energy Relative Precision
High density	31,526	1,535	0.47	721	21%
Medium density	27,667	1,040	0.47	489	28%
Total	**59,193**	**2,575**	**0.47**	**1,210**	**17%**

Table 4-9
Evaluated Net Program Level Demand Impacts

Stratum	Measure Installations	Ex Post Gross Peak Demand Savings (kW)	NTGR	Ex Post Net Peak Demand Savings[26] (kW)	Peak Demand Relative Precision
High density	31,526	886	0.47	416	35%
Medium density	27,667	726	0.47	341	37%
Total	**59,193**	**1,612**	**0.47**	**758**	**26%**

[26] The net savings and precision for net energy and demand are provided for information purposes. The workplan for this evaluation was submitted in May 2012 and approved in June 2012 prior to inclusion of 90/10 precision on net savings as a target in DPS guidelines. This evaluation targeted 90/10 precision on gross savings and NTGR. CECONY's position is that the NTG results should be used prospectively.

5 Conclusions and Recommendations

As a result of the evaluation, the evaluation team makes several conclusions and recommendations, which are contained in the following section.

5.1 Conclusions

The results of this study show three main conclusions. These conclusions are listed below and discussed in detail in the Results section.

1. Usage is higher in high-density population areas than in medium-density population areas within CECONY territory.
2. Hours of use are higher than specified by the January 2011 commission order or the latest NYTM.
3. Usage peaks later in the day than expected, resulting in a reduced coincidence factor.

In addition, the evaluation team notes that FR for this program is driven, at least in part, by transformational changes in the market. That is, the program's relatively high FR rate likely is due to some extent to a transformation of the room-AC market in New York and across the country. ENERGY STAR products regularly go through a cycle of market transformation, in which their incremental costs decrease and perceived benefits increase over time, resulting in increased sales. This increase in sales results in a parallel increase in self-reported FR in utility incentive programs. Eventually, when the market is almost entirely transformed, the ENERGY STAR requirements are updated to qualify only higher efficiency models. The next ENERGY STAR requirement update for room ACs will be on October 1, 2013. At that point, the market targeted by the program will shift, and FR for programs based on incentivizing ENERGY STAR units are expected to decrease. The update to ENERGY STAR requirements indicates that the market has been transformed.

The evaluation team suggests that CECONY, along with other utilities that have sponsored ENERGY STAR room-AC programs in recent years, is likely responsible for some portion of this market transformation, including the NPSO that has occurred in New York through changes in stocking practices of major retailers.[27] This phenomenon should be taken in to account when assessing the cost-effectiveness of the program and deciding about its future. Future years of this program should not have the high FR that the program of the past few years has experienced, due to the revised (more stringent) ENERGY STAR requirements.

5.2 Recommendations

The evaluation team's recommendations for the program, the NYTM, and any future evaluations are given in the following section.

[27] Arizona Public Service has claimed savings for market transformation. For more information, see *SEER is Overrated – Capturing Savings from Residential HVAC Market Effects* (from ACEEE Summer Study 2012).

5.2.1 Program Recommendations

The evaluation team offers four recommendations for increasing program cost effectiveness. These are listed below and then discussed in detail. The evaluation team's recommendations focus on driving participation toward higher energy savings per transaction or on lowering the cost of achieving savings.

1. **Consider targeted marketing focused on higher population density areas.** Because the results of this study show that higher savings are achieved in higher population density areas of New York City, the evaluation team suggests using targeted marketing focused on Manhattan, Brooklyn, and the Bronx to drive participation in higher population density areas. This would achieve higher savings per unit with equal costs.
2. **Consider redesigning the program to utilize an upstream or midstream approach to implementation.** In order to decrease administrative costs and increase program participation, CECONY should consider implementing an upstream or midstream program. Instead of offering the customer rebates, consider providing incentives to product suppliers or retailers to ensure that store shelves are stocked only with ENERGY STAR-rated room ACs at an already-incentivized price. This should drive increased participation with lower administrative costs and has the potential for a large market influence.
3. **Consider implementing higher efficiency tiers to drive participation for higher savings units.** In addition to leveraging the ENERGY STAR requirement update, CECONY should consider implementing more rigorous program participation requirements by efficiency level or offering higher incentives for higher savings tiers. This should increase participation for higher efficiency units and increase overall savings.
4. **Consider bundling room ACs with additional measures.** To increase savings per transaction with minimal incremental cost to CECONY, consider offering participants the option of bundling their room AC with other ENERGY STAR appliances or measures. One possibility for increasing savings is to add an opt-in, low-cost measure to the rebate application. For example, participants could check a box to receive a heavily discounted smart strip, in lieu of part of their rebate. This is a way to drive higher savings per participant at minimal cost to the program.[28] Con Edison is currently exploring options to add a controllability function/device to allow customers who purchase a qualifying Room AC unit through the Residential Room AC Program, to be able to program those units remotely. This option has the potential to enhance the program's value in the future.

5.2.2 Recommendations for the New York Technical Manual

The NYTM should adopt the verified hours of use for both CECONY and O&R territories, as shown in Table 5-1 and Table 5-2, respectively, for use with the existing algorithm in the NYTM. If possible, the CECONY program should offer deemed hours of use for participants based on their population-density based stratum. If this is not possible, it is recommended that the program use the weighted average of 500

[28] A recent opt-in giveaway program in Maryland showed surprisingly high installation rates, as shown in a forthcoming EmPOWER Maryland evaluation report.

for the entire CECONY program population. The evaluation team recommends that O&R program use an average of Newburgh, NY and medium density CECONY for the deemed hours of use.

Table 5-1
Meter-based EFLH for Use in NYTM - CECONY

Stratum	CECONY Boroughs	Meter-based EFLH
High density CECONY	Manhattan, Brooklyn, Bronx	552
Medium density CECONY	Queens, Westchester County, Staten Island	423
Weighted average CECONY		**500**

Table 5-2
Meter-based EFLH for Use in NYTM – O&R

Stratum	CECONY Boroughs	Meter-based EFLH
Medium density CECONY	Queens, Westchester County, Staten Island	423
Newburgh, NY		407
O&R Average		**415**

5.2.3 Evaluation Recommendations

Upon completing this evaluation, the evaluation team has some recommendations for ways to improve future room AC evaluations.

- If using double ratio estimation method, design the metered sample differently.
  - Conduct the phone survey earlier to determine predicted run time before the field study begins and post stratify based on predicted run time.

    Ideally, the sample of metered sites from within the phone survey sites would have provided improved precision on the sites that were predicted to have high run times by oversampling those substrata. This would have been implemented by pre-processing the phone survey before the field study started to determine predicted total run times for each site, and then post-stratifying each population density strata into high and low predicted run-time substrata. Upon starting the field study, the sample – still nested within the phone sample – would have included more sites in the high run-time substrata within each population density stratum. Use of this method would require a larger phone sample size.
  - Use a higher coefficient of variation (cv) when sampling the metered sites from within the phone survey sample.

In this study, a coefficient of variation (cv) of 0.25 was used when sampling the metered sites from within the phone survey sample because the evaluation team assumed that the phone survey would accurately predict metered run time[29]. A low cv assumes that there is little variation between the

[29] CV of 0.25 was used based on professional judgment and past experience with air conditioning studies.

phone survey and metered samples and results in a low on-site metering sample. A higher cv should have been used and would have resulted in a larger on-site sample.

- ❑ Shift evaluation resources from phone surveys towards metering of sites.

While the double-ratio estimation method worked in this evaluation as a way to decrease costs and increase precision, the method did not provide as strong of an advantage for the room AC measure as it may for other measures. Because room ACs are used in a wide variety of applications, the metered run time cannot be predicted as well by an engineering-based phone survey. In this case, phone surveys needed to be performed for attribution, so the incremental cost to add verification questions was relatively low. The incremental cost of each metered site is approximately $2,000. In this particular study, the cost of adding usage questions to the survey, fielding those questions, and analyzing those results worked out to approximately $30,000. This would purchase fifteen additional on-site visits and would not have improved the confidence and precision compared to the two-stage phone and on-site method used. The evaluation team recommends continuing to use a two-stage phone survey and on-site metering method, with a more simplified set of usage survey questions and accompanying analysis, which would allow for a larger on-site sample, focused on people who say they use their room ACs more than their peers.

- ❑ Do not use an engineering-based phone survey alone to determine run-time results for room air conditioning.

The evaluation team determined that a usage-based phone survey is a weak predictor of actual room-AC usage. For this reason, the evaluation team does not recommend using a survey of this type as the only method to calculate savings within an evaluation of this measure.

- ❑ Prioritize rigor in evaluation method rather than precision. Do not target 90/10 for room AC programs or for typical smaller programs with highly rigorous metering evaluations.

A relative precision target of 20% will achieve the accuracy necessary to make decisions around small programs without consuming a large portion of the program budgets. A metering only evaluation with a goal of achieving 90/10 would have sampled 150 sites (with an additional cost of approximately $200,000). The additional budget required to achieve 90/10 in the case of this evaluation would have been approximately $175,000.

A highly rigorous study with lower relative precision is of greater quality and value than a low rigor study in which 90/10 is achieved. If the evaluation team had used only the lower rigor phone survey results in this study, the sampling uncertainty may have reached 10%, but the true uncertainty and inaccuracy in the results would have been much higher.

APPENDIX A – DETAILED DATA COLLECTION METHODS

This appendix explains the detailed data collection methods of the evaluation.

Sample Design

A stratified random sample of program participants acquired in 2011 was pulled for the Residential Room AC Program telephone survey and on-site M&V activities, with a single participating household as the sampling unit. The selection of customers from the most recent year reduced the time between customer decision-making and the attribution surveys and should improve customer recruitment rates. On-site samples were nested within the phone survey samples.

The Residential Room AC phone sample was stratified into high density (Manhattan, Brooklyn, Bronx) and medium and low density (Queens, Staten Island, Westchester). Other characteristics (equipment size, county, and manufacturer) were sampled on a quota basis to ensure representativeness. This secondary stratification was not used to determine sample weights for stratification, but rather to impose maximum caps (quotas) on the contributions from any single group in order to eliminate potential bias. After the phone survey processing is completed, the nested on-site sample was further stratified into high and low users on the basis of predicted run time[30]. The results of the on-site metering were used to calculate an adjustment ratio on the phone survey and billing results. This method is known as double-ratio estimation.[31] The assumed coefficients of variation and resulting sample sizes and final confidence and relative precision are shown in Table A-1.

Table A-1
Residential Room AC Sample Design

Stratum	Total Acquired Participants in 2011	Reported Savings (kWh)	Phone CV	Phone Surveys	On-Site to Phone CV	On-Site M&V Surveys	Final Projected Precision at 90%
High density	21,136	831,182	0.7	100	0.25	30	90/14
Medium and low density	17,653	710,885	0.7	90	0.25	25	90/15
Total	**38,789**	**1,542,067**		**190**		**55**	**90/10**

The coefficients of variation (CV) for the phone survey and on-site surveys were estimated from other impact evaluations of Residential AC measures. However, since the programs have not been evaluated previously, the actual CVs were unknown at the time of sampling and were determined at the conclusion of the study. The actual program precision is a function of the CVs, and therefore the final precision

30 Ideally this post stratification would have happened earlier in order to dictate the onsite metering sample. In this evaluation, the post stratification was done after the onsite metering sample was chosen due to time restraints.

31 The total relative precision in this double-ratio estimation case is calculated as the square root of the sum of the squares of the relative precision of the phone survey and the relative precision of the on-site survey. This method is described in detail in Wright, R. L. et al., "Double Ratio Analysis: A New Tool for Cost-Effective Monitoring", in *Proceedings of the 1994 ACEEE Summer Study on Buildings*.

attained varies from the projected precision shown in Table A-1. The actual program CVs and precision are shown in Table A-2 below.

Table A-2
Residential Room AC Sample Design

Stratum	Total Acquired Participants in 2011	Predicted Phone CV	Actual Phone CV	Predicted On-Site to Phone CV	Actual On-Site to Phone CV	Predicted Precision at 90% Confidence	Actual Precision at 90% Confidence
High density	21,136	0.7	0.4	0.25	0.6	90/14	90/19
Medium and low density	17,653	0.7	0.5	0.25	0.7	90/15	90/26
Total	**38,789**					**90/10**	**90/15**

The secondary stratification targets are shown in Tables A-3, A-4, and A-5.

Table A-3
Residential Room AC Manufacturer Phone Survey Sample Quota

Manufacturer	Fraction of Program Population	Minimum Phone Samples	Maximum Phone Samples
Frigidaire	36%	55	82
Friedrich	19%	29	44
Sharp	13%	19	29
GE	9%	14	22
LG	9%	13	20
Kenmore	6%	9	13
Generations	6%	9	13
Other	2%	3	5

Table A-4
Residential Room AC Borough Phone Survey Sampling Quota

Borough	Fraction of Program Population	Minimum Phone Samples	Maximum Phone Samples
Brooklyn	32%	49	74
Queens	32%	49	73
New York	11%	17	25
Bronx	10%	15	22
Westchester	9%	14	20

Richmond (Staten Island)	6%	9	13

Table A-5
Residential Room AC Size Phone Survey Sample Quota

Size (Btu/hr)	Fraction of Program Population	Minimum Phone Samples	Maximum Phone Samples
<8,000	36%	54	82
8,000 to 13,999	56%	85	128
14,000 to 19,999	6%	9	14
>=20,000	2%	3	5

Participant Survey Final Sample Disposition

The Residential Room Air Conditioner Program participants were surveyed from June 26, 2012, through July 23, 2012. The evaluation team completed a total of 193 interviews. The telephone interviews were conducted using a Computer-Assisted Telephone Interviewing (CATI) system. Table A-5 shows the final survey dispositions for the participant survey.

To minimize the measurement error, the survey was tested internally for comprehension. Additionally, it was pre-tested with several participants to ensure that survey questions are interpreted correctly and answered in a consistent manner.

Table A-6
Residential Room ASC Program Participant Survey Dispositions

Disposition	N
Completed interviews	193
Eligible non-interviews	1,053
Refusals	336
Break off	33
Telephone answering device	252
Respondent never available	375
Language problem	57
Not eligible	305
Fax/data line	21
Non-working	183
Wrong number	64
Business/government	23
No eligible respondent	13
Duplicate number	1
Unknown eligibility non-interview	1,204
Not dialed/worked	749
No Answer	449
Busy	3
Call Blocking	3
Total Participants in Sample	**2,755**

Table A-6 provides the response and cooperation rates. The survey response rate is the number of completed interviews divided by the total number of potentially eligible respondents in the sample. The evaluation team calculated the response rate using the standards and formulas[32] set forth by the American Association for Public Opinion Research (AAPOR).[33]

The evaluation team also calculated a cooperation rate, which is the number of completed interviews divided by the total number of eligible sample units actually contacted. The cooperation rate gives the percentage of participants who completed an interview out of all of the participants with whom the evaluation team actually spoke. We used AAPOR Cooperation Rate 1 (COOP1).

Table A-7
Residential Room AC Program Participant Survey
Response and Cooperation Rates

AAPOR Rate	Percentage
Response rate (RR3)	8%
Cooperation rate	34%

There are multiple sources of non-sampling error that can impact survey results, including non-response error and resulting coverage bias. This type of bias is usually overcome through comparing and, if needed, weighting the survey results to the observable characteristics (generally demographic or household) in the population of customers targeted by the survey effort. Because the demographic composition of the participant population is unknown and may have inherent differences from the overall customer population, the non-response bias could not be calculated. However, we tried to mitigate the non-response bias through the fielding process by taking the following steps:

- Calling participants multiple times at varying times of the day and week
- Extending the fielding process over a period of time to “work” the sample.

On-site visit participants were chosen from the telephone survey sample. The final dispositions of the on-site sample are shown in Table A-7.

Table A-8
Room Air Conditioner Telephone and On-Site Sample Targets and Achieved Sample

Measure	On-Site Targets	On-Sites Complete	On-sites with Usable Data Target	On-site Surveys with Usable Data
Room AC	55	55	50	54

On-Site Survey

A list of all the information collected on-site at each sampled site is below under the categories of Equipment Information, Logger Information, Customer Interview, and Site Characteristics.

[32] We used AAPOR Response Rate 3 (RR3). The calculation includes an estimate of what proportion of cases of unknown eligibility are actually eligible.

[33] *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*, AAPOR, 2011. http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156

Equipment Information

- ❑ Room AC manufacturer/model
- ❑ Unit size (Btu/h)
- ❑ SEER

Logger Information

- ❑ Thermostat temperature logger details
- ❑ Eagle plug-in logger details

Customer Interview

- ❑ Gift card number, signature
- ❑ Year home built
- ❑ Total conditioned floor area
- ❑ Floor space served by new unit
- ❑ Number of conditioned floors
- ❑ Number of AC units on-site

Site Characteristics

- ❑ Home setting and type
- ❑ Average ceiling height
- ❑ Foundation information (if single-family home)
- ❑ Infiltration information
- ❑ Electric meter number and reading
- ❑ Wall information (photos of each side of house), construction, exterior finish
- ❑ Window information (photos of each side of house), shading, panes
- ❑ Detailed building sketch
- ❑ Room details: open/closed, room sketch, building level, ceiling height, window info, plug loads, current AC settings

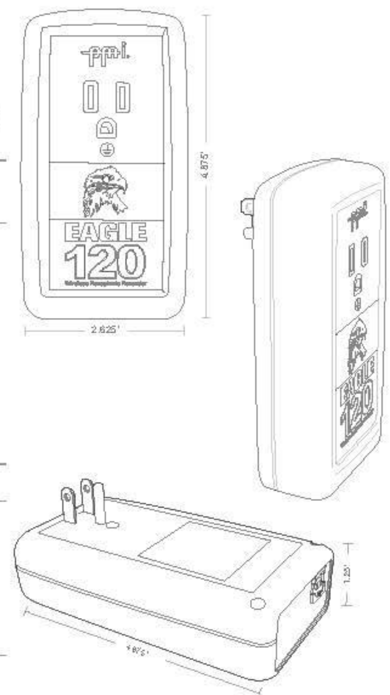
Metering Equipment Details

At each site, the field technician installed meters to log the instantaneous power usage of the room AC unit and the temperature and relative humidity of the room containing the unit. The two meters used at each site are the PMI Eagle 120 and the HOBO U12. The PMI Eagle 120 is a plug-in energy logger with time stamps. The HOBO U12 is a temperature and relative humidity interval logger. The specifications and pictures of each logger are shown in Figure A-1 and Figure A-2.

