NAVIGANT

Multi-Family Program Impact and Net-to-Gross Evaluation (RES 44)

Draft Final Report

Prepared for:

The Electric and Gas Program Administrators of Massachusetts
Part of the Residential Evaluation Program Area

Submitted by:
Navigant Consulting, Inc.
1375 Walnut Street
Suite 100
Boulder, CO 80302

303.728.2500
navigant.com

Reference No.: 183406
March 30, 2017

TABLE OF CONTENTS

Executive Summary 4

Evaluation Objectives and Methodology 4
Evaluation Activities 4
Findings and Recommendations 5

1. Introduction 7

1.1 Program Description 7
1.2 Study Objectives 8
1.3 Summary of Evaluation Activities 9

2. Sample Methodology 11

2.1 Data Request 11
2.2 Sampling for Lighting Impact Tasks 11
2.2.2 Sampling for NTG Task 14

3. Lighting Impact Evaluation 16

3.1 Lighting Impact Evaluation Methodology 16
3.1.1 Site Visits 17
3.1.2 Onsite Data Collection 19
3.1.3 Data Analysis 20
3.2 Lighting Impact Results 22
3.2.1 Common Area Lighting HOU Results 22
3.2.2 Common Area and In-Unit Lighting ISR Results 25
3.3 Qualitative and Contextual Findings 27
3.3.1 Ride-Along Site Visits with the QA/QC Contractor 27
3.3.2 Interviews with the Lead Vendors 27
3.3.3 Qualitative and Contextual Findings from the Interviews 28

4. Net-to-Gross (NTG) Findings 32

4.1 Overall NTG Results 32
4.2 NTG Analysis Methodology 33
4.2.1 Definitions 33
4.2.2 Survey: Implementation and Outreach 38
4.2.3 Survey: Stakeholder Identification Module 39
4.2.4 Survey: Responses 41
4.3 Free Ridership 43
4.3.1 FR Survey Module 43
4.3.2 FR Algorithm 45
4.3.3 FR Results 47
4.4 Spillover 49
4.4.1 SO Survey Module 50
4.4.2 SO Algorithm 59
4.4.3 SO Results 60

5. Conclusions and Recommendations 62

5.1 Quantitative Recommendations 62

5.2 Qualitative Considerations and Recommendations 63

Appendix A. Net-to-Gross Survey A-1

Appendix B. Lead Vendor Interview Guide B-1

ACRONYMS AND ABBREVIATIONS

AC	Air conditioning
C&I	Commercial and industrial
CLC	Cape Lighting Compact
DHW	Domestic hot water
EEAC	Energy Efficiency Advisory Council
FR	Free ridership
HOU	Hours of use
HVAC	Heating, ventilation, and air conditioning
IC	Implementation contractor
ISR	In-service rate
kWh	Kilowatt-hour
LEAN	Low-Income Energy Affordability Network
MF	Multi-family
MMBtu	Million British-Thermal Units
MMRP	Massachusetts Multi-Family Retrofit Program
NG	Natural gas
NTG	Net-to-gross
PA	Program administrator
QA/QC	Quality assurance/quality control
RES 42	*Multi-Family Program Improvement Strategies* study
RES 43	*Census of Massachusetts Multi-Family and Condo Properties*
RES 44	*Multi-Family Program Impact Evaluation* study
SO	Spillover
TRM	Technical reference manual

EXECUTIVE SUMMARY

The Massachusetts Multi-Family Retrofit Program (MMRP) provides comprehensive rebate opportunities for standard income multi-family (MF) buildings with a minimum of five residential units. Through the MMRP the Massachusetts Program Administrators (PAs) offer MF building owners and operators a building assessment to identify energy efficiency retrofit opportunities within their properties. Based on the results of the individual building assessment, the MMRP offers the direct installation of many common area measures for a small copay and in-unit measures at no-cost.

Evaluation Objectives and Methodology

To improve the accuracy of MMRP-reported savings, stakeholders requested an updated impact evaluation of lighting measures and program-wide net-to-gross (NTG) research. The focus on lighting measures for impact evaluation activities reflects lighting's high contribution to overall program savings.

The goals of the *Multi-Family Program Impact* study (RES 44) (i.e., this study) include the following:

- Updated hours of use (HOU) realization rate for common area lighting measures
- Updated in-service rates (ISRs) for both common area and in-unit lighting measures
- Measure category-level NTG ratios for both common areas and in-unit measures
- Assessment of progress made on the RES 42 suggested improvement strategies (March 28, 2017)
- Assessment of updated vendor project reporting and quality assurance procedures

The primary goal of the research completed through this study was to inform savings reporting for the 2017 and 2018 program years and inform the subsequent 2019-2021 planning cycle.

Evaluation Activities

The lighting impact evaluation objectives were addressed through database analysis, project engineering file reviews, and site visits. The evaluation team completed site visits at a total of 23 facilities, which included reviewing 147 common area measures across 15 facilities and 201 in-unit measures installed in 201 units across 14 facilities (six facilities included both common area and in-unit measures).

The evaluation team conducted NTG research through surveys targeted at MMRP participating and nonparticipating renters, condominium owners, and property managers/owners. A total of 1,396 individuals responded to the NTG survey; following a series of screening questions, 189 of these responses were determined eligible to comment on MMRP free ridership. The survey respondents identified 560 non-incentivized, program-influenced actions; after screening, 170 actions were included in the spillover analysis.

Findings and Recommendations

This study resulted in a series of conclusions for the MMRP. Some of these are quantitative, which affect the calculation of program savings, and some qualitative, identifying opportunities for improving program activities. The quantitative and qualitative recommendations from both the impact and NTG portions of this evaluation are presented in Table 1.

Table 1. Findings and Recommendations

Quantitative Findings	Quantitative Recommendations
Finding 1: The vendor-reported common area HOU had no correlation with the logged HOU, as illustrated in Figure 2. The high variance led to low precision on the HOU realization rate. The findings around common area HOU resulted in different recommendations by PA, as the PAs use two separate practices for assigning ex ante common area HOU. Eversource uses space-by-space deemed HOU values as identified in the RES 42 *Preliminary Task 2b and 3 Findings Memo* (March 2017). All other PAs use vendor-reported HOU values, which are customized to the project and space.	**Recommendation 1.1:** To update the 2017 MMRP common area lighting savings, Eversource should replace its currently used space-by-space deemed HOU values with the updated space-by space deemed HOU results from this study, as reported in Table 13. **Recommendation 1.2:** To update the 2017 MMRP common area lighting savings, all PAs other than Eversource should apply the found realization rates of 0.91 for interior lighting and 0.98 for exterior lighting to the common area HOU (also reported in Table 12). **Recommendation 1.3:** For all future program years (2018 and beyond), all PAs should switch to using the space-by-space deemed HOU values reported in Table 13. When the deemed HOU values are applied they should be a accompanied by a HOU realization rate of 1.0.
Finding 2: The evaluation team found ISRs of 1.0 for common areas[1] and 0.88 for in-unit areas (Table 14).	**Recommendation 2.1:** The PAs should apply the ISRs retroactively to 2017 program savings and proactively to future program savings and planning.
Finding 3: The evaluation team found a free ridership ratio of 0.21 and a provisional[2] spillover ratio of 0.28, resulting in a provisional program-level NTG ratio of 1.07 (Table 15).	**Recommendation 3.1:** The PAs should apply the NTG ratio proactively to future program savings and planning. The program-level NTG ratio identified in this study should be applied to gross electric and fuel savings from all measures in the MMRP.

[1] The common area ISR found through this study was 1.02, but the evaluation team recommends rounding this value to 1.0 when applying to the MMRP savings.

[2] The spillover and therefore NTG ratios presented in this report are provisional. In the final step of the spillover ratio total participant and nonparticipant SO energy savings are divided by the ex post gross 2017 MMRP energy savings. The ex post gross 2017 MMRP energy savings were not available at the time that this report was published, therefore provisional values are provided in this document. The provisional values will be updated when the 2017 MMRP ex post gross energy savings are available.

Qualitative Findings	Qualitative Recommendations
Finding 4: The evaluation team found that, in general, quality assurance/quality control (QA/QC) processes had improved for the MMRP since the implementation of the RES 42 suggested improvement strategies which included providing site-specific locations for lighting installations. However, paperwork used by the implementation vendors to track measure installation still varies tremendously.	**Consideration 4.1:** The PAs should consider continuing to implement the suggested improvement strategies from the RES 42 study, specifically those that focus on improving data clarity between the implementation and QA/QC vendors. **Consideration 4.2:** The PAs should consider encouraging a greater level of consistency in the implementation vendors' documentation. This could even go as far as recommending a standard template for all implementation vendors to use. This would increase data clarity and consistency across the PAs.
Finding 5: During the lead vendor interviews, two of the three implementation vendors reported issues with QA/QC inspections occurring while the installation was in progress, before all measures had been installed. The PAs indicate that *in process* QA/QC visits are important to review existing conditions. However, it seems that there is confusion as to what type of visit is supposed to occur and what data is meant to be collected in each instance.	**Recommendation 5.1:** The PAs should work with the implementation and QA/QC vendors to identify the correct flag in the project database to ensure clarity around whether QA/QC visits can both occur when a project is in process and after completion. In addition, the PAs should work with the implementation and QA/QC vendors to clarify what data should be collected at each type of site visit.
Finding 6: The evaluation team found that almost half of renters surveyed, all of whom live in 2017 MMRP participating buildings, did not know that their building had participated in the program.	**Consideration 6.1:** The PAs should consider facilitating improved outreach from implementation vendors to building residents to continue to increase program awareness. In addition, the PAs should consider opportunities to address the MMRP offering directly to renters, so that they become more active participants in the program.

Source: Navigant analysis

1. INTRODUCTION

This report presents the evaluation of the 2017 Massachusetts Multi-Family Retrofit Program (MMRP) and includes a discussion of two discrete activities: a lighting impact analysis and program net-to-gross (NTG) research. This study was conducted by the Massachusetts Residential Retrofit Research Area evaluation team, led by Navigant (referred to as "the evaluation team" or "the team" throughout this document).

The evaluation team conducted the research and analysis were on behalf of the Massachusetts Program Administrators (PAs) and the Energy Efficiency Advisory Council (EEAC). The PAs participating in the MMRP and included in this evaluation are Berkshire Gas Company, Cape Light Compact, Columbia Gas of Massachusetts, Eversource, Liberty Utilities, National Grid, and Unitil.

This study, referred to as RES 44, was guided by the 2016 preliminary findings from the *Multi-Family Program Improvement Strategies (RES 42)* research study. RES 42 included ride-along site visits and an analysis of lighting delta watts as part of the project verification activities. The preliminary RES 42 results identified opportunities to improve project reporting procedures and savings assumptions. The RES 44 impact evaluation activities only address projects completed in 2017 projects that had undergone updated reporting procedures resulting from the RES 42 recommendations. This report is intended to complement the RES 42 findings and suggested improvement strategies and assess the subsequent MMRP changes.

1.1 Program Description

The MMRP serves owners and managers of multi-family (MF) buildings to identify energy efficiency retrofit opportunities and install efficient upgrades. MMRP services are available to market rate buildings with a minimum of five residential units. Low-income MF buildings are served through the Low-Income Energy Affordability Network (LEAN) and were not the focus of this evaluation.[3]

Qualified energy specialists conduct building assessments, typically inspecting common areas (hallways, stairwells, offices, laundry facilities, etc.) and a representative sample of units. The MMRP offers direct installation of many common area measures for a small copay and in-unit measures at no cost. Measures available to properties are determined based on the results of individual building assessments and may include:

- **Building shell:** Air sealing of drafty areas and insulation
- **Domestic hot water:** Low-flow showerheads, faucet aerators, pipe wrap, and water heating equipment
- **Lighting:** Energy efficient lighting upgrades and controls (such as occupancy sensors)
- **Appliances:** ENERGY STAR-certified refrigerators

[3] The Income Eligible program serves both single-family and MF buildings, helping to reduce energy costs in buildings occupied by families living under 60% of the state's median income. https://www.masssave.com/en/ and http://masslean.org/.

- **In-unit Heating, ventilation, and air conditioning (HVAC) equipment:** High efficiency heating and cooling equipment, controls, and programmable thermostats

To offer comprehensive services to MF building stakeholders, the MMFP may also present energy efficiency measures that are traditionally rebated through other Mass Save programs, such as the commercial and industrial (C&I) program.[4] Examples of these additional measures include:

- **Custom measures:** Analysis and rebates for specialized custom measures
- **Domestic hot water:** Large capacity heating equipment
- **Large capacity HVAC equipment, including:**
    - Chillers
    - Energy management systems (EMSs)
    - Heat recovery ventilators (HRVs)/energy recovery ventilators (ERVs)
    - High efficiency equipment upgrades and controls
    - Variable speed drives

The intent of the MMRP is to comprehensively serve MF buildings, including the treatment of all building units, but this is often not possible. Beyond the standard opt-out process in traditional multifamily, many properties served by the MMRP are condominiums, which offer additional customer barriers. Achieving participation from all individual condominium owners within a building is often not possible; thus, there are typically nonparticipating units (condo or apartments) in participating buildings..

1.2 Study Objectives

To improve the accuracy of MMRP-reported savings, stakeholders requested an updated impact evaluation of lighting measures and program-wide NTG research. The focus on lighting measures for impact evaluation activities reflects lighting's high contribution to overall program savings.

The goals of the *Multi-Family Program Impact* study (RES 44) include the following:

- Updated hours of use (HOU) realization rate for common area lighting measures
- Updated in-service rates (ISRs) for both common area and in-unit lighting measures
- Measure category-level NTG ratios for both common areas and in-unit measures
- Assessment of progress made on the RES 42 suggested improvement strategies (March 28, 2017)
- Assessment of updated vendor project reporting and quality assurance procedures

This evaluation methodology was informed by recent MF research studies,[5] and program implementation adjustments were made by the PAs based on recent findings and recommendations. The primary goal of

[4] When C&I program measures, or measures traditionally rebated through other Mass Save programs, are offered to MMRP customers, they are often rebated as custom incentives through the MMRP.

[5] Including DNV GL (August 3, 2016). *2013 National Grid Multifamily Program Gas and Electric Impact Study,* and Navigant (March 28, 2017) *Multifamily Program Improvement Strategies.*

the research completed through RES 44 was to inform savings reporting for the 2017 and 2018 program years and inform the subsequent 2019-2021 planning cycle.

1.3 Summary of Evaluation Activities

The lighting impact activities, which addressed lighting HOU and ISRs, were assessed through database analysis, project engineering file reviews, and site visits. The evaluation team conducted the NTG research through surveys targeted at renters, condominium owners, and property managers/owners. These activities are described in detail in this report. The activities included in the *Multi-Family Program Impact Evaluation* and the rationale for each activity are listed in Table 2.

Table 2. Evaluation Activities

Activity	Rationale
Conduct project kickoff, documentation review (Task 1a)	This activity ensured the PAs, EEAC, and the evaluation team had a consistent understanding of program requirements and processes, confirmed understanding of research needs and objectives, and finalized the work plan.
Request and analyze participation data (Task 1b)	This data analysis was used to refine the sampling strategy and methodological approach based on the data available and population size.
Develop sampling plan (Task 1c)	The sample plan documented the population sizes, stratifications, targeted number of completed project reviews, site visits, surveys, and level of precision for each stratification and the overall evaluation. The plan resulted in agreement on sampling strategies and confirmed the accuracy of the evaluation team's population analysis for all evaluation activities.
Lighting impacts: onsite data collection plan (Task 2a)	The evaluation team formalized the data to be collected during the site visits and the procedures for data collection. The plan was reviewed with all project stakeholders to develop agreement on planned activities and approaches for communicating with MF customers.
Lighting impacts: site visits (Task 2b)	The evaluation team conducted site visits at sampled MF properties. The site visits included: • Installing loggers on common area fixtures • Verifying both common area and in-unit incentivized light bulb/fixture installations • Facilitating NTG surveys with property owners/managers • Distributing promotional door hangers on resident doors to promote the NTG survey
Lighting impacts: data analysis (Task 2c)	Data analysis activities included real-time quality assurance/quality control (QA/QC) of collected data and analysis of final data collection to answer the lighting impacts research questions (updated common area HOU and updated common area and in-unit ISRs).
Lighting impacts: QA/QC process review (Task 2d)	The evaluation team conducted ride-along site visits with the QA/QC vendor and reviewed program documentation to determine whether changes that were made to the QA/QC process due to the RES 42 suggested improvement strategies were being implemented correctly.

Activity	Rationale
NTG: detailed analysis plan (Task 3a)	The evaluation team established a NTG analysis methodology and draft survey instrument that was reviewed and approved by PAs, the EEAC, and the Massachusetts NTG team (representatives from Tetra Tech and NMR Group). This task ensured the NTG methodology, including the approach for integrating all data sources, was well vetted, understood, and deemed reasonable by all stakeholders.
NTG: survey implementation (Task 3b)	A web-based survey was finalized and implemented to minimize respondent burden while capturing critical NTG-related metrics. The single survey instrument gathered responses based on stakeholder type for both participants and nonparticipants: renters, condominium owners, and property owners/managers.
NTG: lead vendor interviews (Task 3d)	The evaluation team interviewed lead vendors to gain vendor perspective on their program implementation and reporting activities. The interview results are used to add context to the free ridership rates; they are not used in the calculation of the NTG ratio.
NTG: data analysis (Task 3e)	Survey results were analyzed based on the NTG analysis plan (Task 3a).
Analyze and report results (Task 4)	Preliminary results were shared with PAs and the EEAC. Their feedback was incorporated into the final results, which were delivered as a standalone product. Final reports also incorporated stakeholder feedback.

Source: Multi-Family Program Impact Evaluation Stage 3 Plan, dated July 20, 2017

2. SAMPLE METHODOLOGY

The evaluation team completed sampling for both the lighting impact and NTG activities. For the lighting impact activity, the team identified a sample of MMRP participants for which site visits were completed to review installed measures. The NTG research was conducted through surveys of participant and nonparticipant renters, condominium owners, and property managers/owners. The methodology that the evaluation team used to identify the samples for each of these activities is discussed in this section.

2.1 Data Request

On August 4, 2017, the evaluation team sent a data request to the Massachusetts PAs requesting data for all MMRP projects completed since January 1, 2017. A summary of the data received from the PAs through this data request is presented in Table 3, including the total number of measures listed and the total savings associated with those measures.

Table 3. Summary of MMRP Data Received through the RES 44 Data Request

Utility	Gas	Electric	Total Measures	Total Savings (MWh)[6]
Berkshire Gas	X		92	116.8
Cape Light Compact		X	1,213	465.8
Columbia Gas	X		-	-
Liberty	X		4	94.1
National Grid[7]	X	X	5,892[8]	9,086.3
Eversource (NStar and WMECo)	X	X	8,611	5,924.7
Unitil	X	X	22	8.1
Total			**15,834**	**15,695.8**

Source: Navigant analysis of PA tracking data, supplied through the RES 44 August 4, 2017 data request

2.2 Sampling for Lighting Impact Tasks

The evaluation team intended to roll up the program-level data and sample at the project level. However, upon review of the provided measure-level data, it was clear that it would be nearly impossible to roll up the data to a consistently defined project level for all PAs. This challenge existed because some PAs

[6] The savings reported in this table include savings from all measures and all fuels (gas savings have been converted to MWh) to allow for comparison to the lighting only population frame presented in Table 4.

[7] The project data supplied by National Grid included all measures installed in MF projects through both the MMRP and the LEAN programs. The evaluation team did not identify this until late in the project timeline, which resulted in some projects being included in the sample dataset and visited through the site visits. The data collected from measures rebated through the LEAN program are not included in this report, except for the deemed HOU reported in Table 13. Table 3 reports the number of measures and kWh savings without including the LEAN measures. If the LEAN measures were included, the total measures for National Grid would be 7,155 and the MWh savings would be 14,089.5.

[8] The evaluation team did not include projects with status of "Installation Scheduled" in the final counts.

associated measures with an account, while others associated measures at a facility level. To overcome these inconsistencies between the different PAs' datasets, the evaluation team opted to leave the measure-level data as-is and use a cluster sampling approach, leveraging geocoding to assign measures to a geographic cluster. This approach resulted in measure-level data being assigned to a *facility*, which may include multiple buildings associated with the same complex. Further, it allowed the evaluation team to work with the data as provided while using a common standard to roll up projects across the PAs.

The evaluation team edited the full dataset provided by the PAs to develop a population frame (Table 4) to support sampling for the RES 44 impact tasks. The critical differences between the raw data provided by the PAs and the population frame used for impact evaluation sampling are the cluster definition (defined through geocoding), the focus on lighting measures, and the removal of projects invoiced before June 1, 2017. The sample frame only included lighting measures because the impact activities were focused only on lighting impacts. Additionally, the sample frame only included projects invoiced after June 1, 2017.[9] This is because program activities were being updated in the first half of the year, and it was determined that projects invoiced after June 1 would be representative of the new program activities, which was this evaluation's focus. The population frame used as the basis for the RES 44 impact evaluation tasks is presented in Table 4.

Table 4. Summary of Lighting Impact Population Frame (i.e., Lighting Measures Invoiced after June 1, 2017)

Utility	Measures	Unique Facilities	Total Savings (MWh)
Cape Light Compact	376	13	87.0
National Grid[10]	1,717	73	3,792.9
Eversource (NStar and WMECo)	1,212	27	1,369.5
Total	**3,305**	**113**	**5,249.4**

Source: Navigant analysis of PA tracking data, supplied through the RES 44 August 4, 2017 data request

2.2.1.1 Sampling Approach

The lighting impact evaluation was expected to provide outcomes for both common area and in-unit lighting measures. However, due to the roll up issues noted above, the evaluation team utilized a facility-level sampling approach that combined the needs of the common area and in-unit samples. The sampling approach used two variables to stratify the population frame: facility-level ex ante savings and the location of facility measures.

1. **Facility-level ex ante savings:** This variable stratifies facilities by total savings into tiny (<6,850 kWh), small (6,850-34,250 kWh), large (34,250-342,500 kWh), and x-large (>342,500 kWh)

[9] The Stage 3 plan indicated that the sample would focus on projects that were "audited after the QA/QC procedures were updated (approximately April 2017)." The PA tracking data did not include consistent accounting of audit dates, but it did include consistent dates for invoicing. Therefore, the evaluation team worked with the PAs to determine that projects invoiced after June 1, 2017 should be representative of the new program activities.

[10] The population frame definition for National Grid includes only the projects rebated through the MMRP and not those rebated through the LEAN program, as discussed in footnote 3.

stratum. To maximize the effectiveness of the field team, projects that fell into the tiny strata were not sampled and a census was taken of projects in the x-large strata.

2. **Location of measures:** This variable groups each facility by the location of installed measures;—i.e., the facility included both common area and in-unit measures (Common + In-Unit), only common area measures (Common + No In-Unit), or only in-unit measures (No Common + In-Unit). For 13 facilities, the evaluation team was unable to determine whether measures were installed in common areas or within units, leading to the creation of the Unknown stratum classification.

The impact evaluation sample, which was designed to achieve an overall relative precision of <10% at 90% confidence, is defined in Table 5.

Table 5. Lighting Impact Evaluation Sample

Strata	Population Size (Facility)	Population Size (kWh Savings)	Assumed CV	Sample (Facility)
Tiny, All	49	157.7	0.4	-
Small, Common + In-Unit	13	797.1	0.4	2
Small, Common + No In-Unit	13	234.3	0.4	2
Small, No Common + In-Unit	16	415.0	0.4	3
Small, Unknown	1	9.9	0.4	1
Large, Common + In-Unit	10	1,282.8	0.4	7
Large, Common + No In-Unit	4	305.3	0.4	2
Large, No Common + In-Unit	3	380.5	0.4	3
Large, Unknown	1	56.3	0.4	1
X-Large, Common + In-Unit	1	435.0	0.4	1
X-Large, Common + No In-Unit	1	773.4	0.4	1
X-Large, No Common + In-Unit	1	402.2	0.4	1
Total	**113**	**5,249.4**	**-**	**24**

Source: Navigant analysis of PA tracking data, supplied through the RES 44 August 4, 2017 data request

The number of site visits by utility was defined through a representativeness quota, as presented in Table 6. For each utility in the final sample, 20%-25% of the utility's facilities represented in the population frame are included in the sample.

Table 6. Lighting Impact Sample Utility Targets

Utility	Population Size (Facility)	Population Size (kWh Savings)	Sample (Facility)
Cape Light Compact	13	87.0	3
National Grid	73	3,792.9	15
Eversource (NStar and WMECo)	27	1,369.5	6
Total	**113**	**5,249.4**	**24**

Source: Navigant analysis of PA tracking data, supplied through the RES 44 August 4, 2017 data request

2.2.2 Sampling for NTG Task

The evaluation team leveraged the lighting impact sample (Table 4) to meet the targets for the NTG survey. However, because the NTG survey collected data on lighting, building shell, domestic hot water (DHW), and HVAC measure types[11], all measure types, except custom measures, were included in the sample. The lighting impact sample includes data collection at 15 facilities where a total of 1,700 non-lighting measures were installed, as identified in Table 7.