Figure A-1
PMI Eagle Logger Data Sheet

EAGLE

EAGLE 120



INPUTS	AC Voltage	60 to 140 VAC RMS Continuous, 0 to 240 VAC Peak, Neutral-Ground 0-75 VAC RMS
	AC Current	0 to 80 amps RMS (15 amps continuous)
	Sample Rate	256 samples/cycle/channel
CHANNELS	Voltage	2 channels
	Current	1 channel
MEASURED QUANTITIES PER CYCLE	RMS Voltage	Volts
	RMS Current	Amps
	Real Power	Watts
	Apparent Power	VAs
	Reactive Power	VARs
	Phase Angle	Degrees
	Power Factor	Watts/VA
	Displacement PF	cos (phase angle)
	Power Usage	kWh, kVARh, kVAh
COMMUNICATIONS	Type	USB, Bluetooth® Wireless (optional)
INFORMATION STORAGE	Interval Graphs	1.2 MB (Standard) 6.9 MB (with memory option)
	Significant Change	1000 records
	Flicker	1000 records
	Waveform Capture	256 KB (standard) 1.7 MB (with memory option)
RECORD SETTINGS	Interval Graphs	1 cycle to 4 hour interval. User selected, stop-when-full, or wrap around memory modes
	Significant Change	1V to 8V in 1V steps
	Flicker	User-defined, or conform to IEEE1453/ IEC61000-4-15, and IEEE Std. 141
	Waveform Capture	Voltage and current threshold, periodic capture
ENVIRONMENTAL	Operating Temp	-20°F to +135° F
	Shock	60 Hz to 2 KHz, acceleration 25G
	Vibration	10Hz to 60Hz, amplitude 1.8mm
ACCURACY	Voltage	0.33% of full scale
	Current	1.0% of full scale
	Power	1.0% of full scale
	Phase Angle	1.0°
	Power Factor	±0.02
	Displacement PF	±0.02
PHYSICAL DIMENSIONS	Size	4.9" L x 2.7" W x 1.25" H
	Weight	0.5 lbs
HARMONICS	Voltage	to the 51st
	Current	to the 51st
	Measures	magnitude, phase, THD

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Figure A-2
HOBO Temperature/Relative Humidity Logger Data Sheet

HOBO® U12 Temperature Data Logger (Part # U12-001)

Inside this package:

- HOBO U12 Temperature Data Logger
- Mounting kit with magnet, hook and loop tape, tie-wrap mount, tie wrap, and two screws.

Doc # 7551-B, MAN-U12-001
Onset Computer Corporation

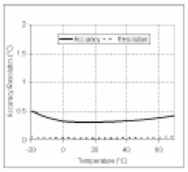
Thank you for purchasing a HOBO data logger. With proper care, it will give you years of accurate and reliable measurements.

The HOBO U12 Temperature Data Logger is a single channel temperature logger with 12-bit resolution and can record up to 43,000 measurements or events. The logger uses a direct USB interface for launching and data readout by a computer.

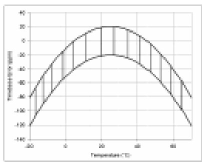
An Onset software starter kit is required for logger operation. Visit www.onsetcomp.com for compatible software.

Specifications

Measurement range	-20° to 70°C (-4° to 158°F)
Accuracy	± 0.35°C from 0° to 50°C (± 0.63°F from 32° to 122°F), see Plot A
Resolution	0.03°C at 25°C (0.05°F at 77°F), see Plot A
Drift	0.1°C/year (0.2°F/year)
Response time	In airflow of 1 m/s (2.2 mph): 6 minutes, typical to 90%
Time accuracy	± 1 minute per month at 25°C (77°F), see Plot B
Operating temperature	Logging: -20° to 70°C (-4° to 158°F) Launch/readout: 0° to 50°C (32° to 122°F), per USB specification
Battery life	1 year typical use
Memory	64K bytes (43,000 12-bit measurements)
Weight	46 g (1.6 oz)
Dimensions	58 x 74 x 22 mm (2.3 x 2.9 x 0.9 inches)
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).



Plot A



Plot B

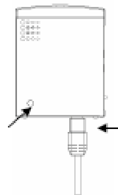
Accessories available

- White waterproof case (Part # SUBC2-WH)
- Gray waterproof case (Part # SUBSC2-GR)

Connecting the logger

The U-Family logger requires an Onset-supplied USB interface cable to connect to the computer. If possible, avoid connecting at temperatures below 0°C (32°F) or above 50°C (122°F).

1. Plug the large end of the USB interface cable into a USB port on the computer.
2. Plug the small end of the USB interface cable into the bottom of the logger as shown in the following diagram.



If the logger has never been connected to the computer before, it may take a few seconds for the new hardware to be detected. Use the logger software to launch and read out the logger.

Important: If you configure the logger to start with a button start, be sure to press and hold down the button on the front of the logger for at least three seconds when you want to begin logging.

You can read out the logger while it continues to log, stop it manually with the software, or let it record data until the memory is full. Refer to the software user's guide for complete details on launching, reading out, and viewing data from the logger.

Sample and event logging

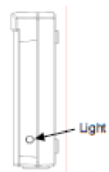
The logger can record two types of data: samples and events. Samples are the sensor measurements recorded at each logging interval (for example, the temperature every minute). Events are independent occurrences triggered by a logger activity. Examples of events recorded asynchronously during deployment include when the logger is connected to the host, when the battery is low, the end of a data file once the logger is stopped, and button pushes.

Press and hold down the button on the front of the logger for one second to record an event. Both a button up and down event will be recorded. This is useful if you want to mark the datafile at a particular point. For example, if the logger is located in an incubator, you might press the button each time the door is opened.

The logger stores 64K of data, and can record up to 43,000 samples and events combined.

Operation

A light (LED) on the side of the logger confirms logger operation.



The following table explains when the logger blinks during logger operation.

When:	The light:
The logger is logging	Blinks once every one to four seconds (the shorter the logging interval, the faster the light blinks); blinks when logging a sample.
The logger is awaiting a start because it was launched in Start At Interval, Delayed Start, or Button Start mode	Blinks once every eight seconds until launch begins.
The button on the logger is being pushed for a Button Start launch	Blinks once every second while pressing the button and then flashes rapidly once you release the button. The light then reverts to a blinking pattern based on the logging interval.

Part #: MAN-U12-001, Doc #: 7551-B

Billing Data

The evaluation team requested the billing data for the summer months from CECONY in mid-November to include all of May, June, July, August, September, and October for all customers who participated in the phone survey. The requested billing data encompassed the entire metering period as well as May and June, to ensure that the entire summer period was included in the billing data disaggregation.

APPENDIX B – DETAILED ANALYSIS METHODS

This appendix details the analysis methods used in this evaluation.

Billing Data Disaggregation

In order to determine cooling consumption values to adjust the phone survey models, the evaluation team analyzed billing data from the phone survey participants. Data from CECONY was in the form of rows containing energy consumption for the past billing period, the billing date, and the number of days in the billing cycle. Data was cleaned and converted to energy consumption for each calendar month by the following process:

1. Determine the average consumption per day in each billing period by dividing total consumption by number of days.
2. Calculate consumption per day at the beginning and end of each billing period by assuming a constant slope between consumption per day of the previous period and that of the following period, and using that slope to adjust the average consumption per day of the current period.
3. Assign consumption values to each day of the billing period by assuming that consumption per day linearly follows the slope calculated in (2).
4. Determine consumption for each calendar month by summing the consumption per day for the appropriate days of the two billing periods that contain part of that month. [34]

End-Use Disaggregation

Once monthly consumption was determined for each site, those monthly total values were broken down by end-use using the Navigant billing data end-use disaggregation method. This method is Navigant's standard practice, and has been used in performing numerous residential evaluations nationwide. The basic steps are as follows:

1. **Determine monthly consumption** for each site by splitting participant billing data into calendar months (described above).
2. **Estimate lighting and DHW usage** based on the U.S. DOE's Building America Research Benchmark.
3. **Calculate the remaining consumption**, which is attributable to HVAC and miscellaneous equipment (all uses other than lighting, DHW, and HVAC), by subtracting lighting and DHW consumption from the monthly total.
4. **Calculate miscellaneous equipment consumption** by:

[34] This method, while more complex than simply determining the portion of each billing period in each month and assigning a proportional amount of the consumption to that month, is a more accurate way of dividing consumption. The alternative method will tend to reduce the (real) split between the highest and lowest consumption months by assuming that consumption in a given billing period is constant; it is important to get an accurate value for the lowest-consumption month, since that drives the end-use disaggregation described below.

a. Identifying the base month, defined as the month with the lowest remaining consumption per day; assume that heating and cooling (HVAC) consumption accounts for a small fraction of the total in the base month (usually ~10%–15% in temperate climates with both heating and cooling).

b. Subtracting the HVAC consumption in the base month from the remaining consumption; assume that this miscellaneous equipment consumption per day is constant throughout the year.

5. Calculate HVAC consumption by subtracting lighting, DHW, and equipment consumption from the monthly total.

6. Split HVAC consumption into heating and cooling by assigning all winter (Nov–March) HVAC consumption to heating and all summer (June–Sept) HVAC consumption to cooling; split swing-season HVAC consumption by assuming heating and cooling are proportional to the heating and cooling degree days in each month.[35]

Lighting and DHW Consumption

The first step in disaggregating monthly energy consumption into end uses is to break out the uses that can be reliably calculated using engineering algorithms and primary research: lighting and DHW.

Annual lighting consumption per household was estimated using an equation from the US DOE's Building America Research Benchmark (BARB), which gives lighting consumption as a function of square footage of floor area:

$$Annual\ lighting\ consumption\ (kWh) = 0.737 \times Floor\ area\ (sq\ ft) + 467$$

Total annual lighting consumption was split into monthly consumption using the seasonal lighting load shape, also from BARB.

Square footage information was sourced from several Internet real estate databases (trulia.com and zillow.com). For the sites that this info was unavailable, a modeled square footage was assigned by a simple linear regression of square footage as a function of total kWh consumption in July, for the sites that did have square footage information.

Hot water heater fuel was not a known value; however, a gas study by GDS Associates[36] indicates that only 4.5% of homes in the CECONY gas service territory have electric hot water. Based on this, the evaluation team assumed that DHW electric consumption was 0 for all homes.[37]

Miscellaneous Equipment Consumption

[35] Heating and cooling degree days were taken from www.degreedays.net, a website that aggregates data from the Weather Underground (www.wunderground.com)

[36] "Natural Gas Energy Efficiency Potential Study", GDS Associates, Inc. Nov 2007.

[37] For the small number of homes for which this is an incorrect assumption, the DHW consumption would be lumped in with the miscellaneous equipment consumption; overall impact on the resulting HVAC consumption is small.

After subtracting the hot water and lighting end uses from the monthly household electricity consumption, the remaining consumption is composed of HVAC and miscellaneous equipment, which includes appliances and plug loads. To find the portion of the remaining consumption that is from miscellaneous equipment, remaining consumption per day was calculated for each month, and the month with the minimum daily remaining consumption was identified. This month is generally in the spring or the fall, and it corresponds to the time of lowest HVAC use. It was assumed that during this minimum-consumption month, HVAC accounted for either 0%, 3%, or 10% of total consumption, based on a visual QC of the data (past experience has shown this to be a reasonable assumption)[38]. Daily equipment consumption for this minimum month was then calculated as the total consumption per day minus the consumption of lighting, DHW, and HVAC. This equipment consumption per day was assumed to remain constant throughout the year.

Heating and Cooling Consumption

Once the monthly lighting, DHW, and miscellaneous equipment consumptions were known, total HVAC consumption was calculated by subtracting these three end uses from the monthly totals. Next, HVAC consumption was split into heating and cooling energy. For November to March, all HVAC consumption was assumed to be heating, while for June to September, all HVAC use was assumed to be cooling. Shoulder month (April, May, and October) heating and cooling consumption was estimated using the relative proportions of heating and cooling degree days by the following steps:

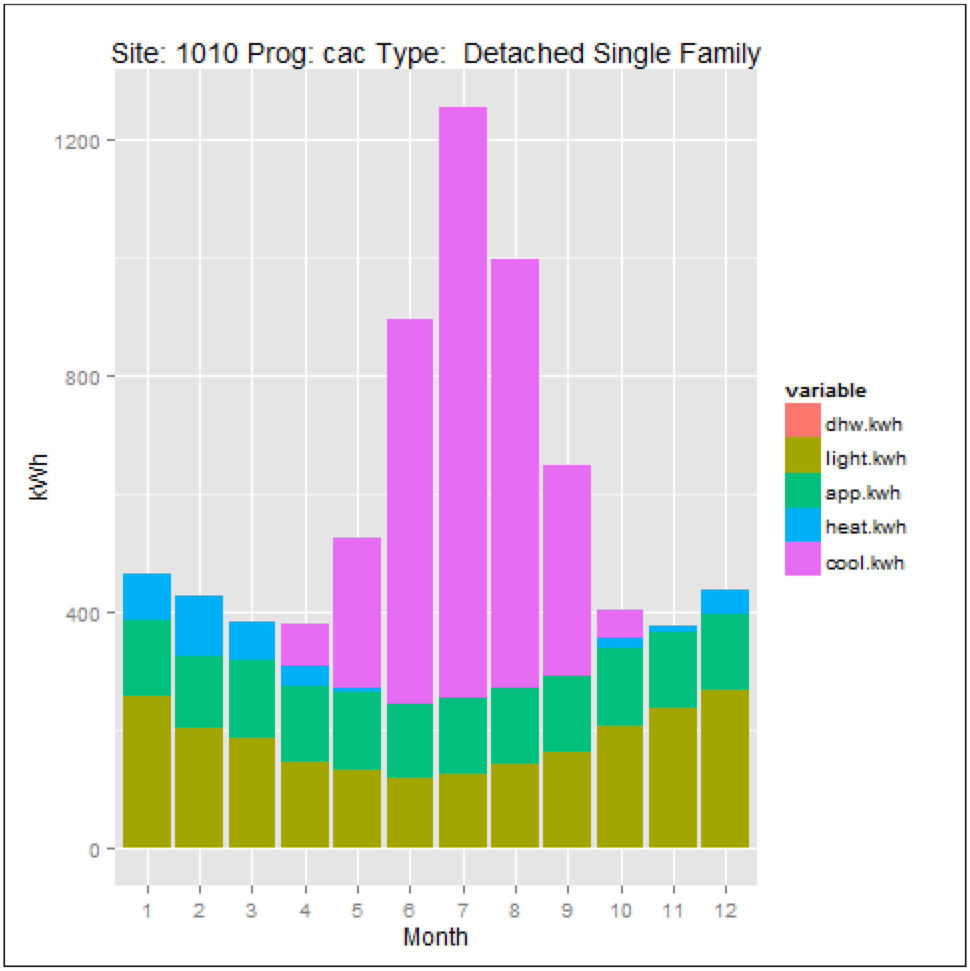
1. Heating degree days (HDD) and cooling degree days (CDD), base 65°F (HDD65 and CDD65), were found for each month.[39]
2. A CDD-to-HDD weighting factor was determined as $WF = \frac{\text{HVAC kWh}_{\text{Jan}} / \text{HDD65}_{\text{Jan}}}{\text{HVAC kWh}_{\text{Jul}} / \text{CDD65}_{\text{Jul}}}$, indicating the relative contributions of CDD and HDD to total HVAC consumption.
3. The fraction of total HVAC in each month that was cooling was calculated as $\frac{\text{CDD65}/\text{WF}}{\text{CDD65}/\text{WF} + \text{HDD65}}$, and
4. Cooling consumption for each month was calculated as total HVAC consumption multiplied by the cooling fraction, with heating consumption accounting for the remainder of the HVAC energy.

An example of a completed end-use disaggregation is shown in Figure B-1.

[38] 10% was assigned to sites that appeared to have electric space heat, indicated by a large increase in total electric consumption during the heating months. 3% was assigned to sites that appeared to have gas space heat with an electric fan as the distribution system, indicated by a small increase in winter electric consumption. 0% was assigned to sites that appeared to have no electric consumption associated with heating, such as multi-family buildings with central steam heat, indicated by no increase in winter electric consumption.

[39] Heating and cooling degree days were taken from www.degreedays.net, a website that aggregates data from the Weather Underground (www.wunderground.com)

Figure B-1
Example of End-Use Disaggregation



Quality Control

The initial disaggregation produced negative HVAC consumption for some sites, due to the error introduced by the uncertainty in the square footage numbers, which resulted in unreasonably high lighting consumption for some sites. To mitigate this error, the evaluation team iterated the disaggregation process for sites that had negative HVAC consumption, reducing the lighting consumption by 25% each time, until no further negative values existed.

A further QC step was completed to identify sites that did not have sufficient billing data for this method to produce a robust result; billing data is inherently subject to irregularities due to occupant behavior (vacations, etc.). Sixty-five sites (out of 338) were flagged as having unreliable data based on a visual QC. For these sites, the cooling consumption was determined by taking the average percent of total consumption due to cooling from the reliable sites, by month, and building type, and applying that percentage to the monthly consumption for each unreliable site.

Controlling for Multiple Units

The final step before the billing data could be compared to the phone survey model was to adjust cooling consumption to represent only a single unit at sites where there were multiple AC units. The adjustment was done in the following steps:

1. Determine total tons of rebated units at each site. Unit size was pulled from the tracking data and summed over all units for each site.
2. Determine total tons of ALL cooling units at each site. First, building square footage was divided by total tons of rebated units. If sq ft/ton was less than 700, it was assumed that the rebated units accounted for all of the cooling equipment at the site. If not, total tons of cooling equipment was calculated by assuming 600 sq ft/ton, and multiplying by the square footage.
3. Determine fraction of cooling attributable to the modeled unit. In all cases, the modeled unit was the largest rebated unit at the site. For sites in which the rebated units accounted for all of the cooling equipment at the site, the fraction attributed to the modeled unit was equal to the ratio of the size (tons) of the largest unit to the total tons of cooling equipment at the site. For sites in which the rebated units did not account for all of the cooling equipment, the same fraction was derived based on the fractional size of the equipment, but it was reduced by 20% to account for the new equipment being more efficient than the older equipment that was still operating.

Phone Survey Processing and Data Cleaning

The evaluation team conducted phone surveys with participants until the quotas were filled. The responses to the survey questions were compiled into an Excel spreadsheet and provided to the analysis team. The analysis team went through a series of steps to process the data, evaluate it for quality, and clean it before generating predicted run times. This section describes those steps.