Table 7. All Lighting vs. Non-Lighting Measures for Lighting Impact Sample

Measure Category	Facilities Including Measure Category	Total Measures	Savings (MWh)
Lighting[12]	24	2,288	3,715
Non-Lighting	15	1,700	332

Source: Navigant analysis of PA tracking data, supplied through the RES 44 August 4, 2017 data request

While the facilities included in the lighting impact sample included diverse measure installations to support the NTG survey, not all the NTG sampling needs were met through the impact sample alone. For example, the impact sample only included 24 facilities, which would only provide a portion of the NTG sample target of 70 participating and nonparticipating property owners and managers. The evaluation team supplemented the impact evaluation data collection process by sending postcards to target groups where the NTG sample targets could not be met by the impact evaluation data collection efforts alone. Table 8 presents the sampling targets for the NTG survey and the pathways by which these population categories were expected to be recruited.

Table 8. NTG Sampling Targets

Population Category	Data Sources	Sample Target	Outreach Pathway
Participating building, apartment renters	PA tracking data	70	• Doorhangers: impact evaluation site visit sample apartments
Participating building, condominium owners	PA tracking data	70	• Doorhangers: impact evaluation site visit sample condominiums
Nonparticipating building, condominium owners	RES 43[13] database	70	• Postcards to condominium owners
Participating and nonparticipating building, property managers/owners	RES 43 database and PA tracking data	70	• Postcards to property managers/owners • Impact evaluation site visit sample of property managers/owners

[11] In particular, the NTG survey collected data on the following measures: efficient lighting (in-unit and common area); lighting controls (common area); air sealing and insulation (in-unit and common area); low-flow showerheads, aerators, pipe insulation, and efficient water heaters (in-unit and common area); heating systems (common area); domestic hot water systems (common area); refrigerators (in-unit); and thermostats (in-unit and common area).

[12] The summary of measures and savings for the lighting category differs from those reported in Table 5, as the NTG survey included consideration of measures completed prior to June 1.

[13] RES 43, *Census of Massachusetts Multi-Family and Condo Properties,* is a parallel study that is attempting to map all MF properties across the state of Massachusetts and provided contact lists for nonparticipating properties and units.

Source: Navigant analysis

3. LIGHTING IMPACT EVALUATION

In August 2016, the *National Grid Multi-Family Program Gas and Electric Impact Study*[14] completed by DNV GL documented a realization rate for the MMRP of 24.4% with a precision of +/- 49.3% at the 90% confidence interval. Though the title may be misleading, this was a statewide study and the results applied to all PAs, in addition this study was a follow-up to a billing analysis that was performed using data from all the PAs. The results from the 2016 study were significantly lower than expected. As a result, the PAs negotiated a 60% realization rate with the EEAC that would be applied to the 2016 MMRP savings and agreed to further investigate the realization rate in this study.

Over 90% of the MMRP electric savings stem from lighting measures, so the evaluation team was tasked by the PAs and EEAC with reviewing and updating MMRP lighting savings calculation inputs. As shown in Equation 1, retrofit lighting savings are calculated based on three variables: 1) delta watts, or the difference between the pre- and post-fixture wattage (ΔW); 2) the quantity of fixtures replaced (Quantity); and 3) the HOU of those fixtures.

Equation 1. Retrofit Lighting Savings Calculation

$$\text{Lighting Savings} = \Delta W \times \text{Quantity} \times \text{HOU}$$

Table 9 further delineates the lighting variables investigated in this study by common area and in-unit categories. The lighting variables that were not investigated through RES 44 were intentionally disregarded, as they had been addressed through the previous RES 42 study. A summary of the RES 44 and RES 42 findings as they apply to each of the three lighting variables is presented in Table 34 in Section 5.1.

Table 9. Lighting Evaluation Variables Address by RES 44

Variable	Common Areas	In-Unit
Delta Watts		
Quantity	X	X
HOU	X	

Source: Navigant analysis

3.1 Lighting Impact Evaluation Methodology

The evaluation team designed the lighting impact evaluation was designed to address both quantitative and qualitative objectives.

- **Quantitative objectives:** Update the HOU for common area lighting measures and the ISRs for common area and in-unit lighting measures, as identified in Table 9. These are discussed in Section 3.2.

[14] http://ma-eeac.org/wordpress/wp-content/uploads/Multifamily-Program-Gas-and-Electric-Impact-Study.pdf

- **Qualitative objectives:** Assess the updated vendor project reporting and quality assurance procedures. This was accomplished through ride-along site visits with the QA/QC vendor and interviews with the lead vendors (discussed in Section 3.3).

3.1.1 Site Visits

The evaluation team conducted site visits between October 2017 and January 2018 at 23 MF facilities throughout Massachusetts that participated in the MMRP in 2016. The team scheduled the site visits by coordinating with the facility manager. If in-unit measures were installed as part of the project, the evaluation team sent the facility managers the list of units where incentivized measures were installed and informed them that the field techs would need to visit up to 10 units while onsite. The team tried to minimize the number of visits to unoccupied units because the ISRs were not expected to be representative of the majority (i.e., occupied) of treated units.

The evaluation team conducted two types of visits: initial visits and follow-up visits. The number of visits that a facility received depended on the facility type. All facilities with common area measures received both an initial visit and a follow-up visit to install and pick up the loggers that were installed to measure HOU. If the facility only had in-unit measures installed, then it received only an initial visit because logging was not required.

During the initial site visit, the onsite team would first meet with the facility manager. During that time, the field techs would discuss the incentivized measures with the facility manager and ask if a site map was available. They would then provide an overview of what the site visit would entail and mention if a follow-up visit was required. Finally, the field techs would have the facility manager take a NTG survey on an iPad. At the conclusion of the site visit, the techs provided the facility manager with a $50 gift card for their time.

The lighting-specific data collected onsite during the initial site visit depended on the facility type: common measures + in-unit measures, common measures + no in-unit measures, and no common measures + in-unit measures.

- **Common + in-unit measure site visits:** The field techs interviewed the facility manager about lighting schedules and control strategies in the common areas. Next, they installed loggers throughout the common areas to confirm HOU for incentivized lighting fixtures. The field techs then counted the installed light fixtures to verify ISRs for the common area measures. Next, they hung door hangers on up to 25 units that participated in the MMRP and up to 25 units that did not participate in the MMRP to a) have individuals take the NTG survey, and b) recruit in-unit participants to allow a site visit during the follow-up visit.
- **Common + no in-unit measure site visits:** The field techs interviewed the facility manager about lighting schedules and control strategies in the common areas. Next, they installed loggers throughout the common areas to confirm HOU for incentivized fixtures. The field techs then counted the installed fixtures to verify ISRs for the common area measures. Next, the field techs hung door hangers on up to 25 units that did not participate in the MMRP to have individuals take the NTG survey.
- **No common + in-unit measure site visits:** The field techs worked with the facility manager to visit up to 10 units to count the installed fixtures to verify the ISRs for the in-unit measures. Upon collecting the measure-level data, the techs provided the customer a $10 gift card and left behind

a door hanger for the customer to complete the NTG survey for which they could earn an additional $25 Amazon gift card.

The purpose of the follow-up visit was to retrieve any loggers that were installed in common areas and/or to verify ISRs for in-unit measures. The data collected during the follow-up visit depended on what was collected on the initial visit and the facility type.

- **Common + in-unit measure site visits:** The field techs retrieved any loggers installed in common areas during the initial site visit. Next, they visited up to 10 units where incentivized measures were installed and had agreed to a site visit. Within these units, the field techs counted the installed fixtures to verify ISRs for the in-unit measures. Upon collecting the measure-level data, the field techs provided the customer a $10 gift card and left behind a door hanger for the customer to complete the NTG survey for which they could earn an additional $25 Amazon gift card. Prior to leaving the facility, the techs collected any remaining information that was not collected during the initial site visit and resolved any outstanding QC items from the initial visit.
- **Common + no in-unit measure site visits:** The field techs retrieved any loggers installed in the common areas during the initial site visit. Prior to leaving the facility, they collected any remaining information that was not collected during the initial site visit and resolved any outstanding QC items from the initial visit.
- **No common + in-unit measure site visits:** The field techs visited up to 10 units where incentivized measures were installed and had agreed to a site visit. During the visit, they counted the installed fixtures to verify ISRs for the in-unit measures. Upon collecting the measure-level data, the field techs provided the customer a $10 gift card and left behind a door hanger for the customer to complete the NTG survey for which they could earn an additional $25 Amazon gift card.

A summary of the achieved lighting impact sample is presented in Table 10. The completed site visits include a range of the facility types described above (common measures + in-unit measures, common measures + no in-unit measures, and no common measures + in-unit measures). In total, the evaluation team reviewed 147 common area measures installed across 15 facilities and 201 in-unit measures installed within 84 units across 14 facilities.

Table 10. RES 44 Achieved Lighting Impact Samples

Strata	Population Size (Facility)	Population Size (kWh Savings)	Sample (Facility)	Completed Site Visits			
				Facility	Common Area Measures	In-Unit Measures	Units Visited
Tiny	49	157.7	-	1	0	26	3
Small	43	1,456.3	8	9	25	48	12
Large	18	2,024.9	13	10	106	113	60
X-Large	3	1,610.6	3	3	16	14	9
Total	**113**	**5,249.4**	**24**	**23**	**147**	**201**	**84**

Source: Navigant analysis

3.1.2 Onsite Data Collection

This section provides a summary of the approach used to verify HOU for incentivized lighting fixtures in common areas and ISRs for incentivized lighting fixtures in both common areas and in units.

- **Verify HOU for common area measures:** The evaluation team verified the HOU for common area measures by installing HOBO UX90-002 lighting on-off loggers for up to 3 weeks. In total, the team installed loggers at 15 facilities where common area measures were installed, with a minimum of two loggers for each unique schedule and control strategy combination. Two loggers were installed to ensure a backup in case one of the loggers failed. In some instances, the evaluation team installed more than two loggers for a given schedule and control strategy combination due to an expected high variation in the HOU (e.g., lights controlled by occupancy sensors in office areas).

  It is important to note that the evaluation team only logged HOU for interior common area measures. The lighting loggers used for this analysis are sensitive to daylight and, therefore, are not viable for logging exterior fixtures. Logging the exterior fixtures would have required installing CTs and 4-channel HOBO loggers at the lighting panel or at the fixtures, which would have required using an electrician. Using an electrician would have significantly increased the cost of the site visits and would have introduced added complexity when scheduling the initial visits and follow-up visits. Scheduling the site visits was already a logistical challenge because the team needed to align the facility managers' limited availability with the Navigant field techs' availability. Because there is not much variation in exterior HOU due to most lights being controlled by photosensors, Navigant did not log exterior fixtures and instead relied on primary and secondary data for the exterior measures, including customer interviews and sunrise/sunset information from the US Navy.[15]

- **Verify ISRs for common areas and in-unit measures:** The evaluation team verified the ISRs for common area and in-unit measures by comparing the reported quantities in the tracking database with the onsite verified quantities. The onsite team used different onsite sampling approaches for common area and in-unit measures. For common area measures, the onsite team verified ISRs for all measures installed at each sampled facility. For in-unit measures, the onsite team verified ISRs in a maximum of 10 units at each facility. This decision was made because it would be nearly impossible to access all units in a facility. The onsite team worked with the facility manager to visit at least one unit of each layout type represented in the facility. For each sampled unit, the evaluation team verified ISRs for all incentivized measures. The onsite team visited 84 units across 14 facilities.

  Navigant collected the following information for incentivized common area and in-unit measures: space type, quantity, wattage, lamp manufacturer, lamp model number, photo of the lamp, control type, and reasons for discrepancies (if applicable).

In addition to the data collected above, the onsite team collected other data to support the impact and NTG evaluations, including:

- **Lighting schedule:** The evaluation team collected lighting schedule information for all common area measures. The schedule data was used to cross-check logger data to ensure reasonability. The team also used this information for the manual exterior HOU calculations.

[15] http://aa.usno.navy.mil/data/docs/Dur_OneYear.php

- **Facility manager NTG survey:** To support the NTG data collection efforts, the field techs had the facility manager take the NTG survey during the initial site visits.
- **In-unit participant NTG survey:** To support the NTG data collection efforts, the field techs had in-unit customers take the NTG survey during the site visits. In addition, during the initial visit, the field techs hung door hangers on participant and nonparticipant units, as described in Section 3.1.1.

3.1.3 Data Analysis

The evaluation team analyzed the data collected onsite to develop an HOU realization rate for common area measures, deemed HOU values by space type, and an ISR for both common area and in-unit measures.

3.1.3.1 Hours of Use (HOU)

The PAs use two separate practices for assigning HOU for common area fixtures in the ex ante calculations:

- Eversource uses a deemed HOU value by space type, specifically the **Adjusted HOU** values identified in the RES 42 *Preliminary Task 2b and 3 Findings Memo* (published in March 2017 and presented in Table 11).

Table 11. Adjusted HOU Values from RES 42 Study

Room	TRM Deemed HOU	Adjusted HOU
Common Hall	24	24
Elevator	24	24
Lobby	24	24
Stairs	24	24
Laundry	24	12
Mechanical Room	24	2
Mgmt. Office	24	8
Other	24	8
Exterior	12	12

Source: RES 42 Preliminary Task 2b and 3 Findings Memo, March 2017

- All other PAs use vendor-reported HOU values, which are customized by project and space.

Because of the differences in assigning HOU values in the ex ante calculations, Navigant presented the HOU results using two separate methods: 1) an HOU realization rate for common area measures and 2) deemed HOU values by space type. The HOU realization rate was calculated using logger data from the onsite visits and applies to all utilities except Eversource because it is not applicable to projects that use a deemed HOU for ex ante calculations. The deemed HOU values by space type were calculated using logger data from the onsite visits and applies to all utilities. The details for calculating each type of the HOU results are presented below:

- **HOU realization rate (interior):** The first step in calculating the interior common area HOU realization rate was extrapolating the logger data for an entire year. The evaluation team plotted the logger data (Figure 1), which showed the hours each day that the lights were on and off, allowing for visual QC of the data for each facility. Holidays were treated separately from standard week and weekend days due to the difference in lighting usage during those days. In the extrapolation, data collected for holidays during the logger period was extrapolated to all holidays throughout the year.

  The hourly on-fraction is the percentage of each hour the logger records the light as on. The on-fraction average was collected at the weekday and weekend hourly-level for all logged hours and was then extrapolated to the entire year for each hour of any given weekend or weekday. The logger data was then joined to the data collected onsite, such as the logged space type and quantity of fixtures in each space. In the extrapolation to annual HOU for each logger, the evaluation team accounted for the measures associated with each logger, the space type in which the logger was installed, and the HOU during the logged period.

Figure 1. Example Logger Data Plot for Office with Occupancy Sensors

Source: Navigant analysis of logger data using HOBOware software and Onset UX90-002 loggers

The team then calculated the HOU realization rate at the logger-level, measure-level, facility-level, strata-level, and program-level. The HOU realization rate is equal to the annual, extrapolated, logged HOU divided by the vendor-reported HOU captured in the tracking database. To roll up the HOU realization rate to each of the different levels, the evaluation team weighted the HOU realization rate by the ex ante savings, which ensured that the results for higher savings measures affected the results more than lower savings measures. For example, to roll up the HOU realization rate from the measure-level to the facility-level, the evaluation team weighted the HOU realization rate calculated for each measure by the ex ante savings for the measure. This process was used for interior common area measures only.

- **HOU realization rate (exterior):** For the exterior common area HOU realization rate, the evaluation team relied on a combination of customer interview data collected onsite and sunrise/sunset data from the US Navy's website.[16] A different approach was used for exterior measures because it is notoriously challenging to log exterior fixtures, and it would have required significant additional cost to log measures that only made up a small portion of the overall savings. The evaluation team calculated the annual dusk-to-dawn hours for each site using the Navy website and adjusted the HOU based on information gathered onsite about the operating hours, control strategy, and seasonal differences in operation.

  The team calculated the exterior HOU realization rate by dividing the verified HOU by the ex ante HOU. The evaluation team rolled up the HOU realization rate to the facility-level by weighting the HOU realization rate by the ex ante measure savings. The team then rolled up the facility-level HOU realization rate to the strata-level and then the program-level by weighting the HOU realization rate by the ex ante savings.

- **Deemed HOU:** The evaluation team calculated the deemed HOU by space by weighting the logged HOU by the ex ante savings. Like the HOU realization rate calculation, the lighting on-off data measured during the logging period was extrapolated to the entire year, accounting for the differences in HOU between weekends, weekdays, and holidays. The annual logged HOU at the logger-level was rolled up to the measure-level and then to the space type-level. At each level the deemed HOU were weighted by the ex ante savings. The evaluation team calculated the HOU for the four space types: interior – circulation (lobby, hallways, stairwells), interior – other (all other interior space types), parking garage, and exterior.

3.1.3.2 In-Service Rate (ISR)

The ISR was calculated by dividing the quantity of efficient lights found onsite by the ex ante quantity reported in the tracking data. The evaluation team calculated ISRs separately for common area and in-unit measures because, historically, ISRs have been higher for common area measures than in-unit measures. The team calculated an ISR for each measure and then rolled up the findings to the facility-level, weighting them by the ex ante measure savings. The evaluation team then rolled up the facility-level ISR to the strata-level, weighting by the facility ex ante savings, and finally rolled up the strata-level ISR to the portfolio-level, weighting by the strata-level ex ante savings.

3.2 Lighting Impact Results

The final lighting impact results include an HOU realization rate for common area measures, deemed HOU values by space type, and an ISR for both common area and in-unit measures. This section summarizes the evaluation team's final results from analyzing the data collected onsite for the sampled MF facilities.

3.2.1 Common Area Lighting HOU Results

As a reminder, the PAs currently use two separate practices for assigning HOU for common area fixtures in the ex ante calculations, as described in Section 3.1.3.1. Thus, the HOU realization rate finding is

[16] http://aa.usno.navy.mil/data/docs/Dur_OneYear.php

applicable to all PAs except Eversource and the deemed HOU results are applicable to Eversource retroactively, and all PAs proactively.

3.2.1.1 HOU Realization Rate

The program-level HOU realization rates are summarized in Table 12. The evaluation team developed these results from a sample of National Grid and Cape Lighting Compact (CLC) sites only and are only applicable when vendor-reported HOU serves as the basis for the ex ante HOU assumption. The interior HOU realization rate reflects a comparison of the data collected from logged fixtures to the vendor-reported HOU found in the tracking data. The exterior HOU realization rate compares verified HOU developed from a secondary data source that reported sunrise/sunset times and was modified by customer interview data to the vendor-reported HOU found in the tracking data.

Table 12. HOU Realization Rate by Space Type

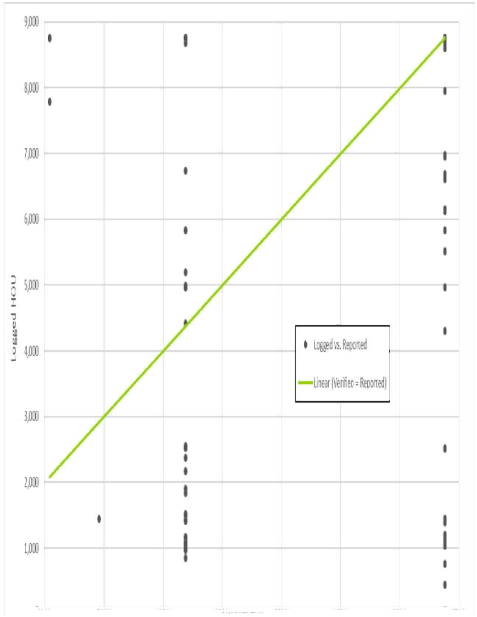
Space Type	Number of Measures	HOU Realization Rate	Confidence/ Precision
Interior	32	0.91	90/30
Exterior	22	0.98[17]	N/A

Source: Navigant analysis

The most significant finding associated with the HOU realization rate is that there was absolutely no correlation between the vendor-reported HOU and the logged HOU for interior fixtures, as illustrated in Figure 2. The green line is a hypothetical benchmark where vendor-reported HOU equals logged HOU. As shown in the graph, the logged HOU is often lower than the vendor-reported HOU because most of the vendor-reported values are either 8,760 hours per year (24 hours per day) or 4,380 hours per year (12 hours per day). There were a handful of vendor-reported values at 2,085 hours per year (5 hours per day) and 2,920 hours per year (8 hours per day).

[17] Confidence/precision is not presented for the exterior results, as the presented values for both realization rate and deemed HOU were developed from analysis of secondary sources because loggers could not be installed in most locations.

Figure 2. Comparison of Reported HOU vs. Logged HOU – Interior



Source: Navigant analysis

During the onsite visits, the evaluation team collected qualitative data that provides context for the quantitative HOU results. The qualitative findings that address the HOU results in include the following:

- **Controls:** Most of the common area fixtures were controlled by light switches, but the evaluation team did encounter some fixtures controlled by occupancy sensors. For example, most fixtures installed in laundry rooms were controlled by occupancy sensors due to the variability in the usage of that space type.
- **Low usage areas:** Most of the incentivized fixtures were located in high usage areas such as hallways or stairways, but some of the fixtures were located in rarely used areas. For example, the field techs found some incentivized measures in storage rooms and maintenance rooms that have low HOU.
- **Infrequently used fixtures:** In most cases hallway and stairway fixtures were on 24/7, but the evaluation team found a few instances where these fixtures were rarely turned on because the space was sufficiently lit by daylight during the day. These lights would only come on for a few hours in the evening after the sun went down.

3.2.1.2 Deemed HOU

As discussed in Section 3.1.3.1, the evaluation team developed the deemed HOU results from a sample of all PAs, making them applicable across all MMRP projects. The deemed HOU calculation does not reference the vendor-reported HOU; rather, the deemed HOU results only rely on the logged HOU and the measure-level ex ante savings (for weighting).

The evaluation team identified four space type categories to classify the deemed HOU findings:

- Interior, circulation (hallways, stairways, and lobbies)
- Interior, other (all other interior areas)
- Exterior
- Parking garages

These categories are more simplified than the deemed HOU inputs Eversource uses, but they were supported by natural breakpoints in the logged data. The previously used deemed HOU were suggested in the RES 42 study and are mapped to the RES 44 results in Table 13.

Table 13. Deemed HOU by Space Type

Space	RES 42 Study		RES 44 Study	
	TRM Deemed HOU	Adjusted HOU	Space (Reclassified from RES 42)	Logged HOU
Common Hall	24	24	Interior, Circulation	8,307 hrs/yr 23 hrs/day
Elevator	24	24		
Lobby	24	24		
Stairs	24	24		
Laundry	24	12	Interior, Other	4,115 hrs/yr 11 hrs/day
Mechanical Room	24	2		
Mgmt. Office	24	8		
Other	24	8		
Exterior	12	12	Exterior	4,689 hrs/yr 13 hrs/day
			Parking Garage	8,760 hrs/yr 24 hrs/day

Source: Navigant analysis (including review from RES 42)

3.2.2 Common Area and In-Unit Lighting ISR Results

The results from calculating the ISR for common area and in-unit measures are summarized in Table 14. The evaluation team calculated and reported common area and in-unit ISRs separately because historically ISRs have been higher for common areas than in units where tenants may remove lights installed through the MMRP. The results of this evaluation align with the historical understanding of ISRs, as the found common area ISR was higher than the ISR for in-unit measures.

Table 14. ISR by Space Type

Location	Number of Measures	ISR	Confidence/ Precision
Common	142	1.02	90/9[18]
In-Unit	132	0.88	90/13

Source: Navigant analysis

During the onsite visits, the evaluation team collected qualitative data that provides context and flavor for the quantitative ISR results. These quantitative findings that address the ISR results in Table 14 include:

- **Site contacts ordered extra bulbs for replacement:** During the QA/QC vendor ride-alongs the QA/QC vendor indicated that facility managers will often order extra lamps through the MMRP because they want to have extra lamps in storage. This could explain some of the instances where Navigant found fewer fixtures onsite than reported in the tracking data.
- **Verified space types did not align with reported space types:** In many instances, the onsite team verified a different space type than was reported in the tracking data. In addition, the evaluation team often found that a single measure was located in multiple space types though the tracking database showed a single space type for the measure location. Differences in reported and verified space types contributed to field techs not finding all the reported measures in some facilities.
- **No record of some reported measures onsite:** There were a few instances where the evaluation team was unable to find the reported measure at the facility. In these instances, the facility manager had no knowledge of the bulb types ever being installed.
- **Verified fixture description did not align with reported fixture description:** National Grid's data tracking system offers a fixed list of fixture descriptions. The evaluation team learned that implementation contractors (ICs) working with this system were directed to prioritize the selection of the correct fixture wattage and sacrifice the selection of the correct fixture description. In some cases, this made it difficult to verify fixtures because it was not clear what exactly was installed.
- **Reported bulbs not found in units:** There were many instances where the evaluation team did not find any or as many incentivized bulbs as reported. The field techs reported three reasons for this finding 1) tenants didn't receive the number of bulbs that were reported in the tracking data, this was most common, 2) the tenants took the incentivized bulbs with them when moving, this seemed to be the reason in about 10-20% of the cases, and 3) the tenants intentionally removed the incentivized measures.
- **In-unit measures were not broken out by unit:** For many of the large projects the tracking database reported in-unit measure installations by the space type (i.e., all measures installed in-unit across the facility). This made it difficult for the evaluation team to locate measures. In these instances, the evaluation team gathered information from the site contact about the various unit layouts at the facility and the expected quantity of fixtures by space type and fixture type.