Data Import and Quality Checks

Once the data was imported into Excel, the evaluation team visually inspected the responses to identify potential issues or incomplete answers. Each participant was asked if they operate their room AC on days when the high temperature was between 70°F–80°F, 80°F–90°F, and above 90°F. If they responded "yes" to these questions, they were then asked what operating mode they use, what temperature setpoint the room AC is set to and what hours of the day the unit is in use. Of the 193 people that the evaluation talked to, 185 of the surveys resulted in responses that contained enough information to create reliable setpoint schedules.

There were three cases where the participants did provide times when they operated their room AC but could not recall or did not provide a setpoint value. For these cases, the evaluation team calculated the average setpoint values for the participants that did respond and populated the schedules with the average values for those who didn't respond.

After reviewing the methodology, weather data, and survey responses, the evaluation team decided that it would be more appropriate for the hours of midnight to 10:00 a.m. to use the previous day's high temperature and the survey responses for that day type rather than the current day. The high temperature from the previous day is much more likely to influence participant behavior in the morning hours than the high temperature for the current day, which has more of an impact on behavior for the current day.

Phone Survey Predicted Run Time

The evaluation team processed the survey responses from the participants to predict room AC run time for the summer of 2012. The final output of the phone survey analysis was an hourly run-time prediction for each participant (who also participated in on-site metering) during the same period that the meter was installed. The general analysis steps are listed below.

1. The participants' responses to the times of day that they operate their room AC on days when the high temperature is 70°F, 80°F, and 90°F were used to create a setpoint schedule for each of these day types.
2. 2012 weather data[40] and the day type setpoint schedules were used to create an hourly setpoint schedule for each participant for the monitored period.
3. The participants' responses to where the room AC is located and if that room is typically isolated when the room AC is in use determine whether or not the room AC is capable of fully meeting the cooling load when it is in use for extended periods.
    a. For room ACs in non-isolated rooms, the evaluation team assumed that the room AC was operating continuously depending on the setpoint schedule.
    b. For room ACs in isolated rooms, an energy model was created [41] to generate hourly cooling loads on the room AC.
4. The evaluation team generated a normalized power adjustment curve as a function of outside air temperature to predict hourly energy consumption.
5. The monthly modeled energy consumption was computed and averaged with the billing cooling energy consumption in order to generate a monthly billing adjustment factor for each participant. The evaluation team applied the monthly adjustment factors to each hourly energy consumption value to generate billing-adjusted hourly run-time and energy consumption values for each participant.[42]
6. The same general methodology was used for generating weather-normalized predicted run-time and energy consumption values for all of the phone survey participants. In this case, a typical weather file was used in the simulation to determine cooling loads and the 2012 monthly billing adjustment factors were used to calculate total run time and energy consumed.

Sample Post Stratification

The evaluation team sorted the sampled sites in ascending order based on the phone-predicted run times for a typical meteorological year. The high population density stratum was divided into three substrata for

[40] The source of the weather data was the National Oceanic and Atmospheric Administration's National Climatic Data Center for Central Park, New York

[41] The U.S. Dept. of Energy's EnergyPlus 7.1 whole building energy simulation program was used with a custom generated weather file for 2012 at Central Park, NY.

[42] In cases where the model predicted zero cooling energy consumption but the billing analysis showed non-zero cooling energy consumption, the average of zero and the non-zero value was assumed to be the cooling energy consumption. The evaluation team generated a monthly cooling load profile from the remaining participants which was applied to the cooling load to generate an hourly cooling load profile for these cases.

low, medium, and high phone-predicted run time. The medium population density stratum was divided into two substrata for low and high phone-predicted run time. Ratio estimation works poorly on numbers that are zero or nearly zero. Therefore, a regression estimation adder – rather than the typical regression ratio estimation – was used for the phone-predicted low run-time substratum in each population density strata. The method of using an adder creates an adjusted estimate that accounts for consumers who claim not to use their room AC at all, but in fact have a low but non-trivial run time as indicated by the metered data.

Phone Survey Responses and Respondent Characteristics

Table B-1, Table B-2, and Table B-3 show the planned maximum and minimum manufacturer types, borough and 47room AC size for the phone survey participants with the actual phone survey respondent values. As the tables show, all of the minimum quotas were met and there were three instances where the quantity surveyed was greater than the planned maximum.

Table B-1
Residential Room AC Manufacturer Phone Survey Sample Quota and Achieved Sample

Manufacturer	Fraction of Program Population	Minimum Phone Samples	Maximum Phone Samples	Actual Phone Survey Participants
Frigidaire	36%	55	82	56
Friedrich	19%	29	44	34
Sharp	13%	19	29	33
GE	9%	14	22	16
LG	9%	13	20	14
Kenmore	6%	9	13	12
Generations	6%	9	13	16
Other	2%	3	5	4
Total	**100%**	**151**	**228**	**185**

Table B-2
Residential Room AC Borough Phone Survey Sampling Quota and Achieved Sample

Borough	Fraction of Program Population	Minimum Phone Samples	Maximum Phone Samples	Actual Phone Survey Participants
Brooklyn	32%	49	74	53
Queens	32%	49	73	64
New York	11%	17	25	19
Bronx	10%	15	22	23
Westchester	9%	14	20	17
Richmond (Staten Island)	6%	9	13	9
Total	**100%**	**153**	**227**	**185**

Table B-3
Residential Room AC Size Phone Survey Sample Quota and Achieved Sample

Size (Btu/hr)	Fraction of Program Population	Minimum Phone Samples	Maximum Phone Samples	Actual Phone Survey Participants
<8,000	36%	54	82	65
8,000 to 13,999	56%	85	128	100
14,000 to 19,999	6%	9	14	16
>=20,000	2%	3	5	4
Total	**100%**	**151**	**229**	**185**

The evaluation team also asked participants where in their house the room AC was installed. Figure B-2 contains the breakdown of room type where the room ACs were installed. Additionally, the evaluation team also asked participants if the room where the room AC was installed was usually closed while the unit was in operation. This information affected how individual participant's room AC was simulated to develop predicted run-time and energy consumption. Figure B-3 shows the breakdown of room ACs installed in isolated vs. not isolated rooms for the phone surveyed participants.

Figure B-2
Room Types Where Room Air Conditioners Were Installed

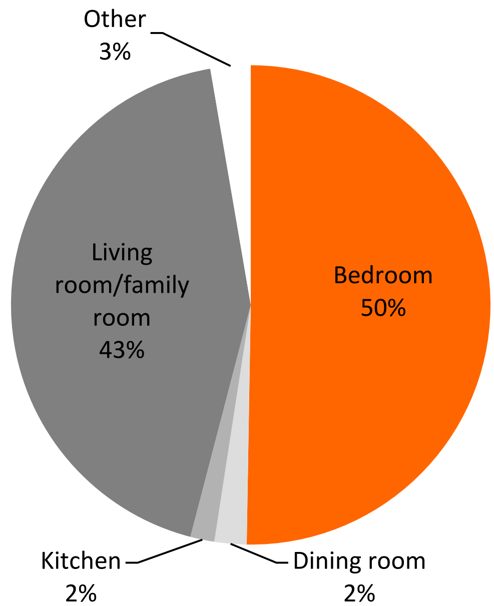
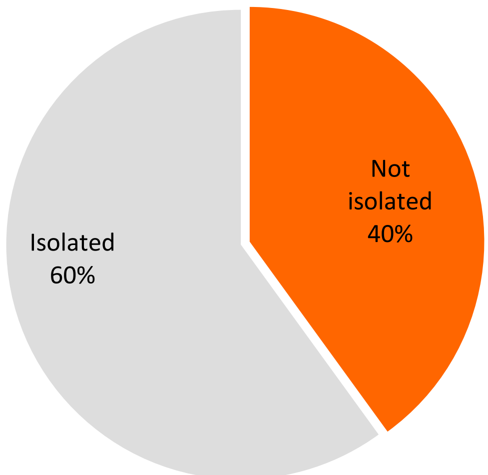
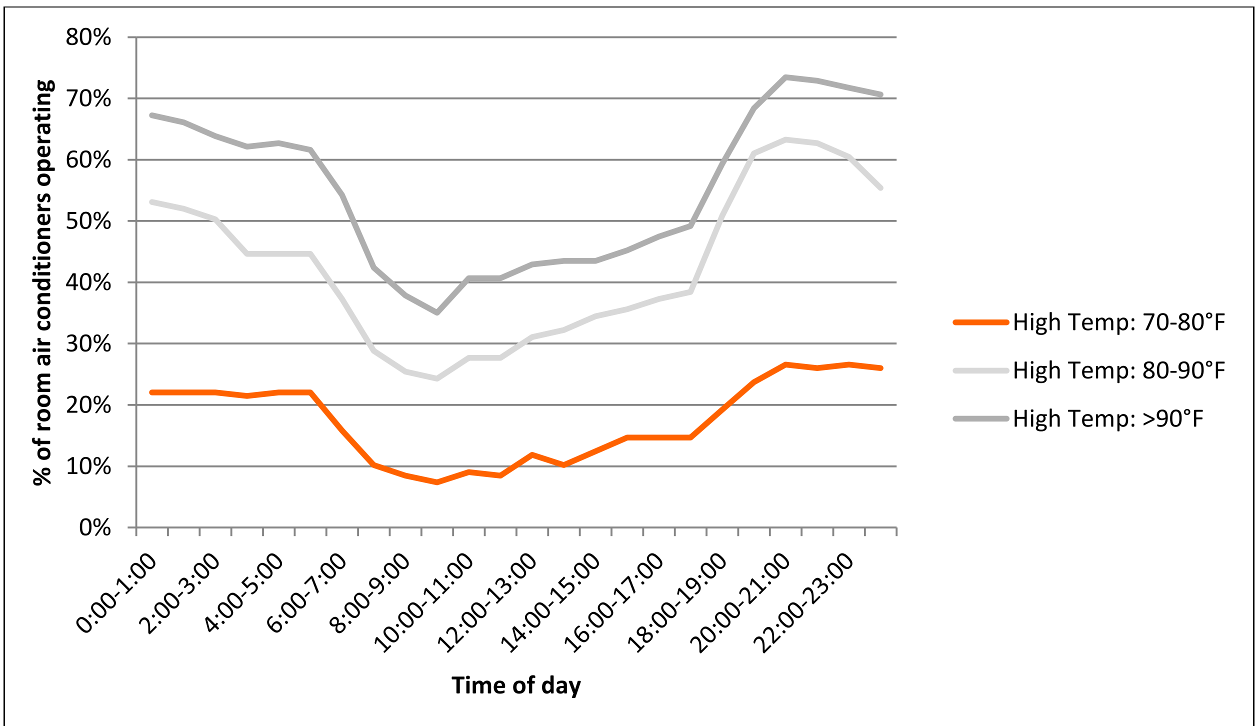


Figure B-3
Quantity of Room Air Conditioners Installed in Isolated vs. Not Isolated Rooms



After cleaning the data, the evaluation team used the procedure outlined above to calculate predicted run times and energy consumption based on the survey responses and billing data from the summer of 2012. Figure B-4 shows the percentage of room ACs that were running during each hour of the day for each of the three day types.

Figure B-4
Profile of Room Air Conditioner Usage for the Three Day Types



Logger Data Processing and Cleaning

This section details the methods used for logger data processing and cleaning for use in the evaluation.

Data Import

The evaluation team began the logger data processing step by combining the list of logger files with the tracking spreadsheet to find missing loggers and catch data entry errors. Once each logger file was matched to a specific end-use at the correct site, all the raw text files were read into SAS and converted to SAS datasets. Care was taken to custom read the different types of HOBO files and the Eagle files, stored in four different configurations of text files, into a consistent format. The raw logger data was combined with contextual data, such as site identification and end use, by merging in the data in the tracking spreadsheet from the site visits.

Initial Data QC

The evaluation team ran some basic QC checks for data quality, and it was determined that the files from the Eagle loggers had some gaps in the time series data, sometimes for multiple days. Based on discussions with the manufacturer, it was determined that these gaps did not compromise the quality of the other data in the logger files – they were likely due to power outages or the logger being unplugged for a period of time. However, it was decided that due to the unknown nature of the gap, it would be necessary to throw out data close to the outage. The evaluation team decided that if a day had greater than 1 hour of total gap time, the entire day would be thrown out. This resulted in the deletion of data from 68 total days at ten sites with a maximum of 23 days deleted at any site[43].

Data Transformation

Next, the evaluation team transformed the data to get it into the format needed for analysis. The Eagle 120s logged average power, which was multiplied by the time interval to get kWh. The data from the installation and retrieval dates for each logger were then deleted, because the installation and removal of the data logging equipment introduces some bad data into the logger file.

Both loggers for each site were combined into a single time series of data by rounding all timestamps to the nearest minute. Because the indoor temperature data was only logged every 5 minutes, the intermediate values were linearly interpolated. The final result was a single time series of data per site which contained room air conditioner unit power draw, indoor temperature, and indoor relative humidity, all at 1-minute intervals.

Finally, OAT was added from a NOAA weather file for Central Park (the same file used in the phone survey models). This single weather station was chosen so that results could be extrapolated to a typical year using a typical meteorological year (TMY) file for the same site. The NOAA temperature data, initially one measurement per hour, was also linearly interpolated to provide temperature readings for each minute.

[43] Even for this site with 23 days deleted, there were 66 good days of data – adequate data to provide robust results for the site.

Visual QC

After transforming the data, the evaluation team did one further round of quality control. The data from each site was plotted, one plot per day, and the plots were visually checked for irregularities. Nine sites were identified for having isolated instances of very high readings of energy consumption. After discussion with the manufacturer, it was determined that these irregularities did not impact the validity of the rest of the data on those logger files; however, data from the days showing the irregularities was deleted.

Logger Data Analysis

After processing and cleaning the logger data, the evaluation team analyzed the data to determine run times in different operational modes.

Run-Time Calculation and Data Summarization

Each data point was determined as either "on" or "off" according to its kW value. Once these assignments were made, the evaluation team calculated unit run time for each logged data point. On points were assigned a full minute of run time while off points were assigned no run time. The calculated run times for each site were summed up to the hourly level. Hourly run times were averaged across all sites by stratum (high, medium) for room AC units. These average run-time values were then used to adjust the phone survey model results.

Indoor Temp Analysis

The logged data was also used to determine the entering wet-bulb value used in the equipment models. The evaluation team first converted the indoor temperature and relative humidity values to indoor wet-bulb temperature values using August-Roche-Magnus approximation. Next, the indoor wet-bulb values were averaged for all "on" points – considered the best approximation of conditions seen by the unit. The most representative value was 64°F. It was assumed that the air wet-bulb temperature would increase by 1°F on average, so 65°F was used in the model.

Room AC Equipment Model

The objective of the equipment modeling step was to produce generic tables that would predict the power draw of a generic unit at of a given efficiency at a given outdoor dry-bulb temperature. For room AC units, there was very little performance information available from manufacturers. As a result, the evaluation team derived in-situ benchmark curves, rather than adjusting generic curves.

In-Situ Benchmark Power Curves

First, the tracking values of unit size and efficiency were verified by looking each logged unit up in the ENERGY STAR database of room AC units. Next, the kWh values from all logged data that was assigned the "high" mode were converted to instantaneous power values. Those power values were then normalized by multiplying by ($EER\ /\ Size\ (tons)$). The normalized power values were aggregated by averaging the instantaneous power of all data points in each one-degree OAT bin. Finally, the averaged normalized power values for each temperature were smoothed by running a linear regression of power as a function of OAT, using only the temperature bins that contained at least 100 data points.

Calculation of Run-Time Adjustment Factors

For each site in the on-site sample, the run time in each bin was calculated using the phone survey and on-site logging analysis. The results were then summed for each bin across all sites, giving a total phone-predicted run time and logged run time for the logged period across all logged sites in each stratum. The on-site logged run time was divided by the phone-predicted run time to derive the adjustment factor for each bin that contained 5 or more hours of logged time. Bins that contained fewer than 5 hours were combined with the next higher or lower bin until an aggregation of greater than 5 hours was available. For example, there might have only been one hour greater than 95 degrees between the hours of noon and 4 p.m. during the logged period. This bin would have been combined with the 90°F–95°F bin for noon to 4 p.m., creating a new, 90°F or more between noon and 4 p.m. bin in place of the two original bins. The resulting adjustment factors were then applied to typical year phone-predicted results.

Unit Savings Equation Derivation

The starting point for the savings equations was a file of hourly run times and temperatures for a typical cooling season, produced by the adjusted phone survey model, run with a Typical Meteorological Year (TMY) weather file. The following steps were taken to derive the energy and peak demand savings as a function of size and efficiency for a typical year:

1. Import TMY modeled hourly run times and temperatures. Separate run times were produced for each stratum. Both run times and outdoor dry-bulb temperatures were given for the entire cooling season (assumed to last from April to October).
2. Combine with run-time adjustment factors by bin. Modeled run times were adjusted by multiplying by the run-time adjustment factor of the bin that corresponded to each hour, derived from the logged data. Run-time adjustment factors were binned OAT, hour of day, and average daily temperature.
3. Determine adjusted normalized unit power for each hour. Adjusted power was derived from the adjusted power benchmark curve, using OAT for each hour. All power values were normalized (in units of kW-EER/ton), to allow them to represent units of generic size and efficiency.[44]
4. Calculate normalized energy consumption for each hour. Normalized energy consumption (in kWh-EER/ton) was calculated for each hour by multiplying adjusted run time by adjusted power. This was done separately for each stratum (high and medium) for RAC units.
5. Calculate normalized peak demand. The CECONY peak period is defined as the hour from 4 to 5 PM on the single hottest day of the year. For the TMY file, that hottest day was July 25th. The peak demand was thus calculated to be equal to the energy consumption from step 4 during the 4-5 PM hour on 7/25, since average power is equal to total energy consumption for a given hour.
6. Find total normalized energy consumption. The hourly values of energy consumption were summed over the entire cooling season to produce total normalized consumption for a typical year (in kWh-EER/ton).

[44] To determine the power of a specific unit, one would multiply that value by the size of the unit in tons, and divide by the rated EER.

7. Derive savings equations. Normalized total consumption and peak demand were combined with baseline assumptions to derive energy and demand savings equations.

    c. Energy

        i. $Energy\ savings\ (kWh/ton)\ =\ Normalized\ total\ consumption\ (kWh - EER/ton)\ \times\ (1/EER_{Base} - 1/EER_{Eff})$.

    d. Demand

        ii. $Peak\ demand\ savings\ (kW/ton)\ =\ Normalized\ peak\ demand\ (kW - EER/ton)\ \times\ (1/EER_{Base} - 1/EER_{Eff})$.