[18] Though the analysis found an ISR >1 for common areas, the evaluation team recommends applying an ISR of 1.0 for these spaces. The >1 ISR is driven by three measures from projects where the team found significant discrepancies between the tracking data and site findings. That the evaluation team found a greater than expected number of fixtures cannot be connected to program activities without exception.

Because the evaluation team did not visit all units at every facility, the goal was to visit at least one unit representing each unique layout and to extrapolate findings to all units in the facility.

- **Measure location not available:** Measure locations were not available in the tracking database for CLC in-unit measures. This did not cause a significant issue for verification because lights were only installed in hallways in one facility and within condos in the other; additionally, the tracking data included the condo numbers. However, the field techs did not have detailed information about where measures were installed within the condos, which made it difficult to locate the measures.
- **Variation in who installed the lamps:** During the interview with the site contact the evaluation team would ask who installed the MMRP-incentivized lights (a contractor or the customer). In most cases, a contractor installed the lights; however, in other cases, the customer installed the lights themselves. For example, one of the facility managers told the evaluation team that a contractor checked two units for common lighting types and provided each unit a list of lights from which they could order. Each unit received a box of bulbs that they had to replace themselves. Instances like this could explain some of the low ISRs, as customers may have only replaced lights as they burned out instead of replacing them all at once.

3.3 Qualitative and Contextual Findings

During the ride-along site visits completed in 2016 as part of the RES 42 project, issues were identified with the MMRP QA/QC processes. Due to this finding, the MMRP updated the standard QA/QC processes, including requiring delivery of the final installed equipment location by unit to the QA/QC vendor for analysis. The evaluation team assessed the updated vendor project reporting and QA procedures through ride-along site visits with the QA/QC vendor; the team also completed interviews with the lead vendors. The details of and findings from these activities are discussed in this section.

3.3.1 Ride-Along Site Visits with the QA/QC Contractor

The evaluation team accompanied the QA/QC vendor (CMC) on five Tier 2 (post-installation) site visits to observe program activities conducted onsite, interview the QA/QC vendor staff, and review the program and project documentation associated with the QA/QC processes. The data collected during the QA/QC ride-along visits did not factor into the quantitative impact analysis discussed in Section 3.2; as such, the evaluation team was not concerned about achieving a random sample of the QA/QC sites. However, the team did try to complete ride-alongs with multiple field techs to get a sense of the variation in QA/QC processes.

3.3.2 Interviews with the Lead Vendors

The evaluation team interviewed lead MMRP implementation contractors and the QA/QC vendor. Survey questions were informed by the RES 42 report, the preliminary RES 44 NTG survey results, and observations from the RES 44 onsite impact evaluation team. Alongside the goal of assessing the implementation of the RES 42 suggested improvement strategies, the interviews also added context to the quantitative results, including:

- Participant knowledge of electrical and gas measure replacement options prior to program participation

- Participant awareness of the program offering prior to participation
- Participant stated intentions to replace key energy using equipment and whether it was based on the program recommendations and support or was decided prior to program participation
- Participant response to the program direct installation value, perceived influence of the free products and services, and program recommendations in their decision to replace the equipment

The team interviewed four primary vendors of the MMRP: CLEAResult (implementation), RISE (implementation), CET (implementation), and CMC (QA/QC). The phone interviews were conducted between January 18 and February 1, 2018.

3.3.3 Qualitative and Contextual Findings from the Interviews

In general, the evaluation team found that the QA/QC processes had improved since the implementation of the RES 42 suggested improvement strategies. However, there is still room for improvement in the overall QA/QC process, as identified in the following sections.

3.3.3.1 Clarity of Project Documentation

Three of the four lead vendors interviewed indicated that the expectations around project documentation have changed—specifically that they have improved—in the last year as a result of implementing the RES 42 suggested improvement strategies. Only CET indicated no change in their documentation; however, they implement the smallest number of projects of the lead vendors that were interviewed. During the ride-along site visits, the implementation team asked CMC to expand upon the consistency and quality of the project documentation across the implementation vendors. CMC responded with the following:

- CMC staff noted varying consistency of documentation between the implementation vendors, but an overall improvement in the last year.
- Most CMC staff reported transferring implementation vendor-provided documentation into a standard document that they use to direct their site visits.
- One CMC staff member recorded verified measure information separately and compared it to implementation vendor-provided information after the site visit.

In addition, CMC provided the evaluation team six examples of project documentation provided by the implementation vendor and used by CMC to verify measure installation. Five of the six documents were substantially different from each other; observations include the following:

- Two were computer-generated tables, specifying number of bulbs or water conservation devices installed in each unit. These documents did not specify which room within each unit the products were installed.
- Two were handwritten and scanned to PDF documents. The image quality was low and the writing was difficult to make out in places.
- Two were summary documents of entire projects, with unit-level information rolled up on a single row at the measure-level, with no indication as to which measures were installed in which units.

3.3.3.2 Measure Locations for QA/QC Verification

During the RES 42 evaluation, the evaluation team identified that site-level information provided by the Implementation vendors often lacked specific installation locations. Through the RES 44 ride-alongs and lead vendor interviews, the evaluation team addressed whether any changes had been made. The findings included the following:

- CMC staff noted variance in the quality of information from implementation vendors, specifically around the location of installed measures.
- All CMC staff noted that implementation vendors did not typically provide location information for common area measures. However, they generally did receive specific location information for in-unit measures (kitchen, bathroom, living room, etc.).
- Some CMC staff noted that although in-unit measure location information was provided, information such as area or building (in cases with multiples buildings) was absent.
- Within the sample of the five ride-alongs, the evaluation team observed one instance where in-unit measures were incorrectly categorized as common area measures in the project documentation.
- From the six project documentation examples that the evaluation team reviewed, there were two examples of documentation where installation location was significantly lacking. Summaries of the information included in these documents is provided below:
    - *Example 1* – A project with 108 total units reported:
        - (100) 1.75 GPM water-saving showerheads (fixed or handheld, as applicable)
        - (106) 1.5 GPM water-saving faucet aerators (kitchens)
        - (97) 1.0 GPM water-saving showerheads (baths)
    - *Example 2* – A project with 166 units where a handwritten report showed two identical measures were installed in every unit:
        - Locations: Bedroom and kitchen
        - Base measure: 60 W Incandescent
        - Efficient measure: 10 W LED
        - One wired control for each unit, with no explanation

3.3.3.3 Definition and Application of Grading System

As part of the QA/QC process, the QA/QC vendor assigns each of the projects a pass/fail rating. The RES 42 study found that the project-level grading was not consistently applied, even by individual raters working for the implementation vendor. The evaluation team discussed the grading system with each of the QA/QC vendor field techs during the ride-along site visits and found the following:

- All CMC staff defined grades in the following way:
    - **Pass:** Correct count, product type, and location
    - **Pass with Note:** Correct count and either incorrect product type or incorrect location
    - **Fail:** Incorrect count

- Some CMC staff indicated that there may be variance in the level of detail offered when “Pass with Note” was used. In most cases, only significant failures/flaws were recorded.
- Some CMC staff suggested that the Pass/Fail determination is somewhat a function of the quality of the documents provided by the implementation vendor. They indicated that higher quality source information reduces the potential for differences in interpretation.

After grades are assigned to measures, the implementation vendor and the PA are notified of any "Pass with Note" or "Fail" measures. If these grades are received, the PA responds to all parties asking for the implementation vendor to return to the site and remedy the problem. The implementation vendor then sends a note to the PA and the QA/QC vendor either letting them know that it was a false fail or that the situation was resolved. The implementation vendors indicated that the typical reasons for a “Fail” include:

- Lighting, specifically when codes in the tracking database do not match exactly what is installed. Through the impact evaluation, the evaluation team learned that the National Grid database offers a set list of products and asks vendors to prioritize recording a product with the correct wattage over the correct product description. This may lead to some of the confusion.
- Smart strips, because the implementation vendor sometimes does not have the ability to install without the input of the renter or owner.
- Two of the three implementation vendors reported issues with QA/QC inspections occurring while the installation was in progress, before all measures had been installed.

3.3.3.4 Other Qualitative and Contextual Findings

In addition to the qualitative and contextual findings related to specific results and suggested improvement strategies from the RES 42 study, the evaluation team collected findings about the implementation vendor QA/QC vendor processes and interactions.

- Ride-along visits with CMC:
    - CMC staff were professional and thorough in confirming measures.
    - When visiting sites, most CMC staff used personal best practices. This included using personal digital devices for recording site information and tricks for interpreting highly unorganized source documents.
    - CMC staff indicated that reoccurring challenges include inadequate information from property managers, difficulty verifying in-unit measures, and inaccurate measure information from implementation vendors.
- All three implementation vendors indicated they rarely leave behind anything for participants to install themselves, except for smart strips and sometimes aerators if a facility manager does not have a key handy. This somewhat contradicts what was found by the field techs during the lighting impact evaluation site visits, where facility managers described instances of lighting being left behind for the customer to install.
- The three implementation vendors indicated similar ways of dealing with individual apartment or condo owners who are interested in participating in the program, without interest from the rest of the building. In these cases, the implementation vendors try to encourage vocal residents to convince the facility manager or condo board to encourage broader participation—i.e., more than five units. In some cases, these individuals are served through the MMRP, but one of the

implementation vendors indicated "that is a big waste of time." They sometimes receive approval from the PAs to send the individual through the HES program, but that is still rare.

- One implementation vendor indicated that the quality of project leads seems to be declining; they are seeing smaller and newer buildings. It should be noted that the concurrent RES 43 study is exploring the extent to which the MMRP has served buildings in Massachusetts and what percentage of buildings still remain unserved. They implementation vendor said that the program may need to more rigorously prioritize jobs, which could make the program more efficient. For example, the low-income MF program prioritizes projects based on total energy usage.

3.3.3.5 Qualitative NTG-Related Findings

Lead vendors interviewed indicated varying levels of outreach to building residents:

- The staff of one lead vendor indicated significant outreach to generate resident awareness in participating buildings, including sign-up sheets, letters to residents, lawn signs, and door hangers. It was noted that at some participating buildings, the condominium board helps with resident awareness, which is seen to have a large impact on the number of residents who elect to participate with in-unit measures.
- The staff of another lead vendor indicated that outreach was limited to email and that it was not common for the vendor to have access to email contact information. This vendor noted that condominium boards and property managers typically do not support or allow the use of physical program material, such as door hangers.
- The staff of the third lead vendor indicated the use of a sign-up mailing, to which they receive a high response rate (anecdotally, over 50%).

Lead vendors provided consistent perspectives on program free ridership. All indicated that free ridership was likely lower for residents than for property managers. The responses included the following:

- The staff of one lead vendor indicated that many residents wait for the program despite the wide availability and awareness of LED lighting. They also indicated that water-saving and building shell measures would not have been pursued by residents without the program. They mentioned that many facilities are taking advantage of the MMRP program after experiencing ice damage in 2015—some facilities are even making participation mandatory for building shell measures.
- The staff of the other two lead vendors indicated that residents would not have been likely to install energy efficient products without the MMRP. They shared a perceived receptiveness from residents: "If it's free, it's for me." For property managers and rental property owners, both vendors indicated that they see a mix of those who might have acted without the program and others who would not.

4. NET-TO-GROSS (NTG) FINDINGS

The goal of the NTG study was to assess the change in energy consumption attributable to program activities. The research considered participant and nonparticipant spillover (SO) and participant free ridership (FR). This section of the report describes the NTG survey design, implementation, and outreach methodology, analysis methodology, and research results.

4.1 Overall NTG Results

The evaluation team determined the program-level FR ratio to be 0.21 and the provisional program-level SO ratio to be 0.28, resulting in a provisional program-level NTG ratio of 1.07, as illustrated in Table 15.

FR results were analyzed at the measure category-level. To develop the program-level FR result, measure category-level FR results were weighted by the percentage each measure contributed to total program energy savings.[19,20] A detailed description of the FR survey module and analysis methodology is found in Section 4.3.

SO results were also analyzed at the measure level. However, because SO measure savings are influenced by overall program activity rather than individual measures, the SO rate is calculated at the program-level. To develop the SO rates, total participant and nonparticipant SO energy savings are divided by the total ex post gross 2017 MMRP energy savings. The ex post gross 2017 MMRP energy savings were not available at the time that this report was published. Therefore, provisional SO rates were calculated using the 2015 MMRP energy savings as a placeholder value. These provisional values will be updated when the 2017 MMRP ex post gross energy savings are available. A detailed description of the SO survey module and analysis methodology is found in Section 0.

Table 15. Overall NTG Results

Measure Category	FR Ratio	FR Confidence/ Precision	Provisional SO Ratio	SO Confidence/ Precision	Provisional NTG Ratio	NTG Confidence/ Precision
Program Level	0.21	90/15	0.28	90/32	1.07	90/14

Source: Navigant analysis

The program-level NTG ratio should be applied to gross electric and fuel savings from all measures in the MMRP.

[19] As determined from preliminary data reported by individual PAs to the evaluation team for the impact evaluation.

[20] When scoped, the RES 44 study had planned to deliver measure category-level NTG results. Measure category-level FR results are presented in Section 4.3, however through discussion of the preliminary results with the PAs and EEAC it was decided that the final recommendation would be a program-level NTG ratio. This is because the measure category-level results are very similar and the precision was low when reported at the measure-level.

4.2 NTG Analysis Methodology

The evaluation team conducted a review of contemporary industry best practices to develop the NTG analysis methodology, survey questions, and NTG algorithms used in this research. *Massachusetts 2017 Net to Gross Methodology Research* (TXC08) is the foundational document guiding the overall study design. TXC08 references the *Massachusetts 2011 Cross Cutting Net to Gross Methodologies for both Residential and Commercial & Industrial sectors* report. Some survey questions were retained from the 2011 MF program NTG research project for consistency. The 2011 and 2017 Massachusetts NTG guidance documents both reference methodologies from jurisdictions beyond Massachusetts; the evaluation team also reviewed and incorporated best practices from recent studies or best practice reports in Illinois, Pennsylvania, California, and Michigan as appropriate.

A sample of 2017 MMRP participants and nonparticipants were invited to participate in a web-based survey to explore stakeholder intent, program influence, and to inform the NTG analysis. The survey instrument was designed to support an enhanced self-report approach to estimate net savings. The team analyzed the survey results to establish a NTG estimate representative of the MMRP's influence on resulting savings. The NTG analysis considered the following:

- FR and SO for resident-owned devices among participating renters and nonparticipating renters in participating buildings
- FR and SO among participating condominium owners and nonparticipating condominium owners in participating buildings
- SO among nonparticipating condominium owners in nonparticipating buildings
- FR and SO among property owners/managers for building-owned devices in both participating and nonparticipating buildings

Additionally, the evaluation team conducted qualitative interviews with MMRP lead vendors to provide context to FR and SO results across the program. The qualitative results of these interviews are presented in Section 3.3.

4.2.1 Definitions

This section provides key definitions for the NTG research and analysis methodology, stakeholders, participation, and building types. Table 16 defines NTG ratio, FR, and SO.

Table 16. NTG Definitions

Term	Definition
Net-to-Gross (NTG) Ratio	Gross impacts are the change in energy consumption that result directly from program-related actions regardless of why the customer participated. NTG is expressed as a percentage and is applied to the gross savings impacts to calculate the net savings impacts that are attributable to program actions. The NTG ratio is calculated as: **NTG Ratio = 1 – FR Score + SO Rate**
	Market effects not captured by SO (such as distributor/retailer product stocking or contractor actions) were not part of this research, as they are an insignificant aspect of this program's implementation methodology.

Term	Definition
	NTG ratios have been developed at the measure category-level for both common areas and in-unit measures. Measure categories included lighting, building shell, domestic hot water, and HVAC. There was insufficient participation identified in the survey responses to support research of custom measures.
Free Ridership (FR)	A free rider is a program participant who would have implemented the program's measures or practices in the absence of the program. Free riders can be either: • **TOTAL**, in which the participant's actions would have completely replicated the program measure • **PARTIAL**, in which the participant's actions would have partially replicated the program measure • **DEFERRED**, in which the participant's actions would have partially or completely replicated the program measure but at a future time
Spillover (SO)	SO savings represent reductions in energy consumption and/or demand caused by the presence of an energy efficiency program but outside of the program's direct impacts. SO is classified as like and unlike, representing those measures that are both supported and non-supported by the program. Spillover includes both: • **PARTICIPANTS** – either property owners or residents taking additional action in participating buildings • **NONPARTICIPANTS** – property owners or condo owners acting in nonparticipating buildings and residents of a participating building acting in a nonparticipating unit[21]

Sources: Net-to-Gross Methodology Research – TXC08, March 2017 and Navigant analysis

The NTG research was designed to obtain results across multiple stakeholders in different building ownership structures, recognizing their distinct relationships to each other and the buildings they own, rent, or manage. Survey respondents self-identified their role (renters, condominium owners, or property owners/managers) and whether their building participated in the MMRP in 2017. These responses were the basis for subsequent questions presented to each respondent. For example, renters were not asked about large measures such as boilers and nonparticipants were not asked the FR battery. Survey respondents may manage or reside in either participating or nonparticipating buildings.

Participating and nonparticipating buildings are defined in Table 17. MF building stakeholder roles are defined in Table 18.

Table 17. MF Building Definition

Term	Definition
Participating Building	A MF building with at least five dwelling units that participated in the MMRP in 2017.

[21] If a program participating condo owner or apartment renter takes program incentivized measures, such as light bulbs, with them to a new apartment or condo, this action is not counted as spillover.

Nonparticipating Building	A MF building with at least five dwelling units that did not participate in the MMRP in 2017. • A nonparticipating building may have participated previously. • A nonparticipating building may be owned or managed by a stakeholder with other participating buildings in their portfolio. • Nonparticipating buildings must be located in Massachusetts.

Source: Navigant analysis

Table 18. MF Stakeholder Definitions

Term	Definition

Participant Stakeholder	**RESIDENTS** are either condo owners or apartment renters who had measures installed in their units by the MMRP in 2017.
	• A resident renting a condo was assumed to have the responsibilities of a renter.
	• Residents in a participating building who did not have measures installed in their unit are defined as a nonparticipant and were not asked FR questions.
	• Questions were tailored to both condo owners and renters, reflective of their financial responsibilities:
	  ○ Condo owners were asked about in-unit building shell and mechanical system decisions, whereas these measures are not applicable to most renters.
	  ○ Renters were asked about smaller, in-unit measures such as screw-based lighting products.
	PROPERTY OWNER/MANAGERS are the owners or managers of a building participating in the MMRP in 2017.
	• Participating property owners and managers may have a mix of participating and nonparticipating buildings due to multiple properties in their portfolio.
	• Participant FR and SO questions were targeted to those buildings participating in 2017.
	• Participant SO questions were also asked about buildings that did not participate in 2017 but are owned by a property owner/manager of a 2017 participating building.
	• Property owners and managers were asked about measures typical in common areas and central building systems and about larger in-unit equipment (refrigerators, heating, domestic hot water, etc.).

Nonparticipant Stakeholder	**RESIDENTS** are either condo owners or apartment renters in a 2017 participating building who did not have measures installed in their unit. Nonparticipants also include a nonparticipating condo owner in a nonparticipating building. • Nonparticipating renters in nonparticipating buildings were excluded from the research. • Questions were tailored to both condo owners and renters to focus on measures for which they were the primary decision makers; condo owners were asked about in-unit building shell and mechanical system decisions (these measures are not applicable to most renters). **PROPERTY OWNER/MANAGERS** do not own or manage a building that participated in the MMRP in 2017. • Nonparticipant SO questions were only provided to those property owners/managers who had no buildings participate in 2017. • Property owners and managers were asked about measures typical in common areas and central building systems and about larger in-unit equipment (refrigerators, heating, domestic hot water, etc.)

Source: Navigant analysis

Based on the MF building and stakeholder definitions, Table 19 illustrates overlap between the various stakeholder groups and building types. Survey question batteries were mapped to each stakeholder based on their participation status and role in the project (condominium owner, renter, or property owner/manager).

Table 19. Distribution of FR and SO Survey Questions

Stakeholders >		Participating Building					Nonparticipating Building	
		Participating Stakeholder			Nonparticipating Stakeholder			Participating Stakeholder
		Renters	Condo Owners	Property Manager and/or Rental Property Owner	Renters	Condo Owners	Condo Owners	Property Manager and/or Rental Property Owner
Survey Module > Measure Categories Included		**Resident Participant (FR, PSO)**		**PM Participant (FR, PSO)**	**Resident Nonparticipant (NPSO)**		**Resident Nonparticipant (NPSO)**	**PM Nonparticipant (NPSO)**	**PM Participant (PSO)**
Lighting	In-Unit	✓	✓	✓	-	✓	✓	✓	✓
	Common Area	-	-	✓	-	-	-	✓	✓
Building Shell	In-Unit	-	✓	✓	-	✓	✓	✓	✓
	Common Area	-	-	✓	-	-	-	✓	✓
DHW	In-Unit	-	✓	✓	-	✓	✓	✓	✓
	Common Area	-	-	✓	-	-	-	✓	✓
HVAC		-	✓	✓	-	✓	✓	✓	✓
C&I Measures		-	-	✓	-	-	-	✓	✓

FR: Free Rider
PSO: Participant Spillover
NPSO: Nonparticipant Spillover
Source: Navigant analysis

4.2.2 Survey: Implementation and Outreach

The NTG survey was fielded through a web-based instrument. The survey was fielded from October 18, 2017 through January 15, 2018. Four sets of stakeholders were targeted:

- Participating building apartment renters
- Participating building condominium owners
- Nonparticipating building condominium owners
- Participating and nonparticipating property managers/owners

Participating building residents (renters and condominium owners) were notified of the survey in conjunction with the impact evaluation site visits. The field team left door hangers (Figure 3) with identification pin codes specific to program participants and nonparticipants. Residents were directed to a website to complete the survey and offered a $25 Amazon gift card for participation.

The evaluation team also conducted surveys directly with participating building owners/managers while onsite for the impact activities. The participating building owners/managers used an iPad to complete a pre-loaded survey while the field staff conducted data collection tasks.

Outreach was conducted by postcards to obtain feedback from nonparticipating condominium owners and property owners/managers. Postcards (Figure 4) were sent to 20,000 condominium owners and MF property owners. The addresses were sourced from the RES 43 research project database, which included an analysis of Massachusetts property tax records. Postcard recipients were directed to the survey website. To encourage participation, a $25 Amazon gift card incentive was offered to respondents who completed the survey.

Project stakeholders including the Massachusetts NTG team (NMR and Tetra Tech representatives), PA staff, and EEAC staff reviewed the draft and final survey instruments and analysis methodology. The evaluation team incorporated feedback into the final survey instrument.

The survey assessed topics relevant to specific stakeholder groups (identified in Table 20). The full survey instrument is included in Appendix A.

Figure 3. NTG Survey Recruitment Door Hanger

Figure 4. NTG Survey Recruitment Postcard

Table 20. Stakeholder Survey Topics

Survey Topic	Renters	Condominium Owners	Property Owner/ Manager
Initial initiative awareness	X	X	X
Timing of program service awareness relative to decision to replace measures		X	X
Owner goals for program participation; alignment of program services to meet owner needs		X	X
Influence of various program components on decision to replace at time they did, including audit, installation cost, direct installation, project management		X	X
Influence of various program components on decision to replace at time they did, including direct installation, installation cost, property owner recommendation	X		
Likelihood of purchasing same efficiency level in the absence of the initiative	X	X	X
Additional actions participants took that were not part of the program/project incentive package	X	X	X

Source: Navigant analysis

4.2.3 Survey: Stakeholder Identification Module

A single survey instrument was used for all stakeholders and building types. The stakeholder identification module asked respondents a series of questions to categorize their role and determine the subsequent set of questions to be presented.