Program Savings Calculation

Final program savings were calculated by combining the savings equations with the program tracking data. Before savings could be calculated, the tracking data was cleaned in the following steps:

1. Verify room AC units in the ENERGY STAR database. The evaluation team verified the tracking data for size and efficiency of RAC units by comparing to the units in the ENERGY STAR database of products, both to check the accuracy of the tracking data and to determine the proper baseline EER to use for each unit. The federal standard EER varies based on several parameters not tracked in the data (louvered sides, reverse cycle, and casement/non-casement), but by looking up the models in the database it was possible to assign appropriate baseline EER values. After cleaning the model numbers, 96% of the tracking records were matched to the database.
2. Assign base efficiency. The base EER value from the ENERGY STAR database was used where available; where that value was missing, it was filled with the average base EER of all units of the same size.
3. Calculated savings by line item by merging in savings equations and calculating savings by unit SEER, EER, and size.

Comparison of Phone-Predicted and Logged Results

Figure B-5 shows the relationship between the billing adjusted phone-predicted run time over the logged period and the metered run time for the fifty-four sites that had meters installed. The graph clearly shows that the most participants either run their ACs significantly more or less than they thought based on their responses to the survey questions. Using simple linear regression, the correlation coefficient (R^2) value is only 0.21, which indicates that the phone-predicted run time is not a good indicator of actual room AC use.

Figure B-5
Regression of Logged Run Time on Billing Adjusted Phone-Predicted Run Time

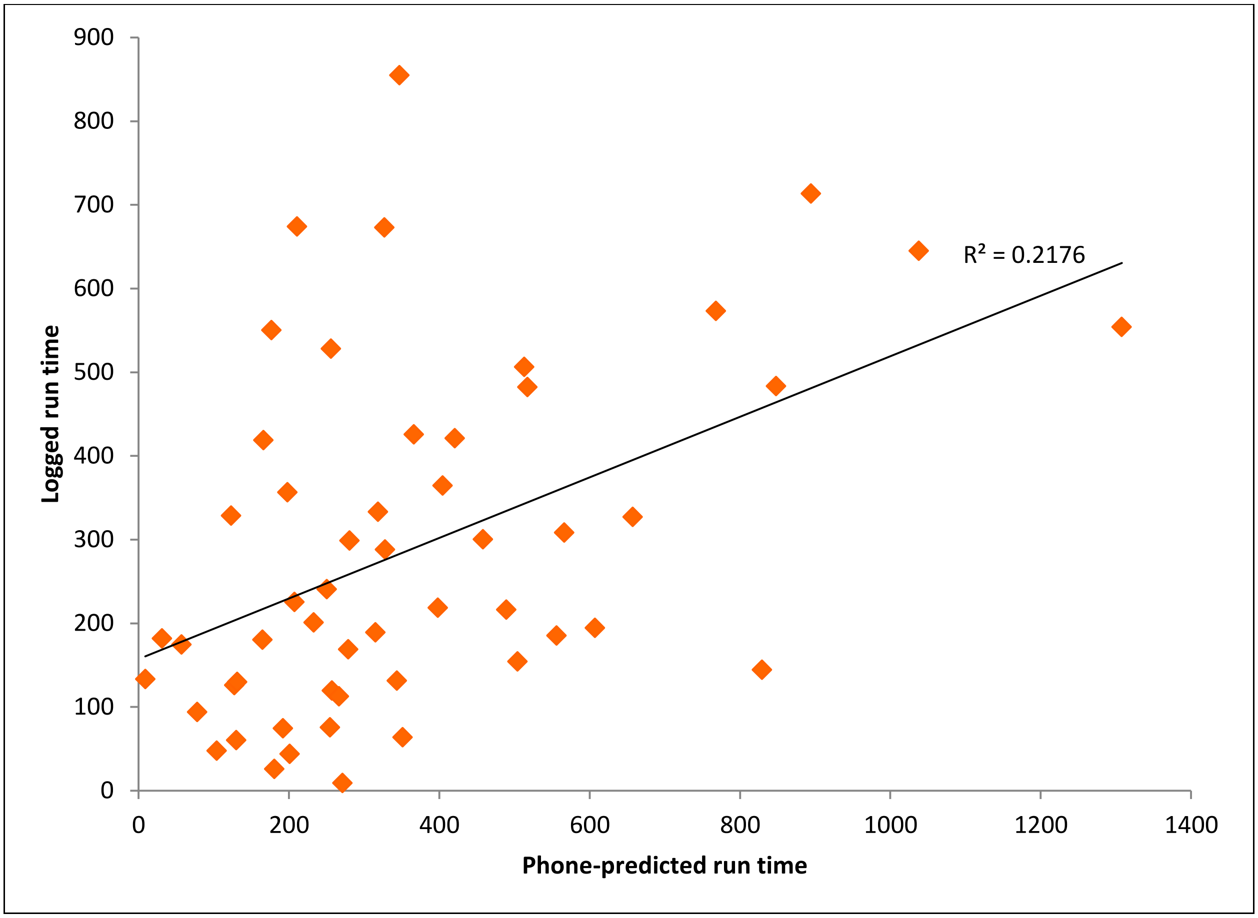
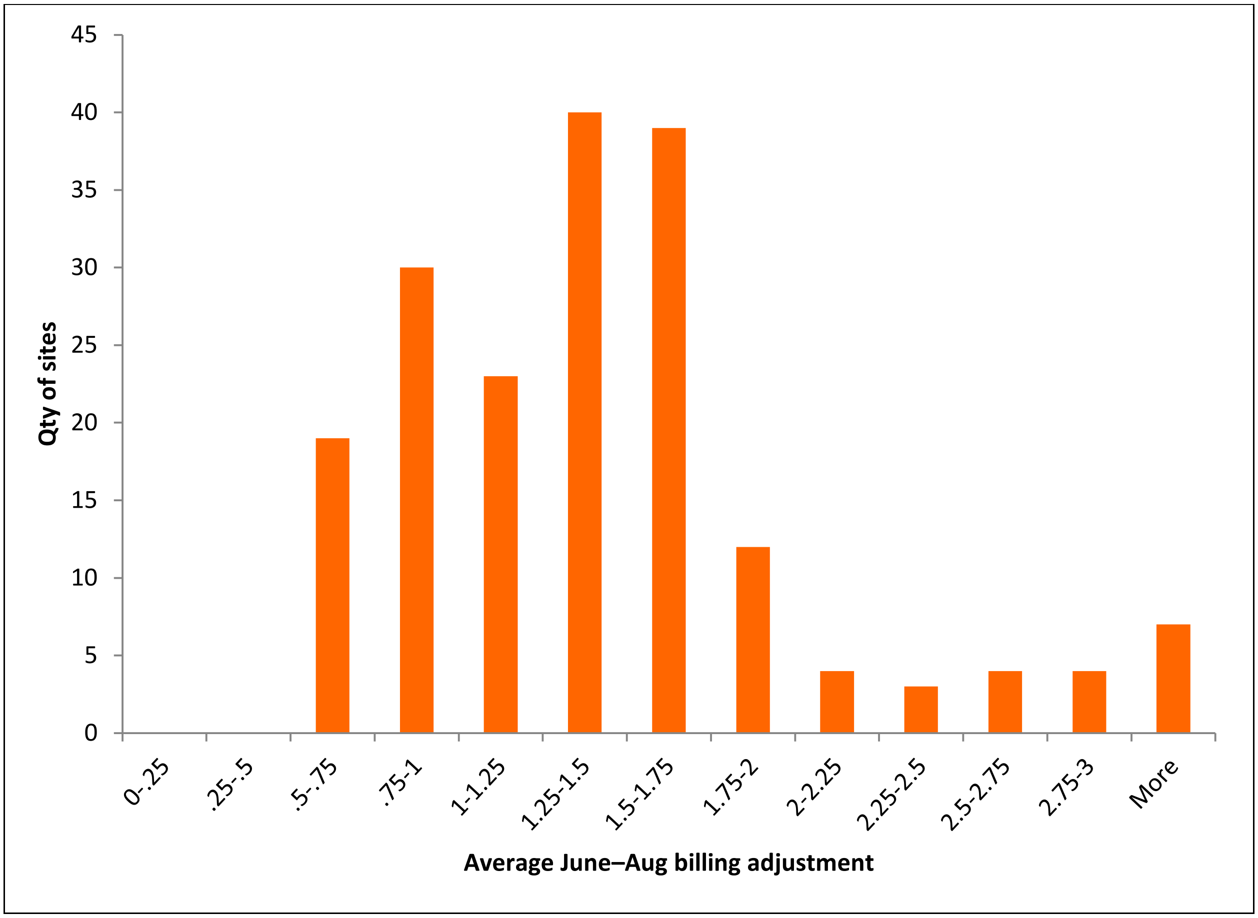


Figure B-6 shows the average billing adjustment factors for June, July, and August (when the majority of cooling occurs) for the 185 phone-surveyed sites. The histogram shows that the billing analysis for the majority of sites increases the phone-predicted energy consumption, mostly by between 1.25 and 1.75 times. This indicates that either the model the evaluation team used to predict energy consumption underestimates consumption or that the respondents actually use their room air conditioners more than they think they do. Based on the poor correlation between phone-predicted and logged run time, the latter is likely the source of the high billing adjustment factors.

Figure B-6
Average June–Aug Billing Adjustment Factors Applied to Phone-Predicted Energy Consumption



Attribution Calculations

Program attribution accounts for the portion of the gross energy savings associated with a program-supported measure or behavior change that would not have been realized in the absence of the program. The program-induced savings, indicated as a net-to-gross ratio (NTGR), is made up of FR and spillover SO and is calculated as $(1 - FR + SO)$.

As part of this evaluation, the evaluation team derived the FR and participant SO components from self-reported information from telephone interviews with program participants and explored the presence of NPSO through the interviews with retailers. The final NTGR includes FR and participant SO rate and represents the percentage of gross program savings that can reliably be attributed to the program.

Methodology for Free Ridership and Spillover

The evaluation team relied on the self-report method to derive both FR and SO estimates. Using the survey instrument developed for this evaluation, program participants were interviewed and asked a series of structured and open-ended questions about the influence of the program and its various components on the decision to purchase or install energy efficient cooling and heating equipment. The algorithm for estimation of the NTGR based on the participant survey is presented below.

Free Ridership

Free riders are program participants who would have implemented the incentivized energy efficient measure(s) even without the program. In other words, FR represents the percent of savings that would have been achieved in the absence of the program. FR estimates are based on a series of questions that explore the influence of the program in making the energy efficient installations, as well as likely actions had the incentive not been available.

The FR participant survey instrument included a series of questions designed to gather data on the customer's preexisting plans to implement the program measure, willingness to have bought the measure even if there was no program incentive (i.e., to pay full cost), and likelihood of taking the same action in the absence of the program. In most cases, methodologies account for participants that were partially influenced by the program in either the timing or number or size of units purchased and installed.

The survey measures and the FR algorithm included the following areas of program influence:

- ❑ Influence on the mere decision to purchase/install new equipment
- ❑ Influence on the efficiency level of the purchased equipment
- ❑ Influence on the quantity of the high efficiency equipment purchased
- ❑ Influence on the timing of the purchase of high efficiency equipment

Using the self-report method, the evaluation team measured each of the areas of influence when estimating FR. When calculating FR, the evaluation team used a two-step approach that included:

- ❑ Step 1 (FR1) – Identifying full free riders and non-free riders and assigning FR values of 1 and 0, respectively
- ❑ Step 2 (FR2) – Further estimating the magnitude of FR

Each respondent's FR score was calculated using either Step 1 or Step 2 above (as they are mutually exclusive). As such, the final estimates are inputs resulting from either Step 1 or Step 2. The final FR value equals:

$$FR = FR1 \text{ } or \text{ } FR2$$

To arrive at the final program-level FR score, the scores of each participant were weighted by the energy savings values for the equipment installed by that participant.

Below is a detailed description of each step, which includes specifics on the questions, inputs, and formula.

Step 1 (FR1) – Initial Determination of Full Free Ridership and Non-Free Ridership

The questions below were used to determine if a participant is a full free rider. Participants who said that they had learned about program rebates *after* purchasing or installing program qualifying equipment were deemed full free riders and were assigned a FR value of 1.

Survey questions:

A1a *When did you first learn that you could receive a rebate from CECONY for purchasing a new high efficiency room air conditioner? Was it before or after you purchased the air conditioner(s)?*

[IF AFTER]

A1b Just to be clear, did you purchase your high efficiency room air conditioner and then later learn that you could receive a rebate from CECONY?

<u>Calculation:</u>

If A1A= After and A1B=Yes → FR=1

On the other hand, participants who said that they would not have purchased/installed any equipment, regardless of its efficiency level, without the program were deemed non-free-riders and assigned a FR value of 0. The following questions were used to determine non-free ridership.

Survey questions:

A3. *If the CECONY rebate had not been available, would you have purchased a room air conditioner at all?*

[IF THEY VOLUNTARILY SAY THAT THE PURCHASE WOULD NOT HAVE HAPPENED IN RESPONSE TO A5 ASKING ABOUT TIMING OF PURCHASE]

A6. *Just to confirm, if the CECONY rebate had not been available, you would NOT have purchased a room air conditioner at all, is that correct?*

Calculation:

If A3=No or A6=Yes → FR=0

Step 2 (FR2) – Estimation of Free Ridership through Program Influences

The goal of most incentive-based energy efficiency programs is to influence customer decision-making regarding energy efficient improvements. Programs can do this by changing *what* customers install, *when* they install it, and *how much* they install. In other words, programs influence the *efficiency*, *timing*, and *quantity* of customers' energy-using equipment installations.

Encouraging customers to install higher efficiency equipment than they would have installed on their own typically leads to the bulk of program savings. Programs may also encourage early replacement of still functioning equipment that is less efficient, thus impacting the timing of the installation so that savings are realized earlier. The incentive may also make it more affordable for customers to install a greater number of high efficiency measures.

As such, the FR algorithm combined the estimates of each of these concepts:

- Program influence on the efficiency level of the installed equipment (EI)
- Program influence on the timing of the installation of high-efficiency equipment (TI)
- Program influence on the quantity of the high-efficiency equipment installed (QI)

To calculate an overall estimate of program influence, the algorithm multiplies the estimates of efficiency (*EI)*, timing (*TI*), and quantity (*QI*). When the three concepts are measured as *distinct* yet *conditional* methods of program influence, it is appropriate and necessary to combine them by using multiplication. Averaging or using some other calculation method would overestimate FR. As such, the formula to calculate FR through program influences will be:

$$FR2 = EI \times TI \times QI$$

This method follows the proposed and approved approach to calculating FR for this program.[45] It should be noted that following the approval and implementation of the Residential Room AC evaluation effort, the FR algorithm that multiplies the three program influence scores (EI, TI, and QI) has been questioned by the DPS as possibly being inadequate in estimating FR. There is an ongoing discussion occurring among the New York Department of Public Service (DPS), CECONY, O&R, evaluators, and other stakeholders regarding the alternative calculation of the FR rate. To-date, agreement has been reached to combine the efficiency and the quantity score multiplicatively. Since the discussions of alternative ways of calculating FR rates started after the NTG approach for the Residential Air Conditioner Program was finalized, approved, and executed, we followed the FR estimation approach that we initially proposed and did not estimate free ridership using an alternative method for this program.

Below is further detail on the how each influence score was calculated as well as the survey questions measuring each area of influence.

Program Influence on Equipment Efficiency (EI)

The survey instrument measured the influence of various program components on **equipment efficiency level**. Based on our knowledge of the program theory, the following program components can be influential in the decision-making process and were therefore included as part of the survey:

- Program rebates (EI1)
- Program marketing (EI2)

A seven-point scale (1–7) was used to measure each of the program components. Opinions in the industry on the use of various rating scales vary. However, there is research providing evidence that a seven-point scale yields more reliable and valid results.[46]

[45] The algorithm was approved by the DPS in May 2012.

[46] Lozano, M., García-Cueto, E., Muñiz, J. 2008. “Effect of the Number of Response Categories on the Reliability and Validity of Rating Scales.” *European Journal of Research Methods for the Behavioral and Social Sciences* 4(2): 73-79.

Survey responses to the efficiency influence questions were converted from the seven-point scale to a value between 0 and 1 using linear transformation. For example, a response of 3 on a seven-point scale became .33 or .66 depending on how the anchor points of the scale were defined to respondents.

There is no reason to believe that linear transformations would yield results that are less reliable or valid than if non-linear transformations of the scale responses were used. A linear transformation approach also seems intuitive given the use of the scalars. Therefore, the linear transformation approach is used in the attribution calculations for this evaluation.

Because program rebates are considered the core program component, their influence was measured through more than one question to ensure reliability of results, with the results averaged to arrive at the overall influence of program rebates on equipment efficiency level.

The score for program influence on efficiency level of the equipment (EI) was calculated as the minimum rating across the overall program rebate score and program marketing score. This allowed for the program to claim the credit for the most influential of its components on the respondent decision-making process. The resulting score took a value between 0 and 1, with 1 being no influence and 0 being maximum influence.

Calculation:

$$EI = MIN(EI1;\ EI2)$$

$$EI1 = 1 - ((A4B - 1)/6)$$

$$EI2 = MEAN(1 - (A4C - 1)/6;\ (A9 - 1)/6)$$

Survey questions:

A4. *Using a scale of 1 to 7, where 1 means no influence and 7 means a great deal of influence, please rate the influence of the following on your decision to purchase the* ***high efficiency*** *room air conditioner(s).*

a. *Information from CECONY's marketing materials and/or website*

b. *CECONY rebates*

A9. *Using a 1 to 7 point scale, where 1 is not at all likely and 7 is very likely how likely is it that you would still have purchased* ***the same efficiency*** *room air conditioner(s) if you had not received a rebate from CECONY?*

Program Influence on Timing (TI)

Program influence on timing was measured by asking participants if the purchase/installation would have happened later in the absence of the program, with the resulting score taking a value of either 0 or 1.

A5. *If the CECONY rebate had not been available, would you have purchased the high efficiency room air conditioner(s) BEFORE the fall of 2011 or would you have purchased it/them DURING or AFTER the fall of 2011?*

Calculation:

$TI = 0\ IF\ A5 =$ During or after the fall of 2011

$TI = 1\ IF\ A5 =$ Before the fall of 2011

Program Influence on Quantity (QI)

Program influence on quantity was measured by asking participants who purchased/installed more than one piece of equipment if they would have purchased/installed fewer without the program. Since the Room Air Conditioning Program offered rebates for a maximum of two units, the quantity score took a value of either 0, 5, or 1.

Survey questions:

A8. *If the CECONY rebate had not been available, would you still have purchased two high efficiency air conditioners or would you have purchased one?*

Calculation:

QI=1 IF A8=Would have purchased two

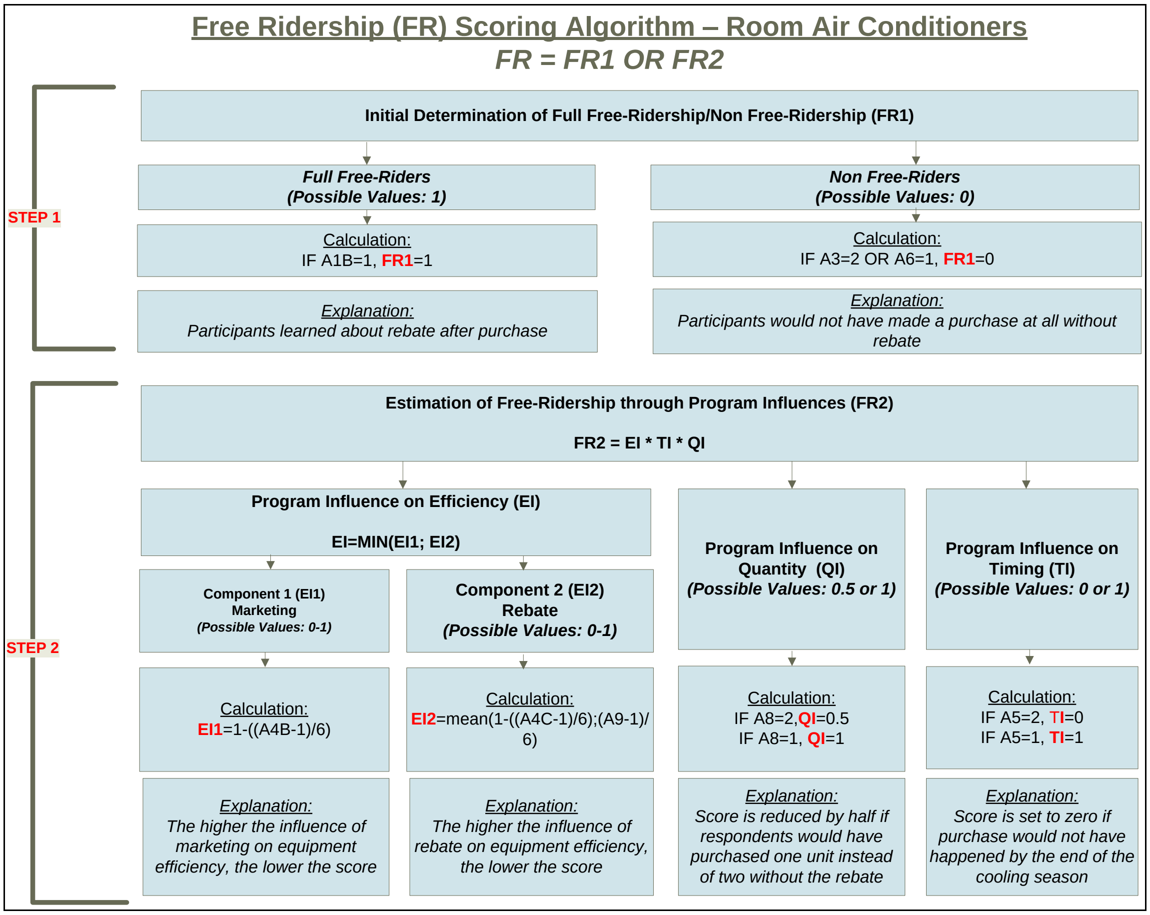
QI=0.5 IF A8=Would have purchased one

The scoring algorithm relied on responses from multiple questions to triangulate FR rate. Because respondents can sometimes give inconsistent answers, the survey instrument included consistency checks to clarify these responses.

A10. *Just to make sure I understand, please explain the importance of the rebate you received from CECONY on your decision to purchase the HIGH EFFICIENCY room air conditioner(s) instead of less efficient room air conditioner(s)?*

Figure B-7 provides graphical depiction of the free-ridership algorithm.

Figure B-7
Free Ridership Algorithm



Spillover

SO represents additional savings (expressed as a percent of total program savings) that were achieved without program rebates but would not have happened in the absence of the program. Participant SO was assessed through surveys/interviews with participating customers by asking about non-program efficiency actions that were taken as a result of participating in the program. The survey instrument contained checks to ensure consistency of response.

The program has not had a substantial marketing component that would promote energy efficiency in general or the installation of other measures aside from the ones rebated through the program. However, past experience suggests that for some, the experience of using one type of energy efficiency equipment can lead to them looking for other ways they can make their homes more energy efficient. If those additional improvements are program-induced, they can result in the SO savings that the program could claim. As part of the participant survey, the evaluation team attempted to determine presence of as well as an estimate of participant SO.

While participant SO can result from a variety of measures, the survey length did not allow for estimation of SO across all possible scenarios. To avoid overburdening participants, the survey could only ask about a limited number of actions that might be taken outside the program. The evaluation team included measures that could reasonably be expected to be influenced by program participation and are more likely to have been implemented without program support. Participant SO was measured for attic insulation, ENERGY STAR clothes washers, and ENERGY STAR refrigerators.

Participants were asked if they made any of the above-listed improvements. Those who did were asked if the CECONY program was of any influence and the degree of influence. Respondents were also asked to explain in their own words exactly how the program influenced their decision to make specific additional improvements. During the analysis, this allowed us to screen out nonqualifying respondents. This question is very effective at ensuring that we are only crediting the program for actions that were influenced by the program. Typically, up to 80% of respondents do not give explanations that link their actions to the program, and therefore their actions are not credited to the program. For respondents who would have passed all of these tests, the evaluation team also would have verified the installations on-site for those who agreed to the metering portion of the study.

SO1. SINCE your participation in the CECONY program, have you made any of the following improvements for which you did NOT receive a rebate from CECONY? Have you..?

a. Insulated your home
b. Purchased an ENERGY STAR refrigerator
c. Purchased an ENERGY STAR clothes washer

[IF YES TO ANY]

SO2. Did your experience with the CECONY program encourage you **in any way** to make the improvement(s)?

SO3. Using a scale of 1 to 7, where 1 is no influence and 7 is a great deal of influence, how much influence did your experience with the CECONY program have on your decision to…?

a. Insulate your home
b. Purchase an ENERGY STAR refrigerator
c. Purchase an ENERGY STAR clothes washer

SO4a/ /SO6a/SO7a. Can you explain how your experience with the CECONY program influenced your decision to purchase a(n) <MEASURE> for your home?

If any energy efficient improvements were heavily influenced by the program[47], participants were asked a few equipment-specific questions that allowed for the calculation of savings associated with the installed equipment. The equipment details explored as part of the survey effort were limited by the survey length as well as by the questions to which the respondents could provide reliable responses.

Had any SO savings been found, the savings values would have been applied to the measures installed outside of the program. Savings would have been estimated for each measure using most recent TRM

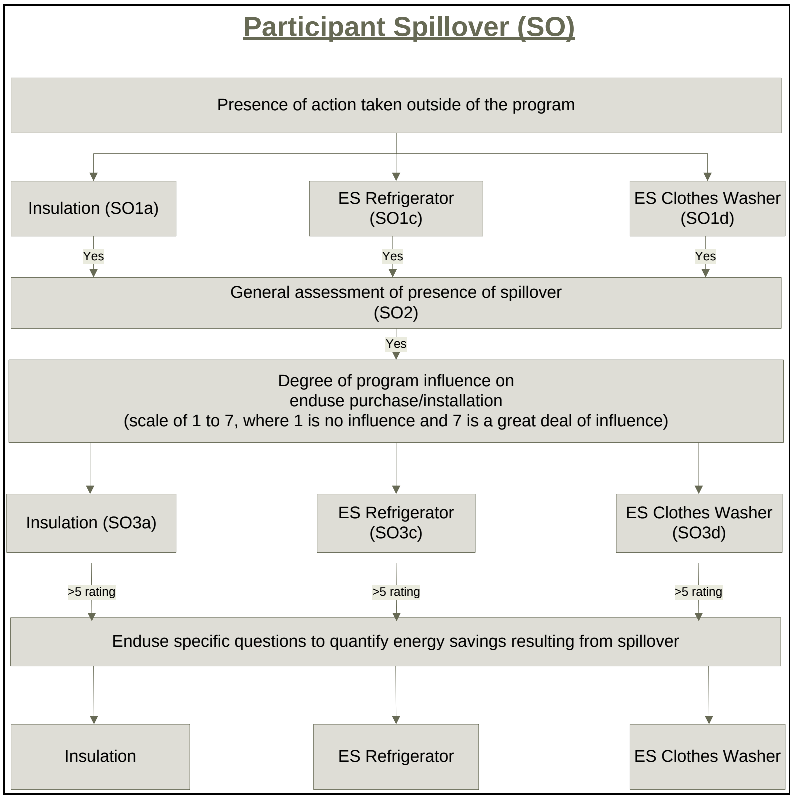
[47] A rating of 6 or 7 on a scale of 1 to 7 where 1 is no influence and 7 is a great deal of influence.

values supplemented by engineering assumptions. The program-level SO savings number would have been determined by extrapolating the survey estimate of SO savings to the larger participant population. The SO factor would have been the ratio estimated population savings due to SO over the total ex post gross program savings.

$$\mathrm{SO} = \frac{Respondent\ energy\ savings\ from\ measures\ installed\ outside\ the\ program}{Respondent\ energy\ savings\ from\ measures\ installed\ through\ the\ program}$$

Figure B-8 provides graphical depiction of the SO algorithm used in this evaluation.

Figure B-8
Spillover Algorithm



As indicated earlier, SO is included in the overall NTGR as (1 - FR + SO).

APPENDIX C – DOUBLE RATIO ESTIMATION

In ratio estimation, instead of measuring the mean of an uncertain variable, the evaluator measures the ratio between the measured values and some prior estimate of the values on a site-specific basis. Ratio estimation is used widely in evaluation of custom projects, but may be applied to many other sampling problems where there is some prior estimate of savings available. The use of the double-ratio estimation technique depends on there being a lower-cost way of collecting data that is indicative of the final results, but not accurate enough to use on its own. By nesting more rigorous on-site measurements inside a large sample of lower rigor data collection, such as billing data or phone survey results, a rigorous result can be achieved with fewer resources.

Double-ratio estimation is especially effective when large outliers (sites with realization rates much higher or much lower than one) may be the primary drivers of the overall results, provided the first stage can effectively find these large outliers. The large sample in the first stage effectively measures the frequency of the large outliers, while the second stage acts to calibrate the results of the first stage to a more accurate set of results for a subsample, while using a much smaller sample than would be required if only the second-stage data collection techniques were being used. Evaluators facing highly rigorous evaluation requirements should incorporate double-ratio estimation more often, in order to maximize value and rigor and reduce risk of not meeting confidence and precision targets. For example, in custom programs, the ultimate confidence and precision are highly dependent on the quality of the ex ante estimates, which can vary widely from project to project and even year to year, as program participation changes. There is always a risk that the actual CV will be significantly higher than was assumed.

A useful metaphor for double-ratio estimation is the process used for extracting gold from river sediments. Prospectors are trying to separate gold from a bunch of gravel and have multiple methods available to them. Some methods are cheaper but offer lower accuracy – there will be other objects of similar density extracted with the gold. Panning is the most accurate method, in that the gold can be extracted in a pure form, but the process is labor-intensive. What modern prospectors do is to combine a first stage of sluicing with a second stage of panning. In the first stage, huge volumes of river sediment are pumped through a sluice, which separates everything that has a similar density to gold from the other contents. This process is very efficient at sorting through high volumes, but the results are not pure gold. In the second stage, the extracted high-density materials are panned to separate the gold from the other high-density material. The result is pure gold. In double-ratio estimation for evaluation, the first stage of information extraction is to perform a set of file reviews or phone verifications, which can be performed inexpensively on a large sample. This is equivalent to sluicing the river sediments to get high-density material. In the second stage, a more accurate method (like on-site metering) is performed on a nested subsample of sites. This is equivalent to the panning method, where the results are pure gold.

Calculating Realization Rates with Double Ratio Estimation

In a double-ratio estimation, there are three sets of numbers being compared:

1. *xjh* is defined as the tracking data estimate for a given sample point *j* in stratum *h*
2. *yjh* is defined as the first stage (phone or file review) estimate of savings for a given sample point *j* in stratum *h*
3. *zjh* is defined as the second stage (on-site metering or verification) estimate of savings for a given sample point *j* in stratum *h*

A double-ratio estimation calculates two ratios, between the first stage and tracking and between the second stage and first stage. In some cases, it may be preferable to calculate statistics on the mean in the first stage, rather than use a ratio. The same general double-sampling method applies, except for the use of standard statistics on the first stage. The first-stage realization rate for the sample point, measuring the realization rate between the tracking and phone/file review estimate, RR_{jh1} is then calculated:

$$RR_{jh1} = \frac{y_{jh}}{x_{jh}}$$

The first-stage realization rate for the sample point, measuring the realization rate between the tracking and phone/file review estimate, RR_{ih2} is then calculated:

$$RR_{jh2} = \frac{z_{jh}}{y_{jh}}$$

The overall sample point realization rate RR_{jh} is then calculated as the product of the two stages:

$$RR_{jh} = RR_{jh1} \times RR_{jh2}$$

The stratum first-stage sample realization rate of stratum *h* is the sum of all phone/file-verified ex post savings in the sample of stratum h divided by the sum of all tracked ex ante savings in the sample (*n* = *j*) of stratum *h*, given by:

$$RR_{h1} = \frac{\sum_1^j y_{jh}}{\sum_1^j x_{jh}}$$

In the second stage, only a subsample of the sites in the first stage sample are used.[48] The stratum second-stage sample realization rate of stratum *h* is the sum of all the on-site-verified ex post savings in the on-site subsample of stratum *h* divided by the sum of all the phone/file-verified ex post savings in the on-site subsample (*n* = *i*) of stratum *h*, given by:

$$RR_{h2} = \frac{\sum_1^i z_{ih}}{\sum_1^i y_{ih}}$$

48 There are *k* members of the population, *j* members out of *k* in the first stage phone/file review sample, and i members out of *j* in the second-stage on-site sample.

The overall stratum realization rate, *RRh*, is then calculated as the product of first and second stage realization rates:

$$RR_h = RR_{h1} \times RR_{h2}$$

The verified total savings estimate for stratum h is the sum of all tracked ex ante estimates in stratum *h* multiplied by the stratum realization rate, given by:

$$TS_h = RR_h \times \sum x_{kh}$$

The verified total savings for the program is the sum of the total savings in the individual strata:

$$TS_p = \sum TS_h$$

The overall realization rate for the program is then calculated by dividing the total verified savings by the total tracked savings:

$$RR_p = \frac{TS_p}{TS'_p}$$

Calculating Confidence and Precision with Double Ratio Estimation

In ratio estimation, an estimate for each member of stratum *h* can be made by multiplying the sample stratum realization rate by the prior estimate. A residual error can then be calculated for each sample point in stratum *h* by taking the difference between the ratio estimate and verified ex post savings for the point. In double-ratio estimation, the first-stage error at each sample point is calculated by taking the difference between the first-stage verified savings and the first-stage realization rate times the tracked value:

$$e_{1jh} = y_{jh} - RR_{h1} \times x_{jh}$$

The sample variance of the first-stage verified total savings in stratum *h* is derived from the stratum first-stage residuals:

$$V_{h1} = \frac{1}{n_{h1} - 1} \sum_{1}^{j} e_{1jh}^2$$

The first-stage finite population correction factor for stratum *h*, FPC_{h1}, is calculated using *Nh*, the stratum population and n_{h1}, the first-stage sample size:

$$FPC_{h1} = \sqrt{\frac{N_h - n_{h1}}{N_h - 1}}$$

The first-stage standard error for stratum *h*, SE_{h1}, is calculated using:

$$SE_{h1} = FPC_{h1} \times \frac{\sqrt{V_{h1}}}{\sqrt{n_{h1}}} \times N_h$$

The first stage relative precision for stratum h, RP_{h1}, is then calculated using the first-stage total savings, TS_{h1}, standard error, SE_{h1}, and t-value, t_1, based on the first stage sample size, n_{h1}:

$$RP_{h1} = t_1 \times \frac{SE_{h1}}{TS_h} \times 100\%$$

In the case where the first stage estimates a mean value, rather than a ratio, the statistics calculation for the first stage is exactly the same as above, except that the individual error terms are calculated using:

$$e_{1ih} = y_{ih} - \frac{\sum_i^{n_{h1}} y_{ih}}{n_{h1}}$$

The second-stage error at each sample point is calculated by taking the difference between the second-stage verified savings and first-stage verified savings:

$$e_{2ih} = z_{ih} - RR_{h2} \times y_{ih}$$

The sample variance of the second-stage verified total savings in stratum h is derived from the stratum second-stage residuals:

$$V_{h2} = \frac{1}{n_{h2} - 1} \sum_{1}^{i} e_{2ih}^2$$

The second-stage finite population correction factor for stratum h, FPC_{h2}, is calculated using N_h, the stratum population and n_{h1}, the first-stage sample size:

$$FPC_{h2} = \sqrt{\frac{N_h - n_{h2}}{N_h - 1}}$$

The second-stage standard error for stratum h, SE_{h2}, is calculated using:

$$SE_{h2} = FPC_{h2} \times \frac{\sqrt{V_{h2}}}{\sqrt{n_{h2}}} \times N_h$$

The second-stage relative precision for stratum h, RP_{h2}, is then calculated using the second-stage total savings, TS_{h2}, standard error, SE_{h2}, and t-value, t_2, based on the second-stage sample size, n_{h2}:

$$RP_{h2} = t_2 \times \frac{SE_{h2}}{TS_h} \times 100\%$$

The overall relative precision for stratum h, RP_{ht}, is then calculated as the square root of the sum of the squares of the relative precisions for the two stages:

$$RP_{ht} = \sqrt{{RP_{h1}}^2 + {RP_{h2}}^2}$$

The total standard error for stratum *h*, SE_{ht}, is then calculated using the first stage t-value, t_1, and the stratum total savings, *TSh*:

$$SE_{ht} = \frac{RP_{ht} \times TS_h}{t_1}$$

The standard error on the total program, SEp is given by:

$$SE_p = \sqrt{\sum_h SE_{ht}{}^2}$$

The relative precision on the total program, RP_t, is calculated using the program total standard error, savings, and t-value, based on the total sample size across all strata:

$$RP_t = t \times \frac{SE_p}{TS_p} \times 100\%$$

References:

- Wright, R.L., et al., “Double Ratio Estimation: A New Tool for Cost-Effective Monitoring,” 1994 ACEEE Summer Study on Building Energy Efficiency, 1994.
- Lohr, S. L., *Sampling: Design and Analysis*, *2nd Edition*, 2010.