Respondents were first asked to self-identify their role on the project as either a condominium owner, renter, or property owner/manager. Next, respondents were asked whether they were a decision maker for energy expenses in their homes, apartments, or buildings. Respondents identifying as a non-decision

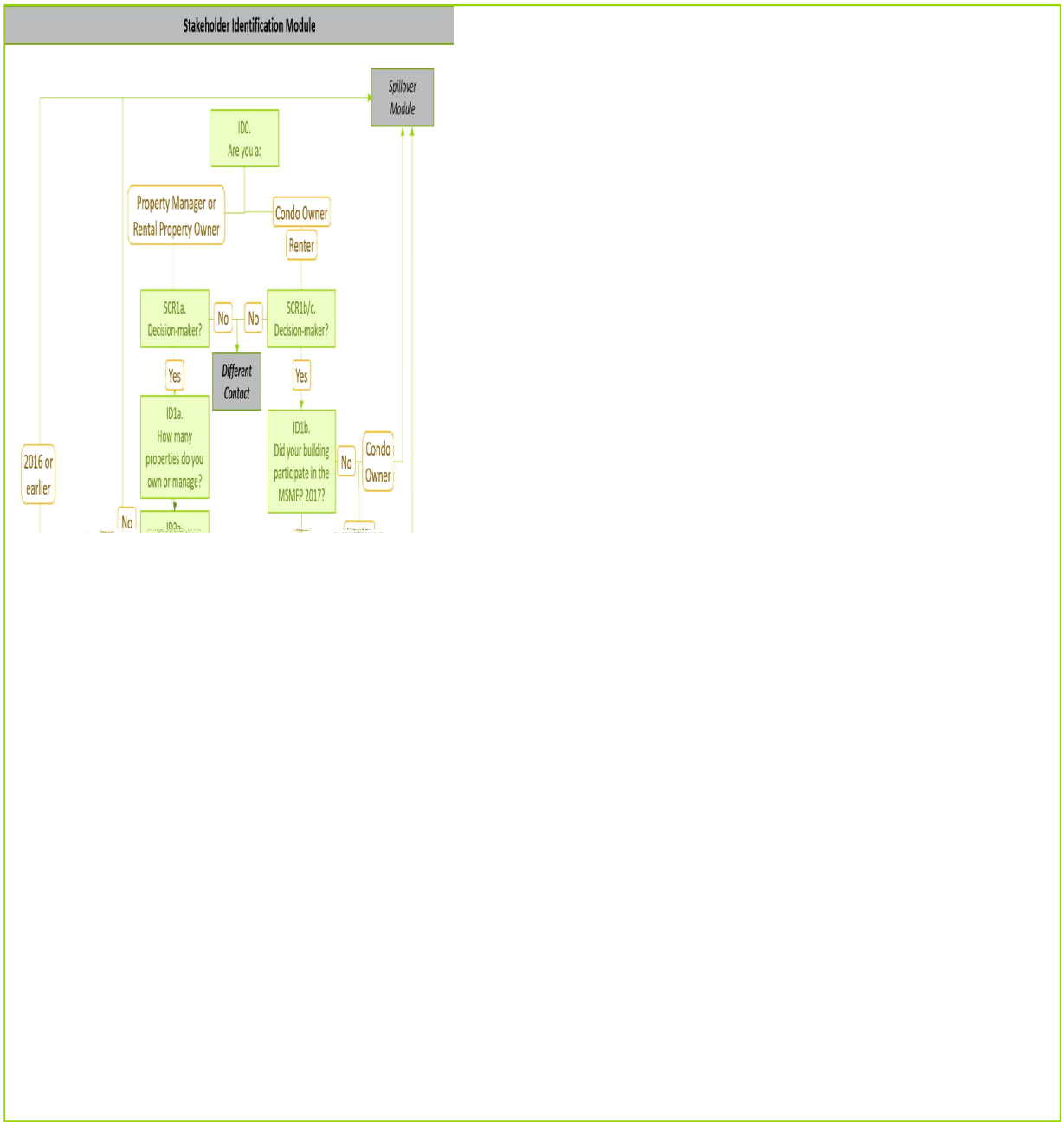
maker were screened out of the survey and asked to refer the survey to the household or building decision maker.

Next, all respondents were asked about their buildings' participation. Respondents indicating their building participated in 2017 were sent to the FR module. Nonparticipating renters were screened out of the survey because FR requires participation; the evaluation did not research nonparticipating renter SO effects. This research parameter is reflective of the program's primary outreach strategy, which targets property owners and managers rather than individual apartment renters.

Property owners/managers were asked how many properties they managed and how many participated in 2017. If these stakeholders had multiple properties with different participation statuses, SO questions were tailored to capture SO activities that occurred in both participating and nonparticipating buildings.

Figure 5 illustrates the stakeholder identification module process flow. Green boxes paraphrase the question(s) presented. See Appendix A for the full survey instrument.

Figure 5. Stakeholder Identification Module Process Flow Chart



Source: Navigant analysis

4.2.4 Survey: Responses

The NTG survey was distributed to stakeholders reflective of their role in the program and participation status. Table 21 illustrates the outreach methodology for the survey.

Table 21. NTG Survey Outreach Methodology

Population Category	Data Sources	Sample Target	Outreach Methodology
Participating building, apartment renters	PA tracking data	70	Doorhangers: impact evaluation site visit sample apartments
Participating building, condominium owners	PA tracking data	70	Doorhangers: impact evaluation site visit sample condominiums
Nonparticipating building, condominium owners	RES 43 database	70	Postcards to condominium owners
Participating and nonparticipating building, property managers/ owners	RES 43 database and PA tracking data	70	• Postcards to property managers/owners • Impact evaluation site visit sample of property managers/owners

Source: Navigant analysis

A total of 1,396 individuals responded to the NTG survey. Of those, 249 respondents were screened out of the FR survey because they were not a responsible party (they indicated that they did not make decisions about energy efficiency products or pay the utility bill). Another 884 respondents were screened out of the FR survey because they did not identify as a participating resident or a property manager associated with a participating building.[22] Seventy-four respondents either did not finish the survey or provided "don't know" responses to the measure-level questions, preventing their responses from being used in the FR analysis. Table 22 illustrates the screening question results and the total number of survey participants that were eligible for the FR analysis.

Table 22. NTG Survey FR Responses

Population Category	Total Respondents	Not Responsible Party[23]	Nonparticipating Stakeholder	Incomplete Survey Response	Total Eligible FR Responses
Participating building apartment renters	153	-10	-59	-27	57
Participating and nonparticipating building condominium owners	740	-217	-427	-15	81
Participating and nonparticipating property managers/owners	503	-22	-398	-32	51
Total	**1,396**	**-249**	**-884**	**-74**	**189**

Source: Navigant analysis of NTG survey results

[22]Two of these 884 respondents were removed after having provided a complete survey response. This is because these respondents were identified as likely LEAN participants. after the survey concluded.

[23] Negative numbers in this table are used to indicate that respondents were removed from the analysis due to screening.

For participating condominium owners and renters, the evaluation team compared the identification battery responses to the MMRP tracking data. Only 48% of renters in participating buildings reported their building as participating in the MMRP.

Of the 1,396 overall survey responses, 386 respondents were screened out of the SO module because they were not aware of the MMRP. As SO savings attribute decision influence to program activities, program unawareness constituted disqualification from the analysis..

Table 23 illustrates the screening question results and the total number of survey participants that were eligible for the SO analysis.

Table 23. NTG Survey SO Responses

Population Category	Total Respondents	Not Responsible Party	Not Aware of MMRP	Incomplete Survey Response	Total Eligible SO Responses
Participating building apartment renters	153	-10	-2	-52	89
Participating building condominium owners	740	-217	-	-4	94
Nonparticipating building condominium owners			-147	-135	269
Participating and nonparticipating property managers/owners	503	-22	-237	-188	56
Total	**1,396**	**-249**	**-386**	**-379**	**508**

Source: Navigant analysis of NTG survey results

4.3 Free Ridership

This section describes the FR survey module, the algorithm used to develop the FR score, and FR results by measure category and stakeholder groups.

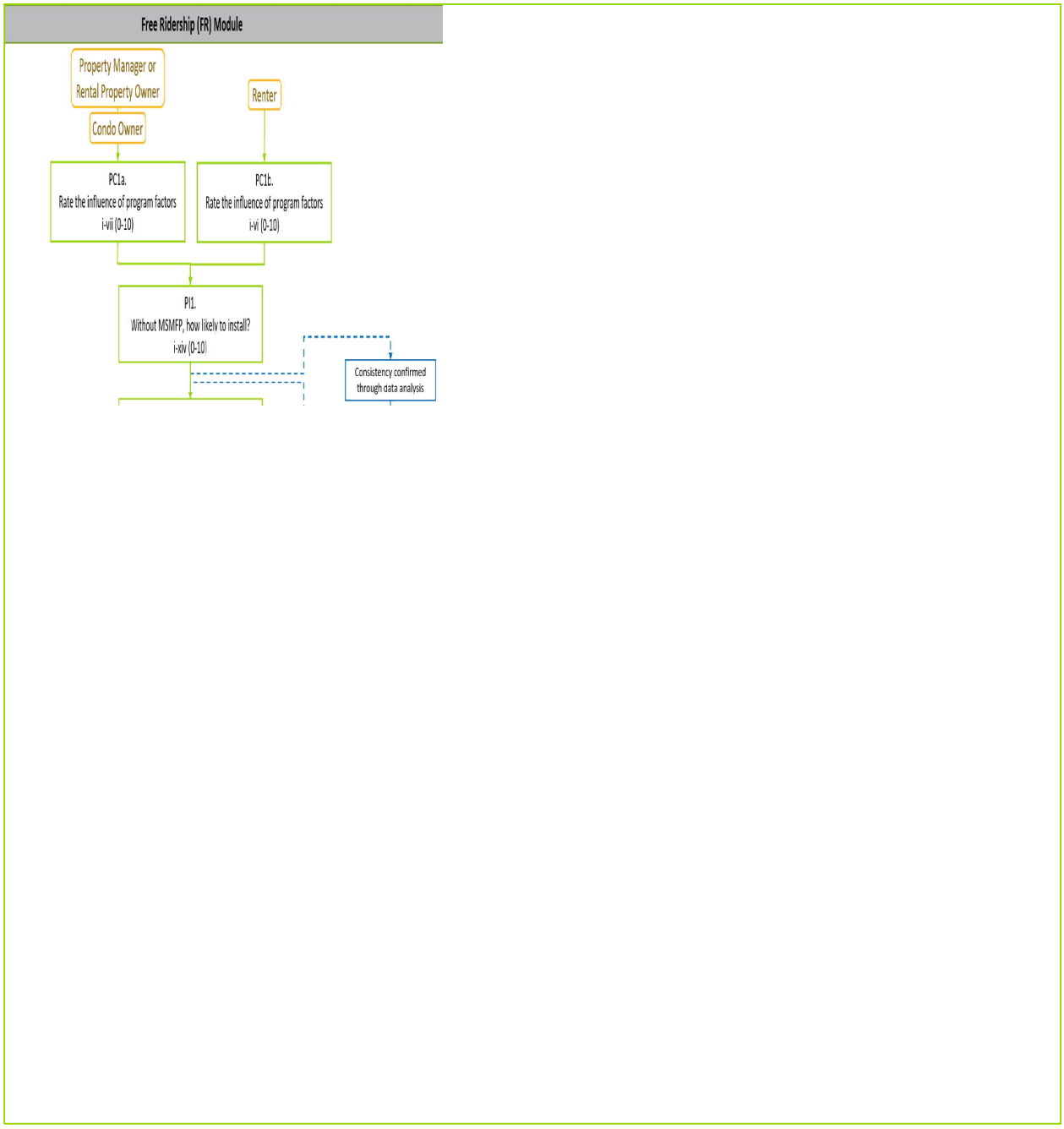
4.3.1 FR Survey Module

The FR survey module assessed the extent to which a participant would have installed the incentivized energy efficient equipment in the absence of the MMRP. Survey questions and measures presented to each respondent were tailored to their role in the market. Participants were asked to rate the influence of various program factors on their decision to install the equipment and whether they would have installed the equipment if the program did not exist. The module also assessed whether the program influenced participants to install equipment sooner or install equipment of a higher efficiency than they would have in the absence of the program.

Respondents were asked to identify which measures were installed in their apartment, condominium, or building, respectively. FR scoring questions were asked of each installed measure to inform measure category-level FR scores.

Figure 6 illustrates the FR module questions. Green boxes paraphrase the question(s) presented. See Appendix A for the full survey instrument.

Figure 6. FR Module Flow Chart



Source: Navigant analysis

4.3.2 FR Algorithm

The FR ratio is based on the average of three program scores developed from several questions. The three scores are averaged together, resulting in a measure-level FR score. These scores include:

- **Program influence score (PI):** The PI score is developed by asking respondents questions about each measure installed and calculating the interim scores: PIL and PIA (see below). The PIL and PIA scores are used to calculate the PI score. PI = PIL * PIA
    - **Program influence likelihood (PIL):** "*[Question PI1] How likely is it that you would have had the efficient product(s) installed if the Mass Save Multifamily Program did not exist?*"

      Answers for each measure (i-xiv) were provided on a 0-10 scale, with 0 representing "not at all likely" and 10 representing "extremely likely." Lower likelihood results in lower FR.

      PIL = question PI1 response/10
    - **Program influence adjustment (PIA):** "*[Question PI2] Did the Mass Save Multifamily Program cause you to have more efficient products installed than you would have if the program did not exist? [Question PI3] If so, What percentage of the efficient product(s) installed by the Mass Save Multifamily Program would you have had installed in 2017 if the Mass Save Multifamily Program did not exist?*"

      Answers to question PI3 were provided for each measure (i-xiv) as a percentage of the products installed. A smaller percentage results in lower FR.