APPENDIX D – RESIDENTIAL HVAC AND ROOM AC PROGRAM PARTICIPANT PHONE SURVEY

Sample Variables

1. Measure Flags
<ROOMAC>
<CENTRALAC>
<HEAT_PUMP>
<ECM_FAN>
<AIR_SEALING>
<DUCT_SEALING>
<WATER_HEATER>
<THERMOSTAT>

2. Measure Quantities
<ROOMAC_QTY>
<CENTRALAC_QTY>
<HEATPUMP_QTY>
<ECMFAN_QTY>
<WATERHEATER_QTY>
<THERMOSTAT_QTY>

3. <INCENTIVE> (Incentive Amount for Main Measure)

4. <PROGRAM> (Residential Room Air Conditioner Program or Residential HVAC Program)

INTRODUCTION

Hi, May I please speak with <NAME FROM DATABASE>

My name is ____ and I'm calling from Opinion Dynamics, an independent research company, on behalf of Con Edison. We're speaking with Con Edison customers who have participated in the <PROGRAM>, which gives rebates to customers who install high efficiency air conditioning or heating equipment.

I would like to ask you some questions about your experience with the <PROGRAM>, as this information will help Con Edison understand how the program may be improved. The questions that I have will only take about 15 minutes and your responses will be kept strictly confidential.

Are you the person who is most knowledgeable about your participation in the Con Edison program?

1. Yes [CONTINUE WITH DECISION MAKER]
2. No [ASK TO SPEAK WITH THE DECISION MAKER]

C1. Are you currently talking to me on a regular landline phone or a cell phone?
1. Regular landline phone
2. Cell Phone
8. (Don't know)
9. (Refused)

[ASK IF C1 = 2; ELSE GO TO SURVEY START]

C2. Are you currently in a place where you can talk safely and answer my questions?
1. Yes
2. No [SCHEDULE CALL BACK]
3. No [DO NOT CALL BACK]
8. (Don't know) [SCHEDULE CALL BACK]
9. (Refused) [SCHEDULE CALL BACK]

[ASK IF ROOMAC=1]

EQUIPMENT VERIFICATION – ROOM AC

EV1. Our records show that you received a rebate from Con Edison for purchasing <ROOMAC_QTY> room air conditioner(s) in 2011. Is this correct?
1. Yes
2. (Yes – but different number)
3. No, did not
8. (Don't know)
9. (Refused)

[SKIP IF EV1 <> 2]

EV1a. How many units did you purchase and received a rebate for? [NUMERIC OPEN END]

[CALCULATE ROOMAC_QTY_VERIFIED USING EV1 & EV1A]

[ASK IF ROOMAC_QTY_VERIFIED=1]

EV1b. Did you purchase this room air conditioner to use in your home or in someone else's home?
1. My home
2. Someone else's home
8. (Don't know)
9. (Refused)

[ASK IF ROOMAC_QTY_VERIFIED>1]

EV1c. Did you purchase these room air conditioners to use them both in your home, to use just one of them in your home and use the other in someone else's home, or to use both of them in someone else's home?

1. Both in my home
2. One in my home and one in someone else's home
3. Both in someone else's home
8. (Don't know)
9. (Refused)

[ASK IF EV1B=2 OR EV1C=2 OR 3]

EV1d. Does Con Edison provide electricity to the home where you plan to use [IF EV1B=2 "THE AIR CONDITIONER", IF EV1C=2, "ONE OF THE AIR CONDITIONERS", IF EV1C=3, "THE AIR CONDITIONERS"] for which you received a rebate from Con Edison?

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

[ASK IF CENTRALAC=1]

EQUIPMENT VERIFICATION – CENTRAL AC

EV2. Our records show that you received a rebate from Con Edison for installing <CENTRALAC_QTY> central air conditioner unit(s) in your home during 2011. Is this correct?

1. Yes
2. (Yes – but different number)
3. No, did not
8. (Don't know)
9. (Refused)

[SKIP IF EV2 <> 2]

EV2a. How many units did you install? [NUMERIC OPEN END]

[CALCULATE CENTRALAC_QTY_VERIFIED USING EV2 & EV2A]

[ASK IF AIR_SEALING =1]

EQUIPMENT VERIFICATION – AIR SEALING

EV3. Our records show that you received a rebate from Con Edison for having air sealing done in your home during 2011. Is this correct? [READ IF NEEDED: THIS IS THE PROCESS OF IDENTIFYING AND FILLING HOLES IN THE FLOORS, WALLS AND CEILINGS OF A HOME TO PREVENT WARM AIR LEAKAGE]

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

[ASK IF DUCT_SEALING =1]

EQUIPMENT VERIFICATION – DUCT SEALING

EV4. Our records show that you received a rebate from Con Edison for having your air ducts sealed during 2011. Is this correct? [READ IF NEEDED: THIS IS THE PROCESS OF IDENTIFYING AND ELIMINATING AIR LEAKS IN THE HOME'S DUCT SYSTEM]

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

[ASK IF HEAT_PUMP =1]

EQUIPMENT VERIFICATION – HEAT PUMP

EV5. Our records show that you received a rebate from Con Edison for installing <HEATPUMP_QTY> heat pump(s) in your home during 2011. Is this correct?

1. Yes
2. (Yes – but different number)
3. No, did not
8. (Don't know)
9. (Refused)

[SKIP IF EV5 <> 2]

EV5a. How many units did you install? [NUMERIC OPEN END]

[CALCULATE HEATPUMP_QTY_VERIFIED USING EV5 & EV5A]

[ASK IF WATERHEATER =1]

EQUIPMENT VERIFICATION – WATER HEATER

EV6. Our records show that you received a rebate from Con Edison for installing <WATERHEATER_QTY> water heater(s) in your home during 2011. Is this correct?

1. Yes
2. (Yes – but different number)
3. No, did not
8. (Don't know)
9. (Refused)

[SKIP IF EV6 <> 2]

EV6a. How many units did you install? [NUMERIC OPEN END]

[CALCULATE WATERHEATER_QTY_VERIFIED USING EV6 & EV6A]

[ASK IF THERMOSTAT=1]

EQUIPMENT VERIFICATION – PROGRAMMABLE THERMOSTAT

EV7. Our records show that you received a rebate from Con Edison for purchasing <THERMOSTAT_QTY> programmable thermostats in your home during 2011. Is this correct?

1. Yes
2. (Yes – but different number)
3. No, did not
8. (Don't know)
9. (Refused)

[SKIP IF EV7 <> 2]

EV7a. How many units did you install? [NUMERIC OPEN END]

[CALCULATE THERMOSTAT_QTY_VERIFIED USING EV7 & EV7A]

[ASK IF ECM_FAN=1]

EQUIPMENT VERIFICATION – ECM FANS

EV8. Our records show that you received a rebate from Con Edison for installing <ECMFAN_QTY> ECM fan(s) during 2011. Is this correct?

1. Yes
2. (Yes – but different number)
3. No, did not
8. (Don't know)
9. (Refused)

[SKIP IF EV8 <> 2]

EV8a. How many units did you install? [NUMERIC OPEN END]

[CALCULATE ECM_FAN_QTY_VERIFIED USING EV8 & EV8A]

[THANK AND TERMINATE IF ALL EV1-EV8=3,8,9,SYSMIS OR EV1B=2,8,9. OR EV1C=3,8,9]

PROGRAM MARKETING AND INTERACTIONS

Q1. How did you first learn about the Con Edison's <PROGRAM>?

01. (Contractor)
02. (Con Edison mailing/letter)
03. (Bill insert)
04. (Con Edison website)
05. (Family/friends/word of mouth)
06. (Retailer/Store)
00. (Other, please specify)
98. (Don't know)
99. (Refused)

[ASK Q2a IF Q1 <> 1 AND (CENTRALAC_QTY_VERIFIED>0 OR HEATPUMP_QTY_VERIFIED>0)]

Q2a. Did your contractor talk to you about the Con Edison's Residential HVAC program and available rebates?

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

Q2b. Did you receive any materials from Con Edison about the benefits of [IF ROOMAC_QTY_VERIFIED>0, READ "ENERGY STAR ROOM AIR CONDITIONERS"; IF CENTRALAC_QTY_VERIFIED>0, READ "ENERGY EFFICIENT COOLING EQUIPMENT"; IF HEATPUMP_QTY_VERIFIED>0, READ "ENERGY EFFICIENT HEATING AND COOLING EQUIPMENT "] or available rebates?

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

Q2c. Did you visit Con Edison's website to learn more about the benefits of [IF ROOMAC_QTY_VERIFIED>0, READ "ENERGY STAR ROOM AIR CONDITIONERS"; IF CENTRALAC_QTY_VERIFIED>0, READ "ENERGY EFFICIENT COOLING EQUIPMENT"; IF HEATPUMP_QTY_VERIFIED>0, READ "ENERGY EFFICIENT HEATING AND COOLING EQUIPMENT "] or available rebates?

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

[ASK IF ROOMAC_QTY_VERIFIED>0, ELSE SKIP TO Q3]

Q2d. Where did you purchase your [IF ROOMAC_QTY_VERIFIED=1, "ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "ROOM AIR CONDITIONERS"]? Was it online, at a store, through a contractor or through another source?

01. Store
02. Online
03. Contractor
00. Other source – specify
98. (Don't know)
99. (Refused)

[ASK IF Q2D=1]

Q2h. When shopping to buy your [IF ROOMAC_QTY_VERIFIED=1, "ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "ROOM AIR CONDITIONERS"], did you see any signs, labels, or print materials from Con Edison about the benefits of ENERGY STAR room air conditioners or available rebates?

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

[ASK Q3 IF CENTRALAC_QTY_VERIFIED>0 OR HEATPUMP_QTY_VERIFIED>0]

Q3. Did you receive a tax credit or rebate from the government for the [IF HEATPUMP_QTY_VERIFIED>0, "HEATING AND COOLING"; ELSE "COOLING"] equipment that you installed?

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

[ASK IF ROOMAC_QTY_VERIFIED>0, ELSE SKIP TO NEXT SECTION]

FREE RIDERSHIP: ROOM AIR CONDITIONER

Next I have a few questions about the decision-making process that led you to purchase your new ENERGY STAR [IF ROOMAC_QTY_VERIFIED=1, "ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "ROOM AIR CONDITIONERS"]

As you may know, ENERGY STAR room air conditioners are air conditioners that have been certified as energy efficient and have an ENERGY STAR label as an indicator of high efficiency.

[ASK IF ROOMAC_QTY_VERIFIED=1]

A0a. Did your new room air conditioner replace an old air conditioner or was it not a replacement?

1. Replacement
2. Not a replacement
8. (Don't know)
9. (Refused)

[ASK IF ROOMAC_QTY_VERIFIED>1]

A0aa. Did both of your new room air conditioners replace old units, did neither of them replace old units, or did only one of them replace an old unit?

1. Both replaced old units
2. Only one replaced an old unit
3. Neither replaced old units
8. (Don't know)
9. (Refused)

[ASK IF A0A=1 OR A0AA=1 OR A0AA=2]

A0b. Why did you replace your old [IF A0AA=1 "ROOM AIR CONDITIONERS"; ELSE "ROOM AIR CONDITIONER"]? [DO NOT READ; MULTIPLE RESPONSE; ACCEPT UP TO 3]

01. (Old air conditioner(s) was/were broken)
02. (Old air conditioner(s) wasn't/were not performing well/wanted improved performance)
03. (Wanted a more energy efficient air conditioner(s)/wanted to save energy)
04. (Wanted a different size air conditioner(s))
00. (Other)
98. (Don't know)
99. (Refused)

A1a. When did you first learn that you could receive a rebate from Con Edison for purchasing [IF ROOMAC_QTY_VERIFIED=1, "A NEW HIGH EFFICIENCY ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "NEW HIGH EFFICIENCY ROOM AIR CONDITIONERS"]? Was it before or after you purchased the [IF ROOMAC_QTY_VERIFIED=1, "AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "AIR CONDITIONERS"]? [INTERVIEWER NOTE: IF LEARNED ABOUT THE REBATE WHILE SHOPPING AT THE STORE, RECORD RESPONSE AS #3]

1. Before
2. After
3. (While in the store shopping for air conditioner(s))
8. (Don't know)
9. (Refused)

[IF A1a <>2 SKIP TO A2A]

A1b. Just to be clear, did you buy your [IF ROOMAC_QTY_VERIFIED=1, "HIGH EFFICIENCY ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "HIGH EFFICIENCY ROOM AIR CONDITIONERS"] and then later learn that you could receive a rebate from Con Edison?

1. Yes [SKIP TO A4]
2. No
8. (Don't know)
9. (Refused)

A2a. Were you already planning to purchase [IF ROOMAC_QTY_VERIFIED=1, "A NEW AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "NEW AIR CONDITIONERS"] when you learned that you could receive a rebate from Con Edison?

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

[ASK IF A2a=1]

A2b. Were you already planning to purchase [IF ROOMAC_QTY_VERIFIED=1, "A HIGH EFFICIENCY AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "HIGH EFFICIENCY AIR CONDITIONERS"] when you learned that you could receive a rebate from Con Edison?

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

A3. Our records show that you received a rebate of $30 from Con Edison for [READ 'EACH' IF 'ROOMAC_QTY_VERIFIED>1; READ 'THE' IF 'ROOMAC_QTY_VERIFIED =1] room air conditioner you purchased. If the Con Edison rebate had not been available, would you have purchased [IF ROOMAC_QTY_VERIFIED=1,"ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1,"ROOM AIR CONDITIONERS"] at all?

1. Yes, would have purchased
2. No, would not have purchased [SKIP TO SO1]
3. (Maybe)
8. (Don't know)
9. (Refused)

A4. Using a scale of 1 to 7, where 1 means no influence and 7 means a great deal of influence, please rate the influence of the following on your decision to purchase the HIGH EFFICIENCY [IF ROOMAC_QTY_VERIFIED=1, "ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "ROOM AIR CONDITIONERS"]…

a. [ASK IF Q2B=1 OR Q2C=1 OR Q2H=1] Information from Con Edison's marketing materials [IF Q2C=1, READ "AND WEBSITE"]
b. [SKIP IF A1B=1] Con Edison rebates

[SKIP TO SO1 IF A1B=1]

A5. If the Con Edison rebate had not been available, would you have purchased the HIGH EFFICIENCY [IF ROOMAC_QTY_VERIFIED=1,"ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1,"ROOM AIR CONDITIONERS"] BEFORE the fall of 2011 or would you have purchased [IF ROOMAC_QTY_VERIFIED=1, "IT"; IF ROOMAC_QTY_VERIFIED>1, "THEM"] DURING OR AFTER the fall of 2011?

1. Would have purchased BEFORE the fall of 2011
2. Would have purchased DURING OR AFTER the fall of 2011
3. (Would not have purchased a room air conditioner(s) at all without rebate)
8. (Don't know)
9. (Refused)

[ASK IF A5=3]

A6. Just to confirm, if the Con Edison rebate had not been available, you would NOT have purchased [IF ROOMAC_QTY_VERIFIED=1, "A ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "ROOM AIR CONDITIONERS"] at all, is that correct?

1. Yes [SKIP TO SO1]
2. No
8. (Don't know)
9. (Refused)

[ASK IF ROOMAC_QTY_VERIFIED>1]

A8. If the Con Edison rebate had not been available, would you still have purchased two HIGH EFFICIENCY air conditioners or would you have purchased one?

1. Two
2. One
8. (Don't know)
9. (Refused)

A9. Using a 1 to 7 point scale where 1 is "not at all likely" and 7 is "very likely" how likely is it that you would still have purchased THE SAME EFFICIENCY [IF ROOMAC_QTY_VERIFIED=1, "ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "ROOM AIR CONDITIONERS"] if you had not received a rebate from Con Edison? [RECORD 1-7; 98=DON'T KNOW; 99=REFUSED]

[ASK IF (A9<3 AND A4C>5) OR (A9>5 AND A4C<3)]

A10. Just to make sure I understand, please explain the importance of the rebate you received from Con Edison on your decision to purchase the [IF ROOMAC_QTY_VERIFIED=1, "HIGH EFFICIENCY ROOM AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "HIGH EFFICIENCY ROOM AIR CONDITIONERS"] instead of less efficient [IF ROOMAC_QTY_VERIFIED=1, "AIR CONDITIONER"; IF ROOMAC_QTY_VERIFIED>1, "AIR CONDITIONERS"].

00. [OPEN END]
98. (Don't know)
99. (Refused)

[ASK IF CENTRALAC_QTY_VERIFIED>0 OR HEATPUMP_QTY_VERIFIED>0, ELSE SKIP TO NEXT SECTION]

FREE RIDERSHIP: RESIDENTIAL HVAC

Next I have a few questions about the decision-making process that led you to install [IF HEATPUMP_QTY_VERIFIED>0, "HEATING AND COOLING"; ELSE "COOLING"] equipment.

B0a. Did you have a central cooling system in your home before you installed new [IF HEATPUMP_QTY_VERIFIED>0, "HEATING AND COOLING"; ELSE "COOLING"] equipment?

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

B1a. When did you first learn that you could receive a rebate from Con Edison for installing new [IF HEATPUMP_QTY_VERIFIED>0, "HEATING AND COOLING"; ELSE "COOLING"] equipment? Was it before or after you installed the equipment?

1. Before
2. After
8. (Don't know)
9. (Refused)

[IF B1a <>2 SKIP TO B2A]

B1b. Just to be clear, did you install your new [IF HEATPUMP_QTY_VERIFIED>0, "HEATING AND COOLING"; ELSE "COOLING"] equipment and then later learn that you could receive a rebate from Con Edison?

1. Yes [SKIP TO B4A]
2. No
8. (Don't know)
9. (Refused)

B2a. Were you already planning to install new [IF HEATPUMP_QTY_VERIFIED>0, "HEATING AND COOLING"; ELSE "COOLING"] equipment when you learned that you could receive a rebate from Con Edison?

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

[ASK IF B2A=1]

B2b. Were you already planning to install HIGH EFFICIENCY [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment when you learned that you could receive a rebate from Con Edison?

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

B3. Our records show that you received a rebate of <INCENTIVE> from Con Edison for installing your new [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment. If the Con Edison rebate had not been available, would you have installed [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment at all?

1. Yes, would have installed new equipment
2. No, would not have installed new equipment [SKIP TO SO1]
3. (Maybe)
8. (Don’t know)
9. (Refused)

B4. Using a scale of 1 to 7, where 1 means no influence and 7 means a great deal of influence, please rate the influence of the following on your decision to install the high efficiency [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment?

a. Contractor recommendations
b. [ASK IF Q2B=1 OR Q2C=1 OR Q2E=1] Information from Con Edison’s marketing materials and [IF Q2C=1, READ “AND WEBSITE”]
c. [SKIP IF B1B=1] Con Edison rebates

B5. Did the availability of the Con Edison rebate cause you to install your HIGH EFFICIENCY [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment EARLIER than you were planning, or did the rebate have no influence on when you installed the equipment?

1. Installed earlier
2. Did not change when installed
3. (Would not have installed the equipment at all without rebate)
8. (Don't know)
9. (Refused)

[ASK IF B5=3]

B6. Just to confirm, if Con Edison rebate had not been available, you would NOT have installed [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment at all, is that correct?

1. Yes [SKIP TO SO1]
2. No
8. (Don’t know)
9. (Refused)

[ASK B5=1]

B7. If the rebate had not been available, when would you have installed your HIGH EFFICIENCY [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment? Would you say…

1. Within 6 months of when you did
2. 6 months to a year later
3. 1 to 2 years later
4. or more than 2 years later
8. (Don't know)
9. (Refused)

[ASK IF CENTRALAC_QTY_VERIFIED OR HEATPUMP_QTY_VERIFIED>1]

B8. If the Con Edison rebate had not been available, would you still have installed <CENTRALAC_QTY_VERIFIED OR HEATPUMP_QTY_VERIFIED> [IF HEATPUMP_QTY_VERIFIED>0, “HIGH EFFICIENCY HEAT PUMPS”; ELSE “HIGH EFFICIENCY CENTRAL AIR CONDITIONING UNITS”] or would you have installed fewer?

1. Same number
2. Fewer
8. (Don’t know)
9. (Refused)

[ASK B8=2]

B8a. How many [IF HEATPUMP_QTY_VERIFIED>0, “HIGH EFFICIENCY HEAT PUMPS”; ELSE “HIGH EFFICIENCY CENTRAL AIR CONDITIONING UNITS”] would you have installed if the rebate had not been available? [NUMERIC OPEN END, 98=DK, 99=REF]

B9. Using a 1 to 7 point scale where 1 is “not at all likely” and 7 is “very likely” how likely is it that you would have installed THE SAME EFFICIENCY [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment if you had not received a rebate from Con Edison? [RECORD 1-7; 98=DK; 99=REF]

[ASK IF (B9<3 AND B4C>5) OR (B9>5 AND B4C<3)]

B10. Just to make sure I understand, please explain the importance of the rebate you received from Con Edison on your decision to install the HIGH EFFICIENCY [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment instead of less efficient equipment.

00. [OPEN END]
98. (Don’t know)
99. (Refused)

[ASK IF Q3=1, ELSE SKIP TO SO1]

You mentioned earlier that you received a rebate from Con Edison AND a government tax credit or rebate for the installation of high efficiency [IF HEATPUMP_QTY_VERIFIED>0, “HEATING AND COOLING”; ELSE “COOLING”] equipment.

B11. Using a 1 to 7 point scale where 1 is "not at all likely" and 7 is "very likely" how likely is it that you would have installed THE SAME EFFICIENCY [IF HEATPUMP_QTY_VERIFIED>0, "HEATING AND COOLING"; ELSE "COOLING"] equipment had neither tax rebates and credits nor Con Edison rebate been available? [RECORD 1-7; 98=DK; 99=REF]

SPILLOVER

SO1. SINCE your participation in the <PROGRAM>, have you made any of the following improvements for which you did NOT receive a rebate from Con Edison? Have you..?

a. Insulated your home
b. Installed energy efficient lighting, such as CFLs or LEDs
c. Purchased an ENERGY STAR refrigerator
d. Purchased an ENERGY STAR clothes washer

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

[ASK IF ANY IN SO1=1, ELSE SKIP TO NEXT SECTION]

SO2. Did your experience with the Con Edison <PROGRAM> encourage you IN ANY WAY to make [IF ONLY ONE IN SO1, "THIS IMPROVEMENT"; IF MORE THAN ONE IN SO1, "ANY OF THESE IMPROVEMENTS"]?

1. Yes
2. No [SKIP TO NEXT SECTION]
8. (Don't know) [SKIP TO NEXT SECTION]
9. (Refused) [SKIP TO NEXT SECTION]

SO3. Using a scale of 1 to 7, where 1 is no influence and 7 is a great deal of influence, how much influence did your experience with the Con Edison <PROGRAM> have on your decision to…?

a. [ASK IF SO1A=1] Insulate your home
b. [ASK IF SO1B=1] Install high efficiency lighting, such as CFLs or LEDs
c. [ASK IF SO1C=1] Purchase an ENERGY STAR refrigerator
d. [ASK IF SO1D=1] Purchase an ENERGY STAR clothes washer

[ASK IF SO3A>5, ELSE SKIP TO SO5A]

SO4a. Can you explain how your experience with the Con Edison <PROGRAM> influenced your decision to insulate your home?

00. [OPEN END]
98. (Don't know)
99. (Refused)

SO4b. What parts of your home did you insulate?

01. Attic
02. Walls
00. (Other, specify)
98. (Don't know)
99. (Refused)

[ASK IF S04B=1, ELSE SKIP TO S05A]

S04c. What type of insulation did you use to insulate your attic? Was it..?

01. Blown in insulation
02. Layer or batting insulation
03. Spray foam insulation
00. or some other type?
98. (Don't know)
99. (Refused)

S04d. Did you have any insulation in your attic before this insulation project?

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

[ASK IF S04D=1]

S04e. Approximately, how many inches of insulation did you have in your attic before the insulation project? [NUMERIC OPEN END, 98=DK, 99=REF] [PROBE FOR BEST ESTIMATE]

S04f. Approximately, how many inches of insulation were added as a result of your project? [NUMERIC OPEN END, 98=DK, 99=REF] [PROBE FOR BEST ESTIMATE]

[ASK IF S04E=98, 99 AND S04D=1]

S04g. What was the R-value of the insulation that you had in your attic before the insulation project? [NUMERIC OPEN END, 98=DK, 99=REF] [PROBE FOR BEST ESTIMATE]

[ASK IF S04F=98, 99]

S04h. What is the R-value of the insulation that was added as a result of your project? [NUMERIC OPEN END, 98=DK, 99=REF] [PROBE FOR BEST ESTIMATE]

[ASK IF S03B>5, ELSE SKIP TO S06A]

S05a. Can you explain how your experience with the Con Edison <PROGRAM> influenced your decision to install energy efficient light bulbs in your home?

00. [OPEN END]
98. (Don't know)
99. (Refused)

S05b. Did you install CFLs, LEDs or both?

1. CFLs
2. LEDs
3. Both
4. (Neither) [SKIP TO S06A]
8. (Don't know) [SKIP TO S06A]
9. (Refused) [SKIP TO S06A]

[ASK IF SO5B=1 OR 3]

SO5c. How many CFLs did you install in your home? [RECORD NUMBER; 98=DON'T KNOW; 99=REFUSED]

[ASK IF SO5B=2 OR 3]

SO5d. How many LEDs did you install in your home? [RECORD NUMBER; 98=DON'T KNOW; 99=REFUSED]

[ASK IF SO3C>5, ELSE SKIP TO SO7A]

SO6a. Can you explain how your experience with the Con Edison <PROGRAM> influenced your decision to purchase an ENERGY STAR refrigerator for your home?

00. [OPEN END]
98. (Don't know)
99. (Refused)

SO6b. What type of ENERGY STAR refrigerator did you get? Does it have..?

1. A top-mounted freezer
2. A bottom-mounted freezer or
3. A side-by-side freezer
8. (Don't know)
9. (Refused)

[ASK IF SO3D>5, ELSE SKIP TO NEXT SECTION]

SO7a. Can you explain how your experience with the Con Edison <PROGRAM> influenced your decision to purchase an ENERGY STAR clothes washer for your home?

00. [OPEN END]
98. (Don't know)
99. (Refused)

[ASK IF EV1B=1 OR EV1C=1 OR 2]

ROOM AIR CONDITIONER

I would like to ask you a few more questions about room air conditioners.

RAC1. How many total room air conditioners do you have in your home?

[NUMERIC OPEN END]

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

[READ IF ROOMAC_QTY_VERIFIED=1 AND EV1B=1]:

When answering the following questions, please think about the room air conditioner for which you received a rebate through Con Edison.

[READ IF ROOMAC_QTY_VERIFIED>1 AND EV1C=2]:

When answering the following questions, please think about the room air conditioner for which you received a rebate through Con Edison that you purchased to use in YOUR home.

[READ IF ROOMAC_QTY_VERIFIED>1 AND EVC1C=1 AND BTUS FOR BOTH UNITS ARE NOT THE SAME]:

When answering the following questions, please think about the room air conditioner that is rated at [BTU VALUE] btus for which you received a rebate from Con Edison. That's the largest room air conditioner that was rebated.

[READ IF ROOMAC_QTY_VERIFIED>1 AND EVC1C=1 AND BTUS FOR BOTH UNITS ARE THE SAME]:

When answering the following questions, please think about just one room air conditioner for which you received a rebate from Con Edison.

RAC2a. In what room is this room air conditioner usually installed?

01. Bedroom
02. Living room/family room
03. Office
04. Kitchen
05. Dining Room
00. (Other)
98. (Don't know)
99. (Refused)

RAC2b. Does this room have a door?

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

[ASK RAC2C IF RAC2B=1; ELSE SKIP TO RAC3]

RAC2c. When the room conditioner is ON, do you usually keep the doors to this room shut or do you usually keep the doors open?

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

RAC3. Is this air conditioner installed year round or do you install it just for cooling season?

01. Installed year round
02. Install it just for cooling season
00. (Other, specify)
98. (Don't know)
99. (Refused)

[ASK RAC4A AND RAC4B IF RAC3=1; ELSE SKIP TO RAC5A]

RAC4a. What month do you typically install this air conditioner for the season?

01. March
02. April
03. May
04. June
05. July
00. Other (specify)
98. (Don't know)
99. (Refused)

RAC4b. What month do you typically remove this air conditioner for the season?

01. August
02. September
03. October
04. November
05. December
00. Other (specify)
98. (Don't know)
99. (Refused)

RAC5a. When you are running this air conditioner, what temperature is the air conditioner's thermostat usually set to?

[NUMERIC OPEN END]

97. (No temperature setting; just dial)
98. (Don't know)
99. (Refused)

[ASK RAC57B IF RAC5A=97; ELSE SKIP TO RAC6]
RAC5b. What number is the dial set to?

[NUMERIC OPEN END]
97. (No temperature setting; just dial)
98. (Don't know)
99. (Refused)

[ASK IF RAC5B=97]
RAC5c.What is the coldest setting on the dial?

[NUMERIC OPEN END]
98. (Don't know)
99. (Refused)

RAC5d.When you use this room air conditioner in the summer, do you usually use it on the high cool setting, the low cool setting, or just the fan setting?

01. High cool or cooling high
02. Low cool or cooling low
03. Fan setting
00. (Other, specify)
98. (Don't know)
99. (Refused)

RAC5e.On the hottest summer WEEK DAYS, with outside high temperature higher than 90 degrees, between 4 and 5 pm, are you typically running this room air conditioner?

1. Yes
2. No
3. (Sometimes/occasionally)
8. (Don't know)
9. (Refused)

The next set of questions is about how you use this air conditioner at different outside temperatures. When answering, please ONLY THINK ABOUT SUMMER WEEK DAYS.

First, please think about summer WEEK DAYS when the outside high temperature is between 70 and 80 degrees…

RAC6. On WEEK DAYS like this, do you use this room air conditioner at all? [IF RESPONDENT SAYS IT VARIES, PROBE FOR A TYPICAL DAY]

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

[ASK IF RAC6=1, ELSE SKIP TO RAC7]

RAC6a.And do you typically keep the air conditioner on all the time, or do you turn it on and off depending on the time of the day?

1. Keep on all the time
2. Turn on and off
8. (Don't know)
9. (Refused)

[ASK IF RAC6A=2]

RAC6b.Between what hours do you TYPICALLY have the air conditioner running?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL DAY WHEN THE TEMPERATURES ARE BETWEEN 70 AND 80]

[FOR EACH RESPONSE, RECORD FROM AND TO TIMES, AS WELL AS AM/PM]

[AFTER EACH RESPONSE PROBE: DO YOU TURN THE ROOM AIR CONDITIONER BACK ON AT ANY OTHER TIME OF DAY OR NIGHT?]

a.	Period 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM
b.	Period 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM
c.	Period 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM

Now, think about summer WEEK DAYS when the outside high temperature is between 80 and 90 degrees…

RAC7. On WEEK DAYS like this, do you use this room air conditioner at all? [IF RESPONDENT SAYS IT VARIES, PROBE FOR A TYPICAL DAY]

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

[ASK IF RAC7=1, ELSE SKIP TO RAC8]

RAC7a.And do you typically keep the air conditioner on all the time, or do you turn it on and off depending on the time of the day?

1. Keep on all the time
2. Turn on and off
8. (Don't know)
9. (Refused)

[ASK IF RAC7A=2]

RAC7b.Between what hours do you TYPICALLY have the air conditioner running?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL DAY WHEN THE TEMPERATURES ARE BETWEEN 80 AND 90]

[FOR EACH RESPONSE, RECORD FROM AND TO TIMES, AS WELL AS AM/PM]

[AFTER EACH RESPONSE PROBE: DO YOU TURN THE ROOM AIR CONDITIONER BACK ON AT ANY OTHER TIME OF DAY OR NIGHT?]

a.	Period 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM
b.	Period 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM
c.	Period 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM

Now, think about hot summer WEEK DAYS when the outside high temperature is 90 degrees or higher…

RAC8. On WEEK DAYS like this, do you use this room air conditioner at all? [IF RESPONDENT SAYS IT VARIES, PROBE FOR A TYPICAL DAY]

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

[ASK IF RAC8=1, ELSE SKIP TO NEXT SECTION]

RAC8a.And do you typically keep the air conditioner on all the time, or do you turn it on and off depending on the time of the day?

1. Keep on all the time
2. Turn on and off
8. (Don't know)
9. (Refused)

[ASK IF RAC8A=2]

RAC8b.Between what hours do you TYPICALLY have the air conditioner running?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL DAY WHEN THE TEMPERATURE IS 90 DEGREES OR HIGHER]

[FOR EACH RESPONSE, RECORD FROM AND TO TIMES, AS WELL AS AM/PM]

[AFTER EACH RESPONSE PROBE: DO YOU TURN THE ROOM AIR CONDITIONER BACK ON AT ANY OTHER TIME OF DAY OR NIGHT?]

a.	Period 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM
b.	Period 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM
c.	Period 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM

[ASK IF CENTRALAC_QTY_VERIFIED>0, ELSE SKIP TO NEXT SECTION]

CENTRAL AIR CONDITIONER

I wanted to ask you a few more questions about the central air conditioning system for which you received a rebate from Con Edison.

[READ IF CENTRALAC_QTY_VERIFIED>1]:
When answering the next set of questions, please focus on just one cooling zone. A cooling zone is an area of your home with its own thermostat.

[ASK IF THERMOSTAT_QTY_VERIFIED=0]
CAC1a. Is your thermostat programmable? That is, can you program it to change temperature settings automatically at different times of the day and night?

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

CAC1b. Do you turn your air conditioner on and off depending on the outdoor temperature, or do you turn it on and leave it on for the season?

1. Turn AC off and on depending on temperature
2. Turn AC and leave it on for the season
8. (Don't know) [SKIP TO NEXT SECTION]
9. (Refused) [SKIP TO NEXT SECTION]

[ASK IF CAC1B=2 AND CAC1A=1 OR THERMOSTAT_QTY_VERIFIED>0]
CAC1c.Do you program your thermostat to automatically change temperatures of your central air conditioning system at different times or do you adjust it manually based on your comfort level?

1. Thermostat is programmed
2. Adjust manually
8. (Don't know)
9. (Refused)

[ASK IF CAC1C=1]
CAC1d. What are your thermostat settings for a TYPICAL SUMMER WEEK DAY?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL DAY IN THE SUMMER]
[FOR EACH RESPONSE, PROBE FOR AND RECORD FROM AND TO TIMES, AS WELL AS AM/PM AND TEMPERATURES]
[AFTER EACH SETTING PROBE: "IS YOUR THERMOSTAT SET TO ADJUST TEMPERATURE AT ANY OTHER TIMES DURING THE DAY OR NIGHT?"]

a.	Setting 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
b.	Setting 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
c.	Setting 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
d.	Setting 4	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]

[ASK IF CAC1B=1]
CAC1e. What is the outside high temperature at which you are typically using your central air conditioner?

1. 75 degrees
2. 80 degrees
3. 85 degrees
4 90 degrees
5. 95 degrees
8. (Don't know)
9. (Refused)

[ASK IF CAC1B=1 OR CAC1B=2 AND CAC1C<>1]
CAC1f.When you use your central air conditioner, between what hours do you TYPICALLY have the central air conditioner running ON SUMMER WEEK DAYS?
[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL SUMMER WEEK DAY]
[FOR EACH RESPONSE, PROBE FOR AND RECORD FROM AND TO TIMES, AS WELL AS AM/PM]
[AFTER EACH RESPONSE PROBE: DO YOU TURN THE CENTRAL AIR CONDITIONER BACK ON AT ANY OTHER TIME OF DAY OR NIGHT?]

a.	Period 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM
b.	Period 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM
c.	Period 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM
d.	Period 4	From [OPEN END] AM/PM	To [OPEN END] AM/PM

[ASK IF CAC1B=1 OR CAC1B=2 AND CAC1C<>1]
CAC1g. At what temperature do you set your thermostat during each of the periods that you just mentioned? Let's start with… [READ TIME PERIODS FROM BELOW]?
[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL SUMMER WEEK DAY]

a.	Period	From READ IN	To READ IN	Temp [OPEN END]
b.	Period	From READ IN	To READ IN	Temp [OPEN END]
c.	Period	From READ IN	To READ IN	Temp [OPEN END]
d.	Period	From READ IN	To READ IN	Temp [OPEN END]

CAC1h.On the hottest summer WEEK DAYS with outside high temperature above 90 degrees, between 4 and 5 pm, are you typically running the central air conditioner?
1. Yes
2. No
3. (Sometimes/occasionally)
8. (Don't know)
9. (Refused)

[ASK IF HEATPUMP_QTY_VERIFIED>0]

HEAT PUMPS

We are interested in learning about how you use the heat pump(s) you purchased through the Con Edison <PROGRAM>.

[READ IF HEATPUMP_QTY_VERIFIED>1]:
When answering the next set of questions, please focus on just one heating and cooling zone. A heating or cooling zone is an area of your home with its own thermostat.

[ASK IF THERMOSTAT_QTY_VERIFIED=0]
HP1. Is your thermostat programmable? That is, can you program it to change temperature settings automatically at different times of the day and night?

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

HP1a. Which of the following modes have you used on your heat pump? Have you used..?
[1=YES; 2=NO; 8=DK; 9=REF]

a. Cooling mode
b. Heating mode
c. Dry mode
d. Fan mode

For the next set of questions, please think about using your heat pump during the summer months for cooling.

HP1b. Do you TYPICALLY turn your heat pump on and off depending on the outdoor temperature, or do you turn it on and leave it on for the season?

1. Turn heat pump off and on depending on temperature
2. Turn heat pump and leave it on for the season
8. (Don't know) [SKIP TO NEXT SECTION]
9. (Refused) [SKIP TO NEXT SECTION]

[ASK IF HP1B=2 AND HP1=1 OR THERMOSTAT_QTY_VERIFIED>0]
HP1c. Do you program your thermostat to automatically change temperatures of your heat pump at different times of the day and night or do you adjust it manually based on your comfort level?

1. Thermostat is programmed
2. Adjust manually
8. (Don't know)
9. (Refused)

[ASK IF HP1C=1]
HP1d. What are your thermostat settings for a TYPICAL SUMMER WEEK DAY?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL SUMMER WEEK DAY]
[FOR EACH RESPONSE, PROBE FOR AND RECORD FROM AND TO TIMES, AS WELL AS AM/PM AND TEMPERATURES]
[AFTER EACH SETTING PROBE: "IS YOUR THERMOSTAT SET TO ADJUST TEMPERATURE AT ANY OTHER TIMES DURING THE DAY OR NIGHT?"]

a.	Setting 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
b.	Setting 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
c.	Setting 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
d.	Setting 4	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]

[ASK IF HP1B=1]
HP1e. What is the outside high temperature at which you start using your heat pump for cooling?

1. 75 degrees
2. 80 degrees
3. 85 degrees
4 90 degrees
5. 95 degrees
8. (Don't know)
9. (Refused)

[ASK IF HP1B=1 OR HP1B=2 AND HP1C<>1]

HP1f.When you use your heat pump, between what hours do you TYPICALLY have the heat pump running ON WEEK DAYS?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL SUMMER WEEK DAY WHEN THE HEAT PUMP IS ON]

[FOR EACH RESPONSE, PROBE FOR AND RECORD FROM AND TO TIMES, AS WELL AS AM/PM]

[AFTER EACH RESPONSE PROBE: DO YOU TURN THE HEAT PUMP BACK ON AT ANY OTHER TIME OF DAY OR NIGHT?]

a.	Period 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM
b.	Period 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM
c.	Period 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM
d.	Period 4	From [OPEN END] AM/PM	To [OPEN END] AM/PM

[ASK IF HP1B=1 OR HP1B=2 AND HP1C<>1]

HP1g. At what temperature do you set your thermostat during each of the periods that you just mentioned? Let's start with… [READ TIME PERIODS FROM BELOW]?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL SUMMER WEEK DAY]

a.	Period	From READ IN	To READ IN	Temp [OPEN END]
b.	Period	From READ IN	To READ IN	Temp [OPEN END]
c.	Period	From READ IN	To READ IN	Temp [OPEN END]
d.	Period	From READ IN	To READ IN	Temp [OPEN END]

HP1h. On the hottest summer WEEK DAYS with outside high temperature higher than 90 degrees, between 4 and 5 pm, are you typically running the heat pump?

1. Yes
2. No
3. (Sometimes/occasionally)
8. (Don't know)
9. (Refused)

For the next set of questions, please think about using your heat pump during the winter months for heating.

HP2b. Do you TYPICALLY turn your heat pump on and off depending on the outdoor temperature, or do you turn it on and leave it on for the season?

1. Turn heat pump off and on depending on temperature
2. Turn heat pump and leave it on for the season
8. (Don't know)
9. (Refused)

[ASK IF HP2B=2 AND HP2A=1 OR THERMOSTAT_QTY_VERIFIED>0]

HP2c.Do you program your thermostat to automatically change temperatures of your heat pump at different times of the day and night or do you adjust it manually based on your comfort level?

1. Thermostat is programmed
2. Adjust manually
8. (Don't know)
9. (Refused)

[ASK IF HP2C=1]

HP2d. What are your thermostat settings for a TYPICAL WINTER WEEK DAY?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL WINTER WEEK DAY WHEN THE HEAT PUMP IS ON]

[FOR EACH RESPONSE, PROBE FOR AND RECORD FROM AND TO TIMES, AS WELL AS AM/PM AND TEMPERATURES]

[AFTER EACH SETTING PROBE: "IS YOUR THERMOSTAT SET TO ADJUST TEMPERATURE AT ANY OTHER TIMES DURING THE DAY OR NIGHT?"]

a.	Setting 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
b.	Setting 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
c.	Setting 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]
d.	Setting 4	From [OPEN END] AM/PM	To [OPEN END] AM/PM	Temp [OPEN END]

[ASK IF HP2B=1]

HP2e. What does the temperature have to be outside for you to start using your heat pump for heating?

[NUMERIC OPEN END; 998=DK; 999=REF]

[ASK IF HP2B=1 OR HP2B=2 AND HP2C<>1]

HP2f.When you use your heat pump, between what hours do you TYPICALLY have the heat pump running ON WEEK DAYS?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL WINTER WEEK DAY WHEN THE PUMP IS ON]

[FOR EACH RESPONSE, PROBE FOR AND RECORD FROM AND TO TIMES, AS WELL AS AM/PM]

[AFTER EACH RESPONSE PROBE: DO YOU TURN THE HEAT PUMP BACK ON AT ANY OTHER TIME OF DAY OR NIGHT?]

a.	Period 1	From [OPEN END] AM/PM	To [OPEN END] AM/PM
b.	Period 2	From [OPEN END] AM/PM	To [OPEN END] AM/PM
c.	Period 3	From [OPEN END] AM/PM	To [OPEN END] AM/PM
d.	Period 4	From [OPEN END] AM/PM	To [OPEN END] AM/PM

[ASK IF HP2B=1 OR HP2B=2 AND HP2C<>1]

HP2g. At what temperature do you set your thermostat during each of the periods that you just mentioned? Let's start with… [READ TIME PERIODS FROM BELOW]?

[IF RESPONDENT SAYS IT DEPENDS, PROBE FOR A TYPICAL WINTER WEEK DAY]

a.	Period	From READ IN	To READ IN	Temp [OPEN END]
b.	Period	From READ IN	To READ IN	Temp [OPEN END]
c.	Period	From READ IN	To READ IN	Temp [OPEN END]
d.	Period	From READ IN	To READ IN	Temp [OPEN END]

DEMOGRAPHICS

I have a few more questions and then we are done.

D1. Do you own or rent your home?
01. Own
02. Rent
00. (Other, specify)
98. (Don't know)
99. (Refused)

D2. Which of the following best describes your home?
01. Detached single family
02. Townhouse
03. Duplex or two-family
04. Apartment, condominium or multifamily home with three or more units
00. (Other, specify)
98. (Don't know)
99. (Refused)

[ASK IF D2=4]
D2a. What floor do you live on? [NUMERIC OPEN END]

[SKIP IF D2=4]
D3. To the best of your knowledge, what type of fuel or energy does your water heater use?
01. Electricity
02. Natural gas
03. Propane or bottled gas
04. Solar
00. Or other fuel type (Specify)
1. 98. (Don't know)
2. 99. (Refused)

SITE VISIT RECRUITER

[READ IF EV1B=1 OR EV1C=1 OR 2]
To better evaluate this program's performance, Con Edison is conducting a metering study to measure how much energy is saved by using high-efficiency air conditioners like the one you installed through the <PROGRAM>. Technicians will be collecting information from the air conditioners of selected customers. Participants in the study will receive two $50 gift cards. The study includes two visits to your home. The first visit will take about 1 hour and would take place during the month of June. The air conditioner needs to already be installed. During this visit, we would need your permission to gather building characteristics and temporarily unplug your room air conditioner. The technician will install a metering device on your air conditioner that will stay in place until September when the technician returns to retrieve the device. That visit will take about 30 minutes. For your participation, you will receive a $50 gift card during the first visit and another $50 gift card during the second visit. The data will be used strictly for the study of the <PROGRAM> and will not affect your electric service or any past or future incentives at all.

(IF NEEDED: If you agree to participate, a team of two field technicians, on behalf of Con Edison, will come to your residence to install power and temperature logger devices on your air conditioner and thermostat as well as take measurements of your home. These loggers will record when your air conditioner is in use and how well it is performing. Technicians will need to get access to the area where the room air conditioner is located within your home. The loggers would be installed in an unobtrusive place and will be removed by us at the end of the research project in September.)

[READ IF CENTRALAC_QTY_VERIFIED>0]
To better evaluate this program's performance, Con Edison is conducting a metering study to measure how much energy is saved by using high-efficiency air conditioners like the one you purchased through the <PROGRAM>. Technicians will be collecting information from the air conditioners of selected customers. Participants in the study will receive two $50 gift cards. The study includes two visits to your home. The first will take about 3 hours and would take place during the month of June. During this visit, we would need your permission to walk around the entire house to gather building characteristics, turn the AC down 10 degrees, and to potentially turn off the power to the entire house for up to 30 minutes. The technician will install a metering device on your air conditioner that will stay in place until September when the technician returns to retrieve the device. That visit will take between 1 and 2 hours. For your participation, you will receive a $50 gift card during the first visit and another $50 gift card during the second visit. The data will be used strictly for the study of the <PROGRAM> and will not affect your electric service or any past or future incentives at all.

(IF NEEDED: If you agree to participate, a team of two field technicians, on behalf of Con Edison, will come to your residence to install power and temperature logger devices on your air conditioner and thermostat as well as take measurements of your home. These loggers will record when your air conditioner is in use and how well it is performing. Technicians will need to get access to the area where the furnace, air handler, or air conditioner is located within your home. The loggers would be installed in an unobtrusive place and will be removed by us at the end of the research project in September.)

[READ IF HEAT_PUMP_QTY_VERIFIED>0]
To better evaluate this program's performance, Con Edison is conducting a metering study to measure how much energy is saved by using high-efficiency heat pumps like the one you purchased through the <PROGRAM>. Technicians will be collecting information from selected customers during both cooling and heating seasons. Participants will receive three $50 gift cards for their participation. The study includes three visits to your home. The first visit will take about 3 hours and would need to take place during the month of June. During this visit, we would need your permission to walk around the entire house to gather building characteristics, turn the heat pump down 10 degrees, and to potentially turn off the power to the entire house for up to 30 minutes. The technician will install a metering device on your heat pump that will stay in place until the following April. The second visit will occur in October and will take about one hour for the technician to check the meters and then reset the equipment for the heating season. The third visit will be in April 2013 when the technician returns to collect the metering device. This visit will take about one hour. For your participation, you will receive a $50 gift card at each visit. The data will be used strictly for the study of the <PROGRAM> and will not affect your electric service or any past or future incentives at all.

(IF NEEDED: If you agree to participate, a team of two field technicians, on behalf of Con Edison, will come to your residence to install power and temperature logger devices on your heat pump and thermostat as well as take measurements of your home. These loggers will record when your heat pump is in use and how well it is performing. Technicians will need to get access to the areas where the outdoor unit and all indoor units are located within your home. The loggers would be installed in an unobtrusive place and will be reset by us in October and then removed by us at the end of the research project in April.)

[ASK R1 IF EV1B=1 OR EV1C=1 OR 2 OR CENTRALAC_QTY_VERIFIED>0]
R1. Are you interested in participating in this study and receiving two $50 gift cards?
- 01. Yes
- 02. No
- 98. (Don't know)
- 99. (Refused)

[ASK IF HEATPUMP_QTY_VERIFIED>0]
R2. Are you interested in participating in this study and receiving three $50 gift cards?
- 01. Yes
- 02. No
- 98. (Don't know)
- 99. (Refused)

[READ IF R1=1 OR R2=1]
Great! Thank you. A representative will be in contact with you to schedule your site visits. Those are all the questions I have for today. Thank you for your time and help in this important study.

[READ IF R1=2,98,99 OR R2=2,98,99]

Those are all the questions I have for today. Thank you for your time and help in this important study.

Appendix E: Glossary of Terms

CECONY or CE (in some tables) – Consolidated Edison Company of New York.

census stratum – In a stratified sample design, the stratum with those participants with the largest savings may have a calculated sample size that exceeds the population of the stratum. A stratum that meets this condition is referred to as a census stratum.

coefficient of variance (CV) – A normalized measure of dispersion of a probability distribution and defined as the ratio of the standard deviation, σ,to the mean, μ:

$$c_v = \frac{\sigma}{\mu}$$

common area (CA) – The areas of a multifamily building that are not leased to tenants, such as corridors and lobbies.

DPS – New York Department of Public Service.

Energy Efficiency Portfolio Standard (EEPS) – The state-mandated utility-administered programs.

energy management system (EMS) – A system used by building operators to monitor, measure, control, and schedule their building loads.

error ratio – In energy efficiency evaluation, the error ratio is a measure of the degree of variance between the reported savings estimates and the evaluated estimates. For a sample, the error ratio is:

$$er = \frac{\sqrt{\sum_{i=1}^{n} w_i \frac{e_i^2}{x_i^\gamma} \sum_{i=1}^{n} w_i x_i^\gamma}}{\sum_{i=1}^{n} w_i x_i}$$

where n is the sample size, w_i is the population expansion weight associated with each sample point i, x_i is the program-reported savings for each sample point i, y_i is the evaluated gross savings for each sample point i, error for each sample point $e_i = y_i - bx_i$, and γ= 0.8.

ex ante savings estimate – Forecasted savings used for program and portfolio planning purposes.

ex post savings estimate – Savings estimate reported by an evaluator after the energy impact evaluation has been completed.

free rider, free ridership (FR) – A program participant who would have implemented the program measure or practice in the absence of the program.

HVAC – Heating, ventilation, and air conditioning.

interval meter – An electric utility meter that measures and stores energy use and demand in 15-minute intervals. Interval meters are required for New York customers to participate in Independent System Operator demand response programs.

in-unit (IU) – The areas of a multifamily building that are leased to tenants, i.e., the individual apartments.

measurement and verification (M&V) – A subset of program impact evaluation that is associated with the documentation of energy savings at individual sites or projects using one or more methods that can involve measurements, engineering calculations, statistical analyses, and/or computer simulation modeling.

National Action Plan for Energy Efficiency – Model energy efficiency program impact evaluation guide abbreviated as NAPEE. This is the DPS-recommended reference guide for impact evaluations.

New York Technical Manual (NYTM) – The DPS-mandated reference document for calculating EEPS program savings.

net to gross, net-to-gross ratio (NTG, NTGR) – The relationship between net energy or net demand savings, where net is measured as what would have occurred without the program, what would have occurred naturally, and gross savings (often evaluated savings). The NTGR is the ratio of net savings to gross savings.

O&R – Orange & Rockland Utilities.

relative precision – Measures the expected error bound of an estimate on a normalized basis. It must be expressed for a specified confidence level. The relative precision (*rp*) of an estimate at 90% confidence is:

$$rp = 1.645 \frac{CV}{\sqrt{n}} \sqrt{1 - \frac{n}{N}}$$

where n is the sample size, N is the population size, and the coefficient of variance is CV = standard deviation / estimate mean value. The square root expression at the end of the equation is the finite population correction factor, which becomes inconsequential and unnecessary for large populations.

realization rate – The term is used in several contexts in the development of reported program savings. The primary applications include the ratio of project tracking system savings data (e.g., initial estimates of project savings) to savings that (1) are adjusted for data errors and (2) incorporate evaluated or verified results of the tracked savings. In the Updated Guidelines, the realization rate does not include program attribution.

savings realization rate (RR) – The ratio of the field of evaluation energy savings to the program's claimed savings. The RR represents the percentage of program-estimated savings that the impact evaluation team estimates as being actually achieved based on the results of the evaluation M&V analysis.

self-reported approach (SRO) – A method for gathering program attribution data through direct interviews with participants.

smart strip – A power strip that uses a master/slave configuration to allow the operational status of one plugged-in appliance to dictate whether or not power is supplied to the other outlets (appliances).

snapback – Snapback occurs when customers actually increase their energy consumption due to reductions in the cost of energy.

spillover (SO) – Includes **participant spillover (PSO)** and **nonparticipant spillover (NPSO)** – Reductions in energy consumption and/or demand caused by the presence of the energy efficiency program, beyond program-related gross savings of participants.

PSO occurs when additional actions are taken to reduce energy use at the same site, but these actions are not included as program savings.

NPSO is the reduction in energy consumption and/or demand from measures installed and actions taken or encouraged by nonparticipating vendors or contractors because of the influence of the program.

stratified ratio estimator (SRE) – An efficient sampling design combining stratified sample design with a ratio estimator. It's most advantageous when the population has a large coefficient of variation (CV). (A large CV occurs, for example, when a substantial portion of the projects have small savings and a small number of projects have very large savings.) The ratio estimator uses supporting information for each unit of the population when this information is highly correlated with the desired estimate to be derived from the evaluation, such as the tracking savings and the evaluated savings.

The RR calculation for electric energy is shown below:

$$RR = \frac{kWh_{Evaluation}}{kWh_{Program}}$$

where RR is the savings realization rate, $kWh_{Evaluation}$ is the evaluation M&V kWh savings (by evaluation M&V contractor), and $kWh_{Program}$ is the kWh savings claimed by program.

TMY3 – Typical meteorological year weather data.

thermostatic radiator valves (TRV) – TRVs regulate the flow of water through the radiator based on achieving a desired air temperature.

upstream and midstream incentive program – a program in which an incentive is paid directly to the retailer, distributor, or manufacturer who stocks and sells high efficiency equipment by the local electric utility so that the price the customer pays is already been reduced; these programs focus on engaging the upstream market actors to accelerate the introduction and sale of more efficiency equipment.