      PIA = if question PI2 response = "no," PIA = 1, otherwise PIA = question PI3 response
- **Program components score (PC):** The PC score is developed by asking respondents to rank the importance of key program factors that influenced their decision to install energy efficient products.

  Answers for each program component were provided on a 0-10 scale where 0 means "not at all important" and 10 means "extremely important." The PC score uses the average for listed program components; more importance results in lower FR.

  Property Manager/Condominium Owners
    - PC = ((average(PC1a i-v)-10)/10)*-1
    - Factors:
        i. The free lighting products
        ii. The rebates for other energy efficiency improvements
        iii. Recommendations from the auditor/contractor/Mass Save representative
        iv. Information from the MMRP or other marketing materials
        v. The no-cost project management and installation

  Renters
    - PC = ((average(PC1b i-iv)-10)/10)*-1
    - Factors:
        i. The free light bulbs

ii. Recommendations from MMRP

iii. Information from the MMRP or other marketing materials

iv. The no-cost installation

- **Program timing (PT):** The PT score is based on whether the program influenced the respondent to install products earlier than they would have without the program. If they responded "Yes, installed sooner than planned," respondents were asked for each measure: "*If the Mass Save Multifamily Program did not exist, what is the likelihood that you would have installed these energy efficient products within 6 months?*"

  Answers for each measure (i-xiv) were provided on a 0-10 scale, where 0 means "not at all" and 10 means "extremely likely." Lower likelihood results in lower FR.

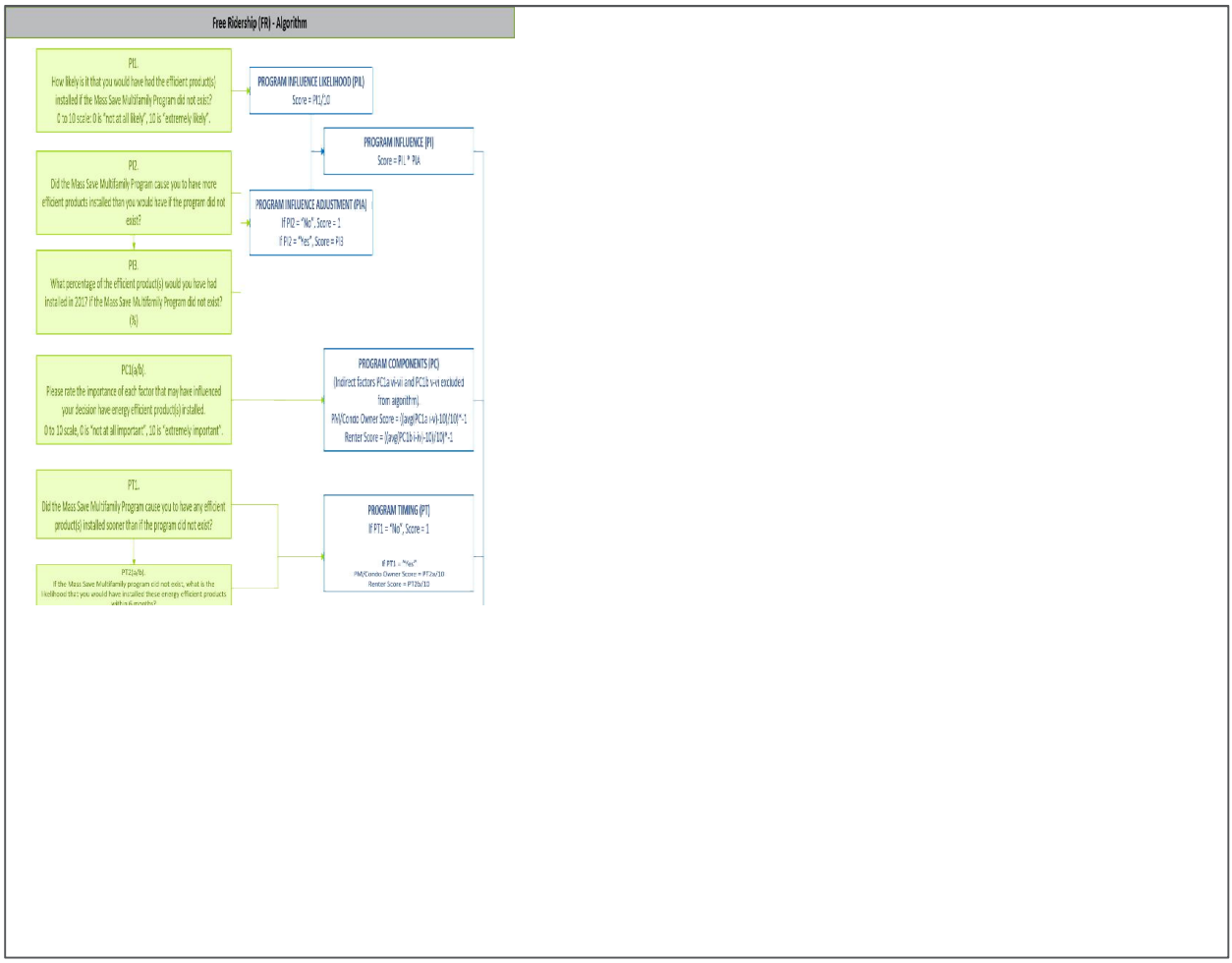
  PT = if question PT1 response = "no," PIA = 1, otherwise PT = question PT2a/b response/10

The evaluation team analyzed respondent's FR responses to ensure consistency across the FR answers. If inconsistencies were identified between a respondent's answers to the FR questions, their measure-level responses were removed from the analysis sample. The final FR score was calculated from consistent survey responses only. The final FR score (0-1) is the average of the three program scores:

FR = AVERAGE (PI, PC, PT)

Figure 7 illustrates the FR algorithm used in the analysis to develop the FR score, including the consistency checks.

Figure 7. FR Algorithm



Source: Navigant analysis

4.3.3 FR Results

Of the 189 survey respondents who qualified to provide FR responses, 87 respondents provided valid FR responses (not removed by the consistency checks or unable to calculate FR scores due to “don’t know” and “unsure” responses). From those 87 respondents, the survey gathered data on a total of 140 installed measures.

The total FR score is a combination of the renter, condominium owner, and rental property owner/ manager survey responses. Measure category FR results were weighted by the percentage of energy savings contribution of each measure category to total program savings. FR scores are provided at the measure category and program-levels in Table 24.

Table 24. Measure Category-Level and Program FR Score

Measure Category	Responses (n)	Measure Category FR Score	FR Score Confidence/ Precision	Percentage of Program Savings	Program-Level FR	Program FR C/P
DHW	21	**0.21**	90/38[24]	10%	**0.21**	**90/15**
Building Shell	26	**0.19**	90/35	25%		
Lighting	72	**0.23**	90/21	46%		
HVAC	18	**0.17**	90/45	18%		
Other (Refrigerator)	3	**0.21**	90/146	1%		

Source: Navigant analysis of NTG survey results

The responses from participating condominium owners and renters were gathered separately. After analyzing the total completed and consistent responses for each stakeholder group, the evaluation team determined that developing separate FR scores for each stakeholder group would result in reduced accuracy due to low responses at the measure level, primarily due to removing inconsistent responses. Results from the two stakeholder groups were determined to be sufficiently similar to warrant combining all survey results in a single FR ratio for both condominiums and rental apartments.

Table 25 illustrates the FR results individually for condominiums and rental apartments and the combined results used to develop the final FR score. Renters were only asked about lighting measures, reflective of their roles and responsibilities.

Table 25. Participating Condominium Owner and Renter FR Results

Measure Category	Participating Condominium Owners, Responses (n)	Participating Condominium Owners, FR Score	Participating Renters, Responses (n)	Participating Renters, FR Score	All Participating Residents, Responses (n)	All Participating Residents, FR Score
DHW	12	0.25	N/A	N/A	12	0.25
Building Shell	19	0.18	N/A	N/A	19	0.18
Lighting	24	0.26	22	0.26	46	0.26

Source: Navigant analysis of NTG survey results

Rental property owner/manager responses were gathered separately for both in-unit and common areas for illustrative purposes. The results for each and the combined totals are shown in Table 26.

[24] Relative precision.

Table 26. Rental Property Owner/Manager FR Results

Measure Category	In Unit, Responses (n)	In Unit, FR Score	Common Area, Responses (n)	Common Area, FR Score	Total, Responses (n)	Total, FR Score
DHW	4	0.18	3	0.22	7	0.20
Building Shell	3	0.21	4	0.22	7	0.21
Lighting	14	0.17	12	0.21	26	0.19
HVAC	-	-	-	-	18	0.17
Other (Refrigerator)	-	-	-	-	3	0.06

Source: Navigant analysis of NTG survey results

The last MMRP NTG research results were reported in 2012. The 2012 results are shown in Table 27 in comparison to the 2018 results derived from this study. FR of lighting increased slightly compared to 2012, which was expected due to the increased availability and lower costs of high quality LED products and the prevalence of the Massachusetts upstream program. This increased FR for lighting caused a corresponding program-level FR increase because lighting savings are almost half (46%) of the overall program savings.

Table 27. Comparison of 2018 FR Results with 2012 Results

Measure Category	2012 Responses[25] (n)	2012 Measure Category FR Score	2018 Responses (n)	2018 Measure Category FR Score
Domestic Hot Water	30	0.15	21	0.22
Building Shell	22	0.19	26	0.19
Lighting	63	0.18	72	0.23
HVAC	20	0.24	18	0.17
Other (Refrigerator)	-	-	3	0.06
Total	**135**	**0.18**	**140**	**0.21**

Sources: Navigant analysis of NTG survey results and Massachusetts Multifamily Program Impact Analysis, July 2012

4.4 Spillover

This section describes the SO survey module, the algorithm used to develop the SO savings, and SO results.

[25] *Massachusetts Multifamily Program Impact Analysis*, Cadmus, July 2012.

4.4.1 SO Survey Module

The SO module assessed the extent to which respondents installed non-incented energy efficient equipment due to the influence of the MMRP. Condominium owners, renters, and property owners/ managers were asked the SO battery of questions. Participants and nonparticipants were asked to identify efficient measures they installed outside of the program and rate the program's influence on their decision to install those measures. Consistent with the FR module, questions were tailored to the stakeholder's role in the market.

Nonparticipants were first asked if they were familiar with the MMRP. SO savings are only attributed to program influences; those who answered that they were not familiar with the program were screened out of the survey.

Respondents were asked if they had installed energy efficient measures:

- **Renters (PSOSCR1):** *"As a result of your buildings' participation with the Mass Save Multifamily Program, have you installed any ADDITIONAL energy efficient products for which you did not receive a Mass Save incentive in 2017?"*
- **Condominium owners and property owners/managers (NPSOSCR2a):** *"Have you made any energy efficiency improvements in your building common spaces or individual units in 2017 for which you did not receive a Mass Save incentive in 2017? This could include for example, weatherization improvements or having efficient lighting or other efficient equipment installed?"*

Respondents who answered "no" to these questions were screened out of the SO module and their survey concluded. Respondents who answered "yes" to this question were asked to select the measures they installed from a list of potential options.

4.4.1.1 SO Measure Selection

Condominium owners and property owners/managers were presented with a list of approximately 30 measures that they may have installed. Property owners/managers were instructed not to respond for actions that their tenants may have taken and to respond only for their Massachusetts properties. Additionally, property owners/managers were offered four installation options for each measure:

- Participating buildings – common areas
- Participating buildings – in individual units
- Nonparticipating buildings – common areas
- Nonparticipating buildings – in individual units

Renters were presented with a list of 16 measure options to choose from. Neither condominium owners nor renters were presented with location options (i.e., common areas or in units, participating or nonparticipating buildings).

4.4.1.2 SO Attribution Threshold Check

Respondents were asked SO attribution threshold check questions to determine the influence of the MMRP on their decision to install any selected, non-incentivized measures. For each selected measure, respondents were asked:

SO2. **Measure attribution score A (AS1):** *"How influential, if at all, was the Mass Save Multifamily Program in your decision to install these efficient product(s) for which you did not receive an incentive?"*

Answers were provided on a 0-10 scale, where 0 indicates "not at all influential" and 10 indicates "extremely influential."

SO3. **Measure attribution score B (AS3):** *"If the Mass Save Multifamily Program did not exist, how likely is it that you still would have installed the efficient product(s) for which you did not receive an incentive within the last year?"*

Answers were provided on a 0-10 scale, where 0 indicates "not at all likely" and 10 indicates "extremely likely."

The SO attribution threshold check compared the two attribution questions to determine whether any savings could be attributed to MMRP activities. For each attribution score question, the maximum score from the SO measures selected by the respondent was used in this equation:

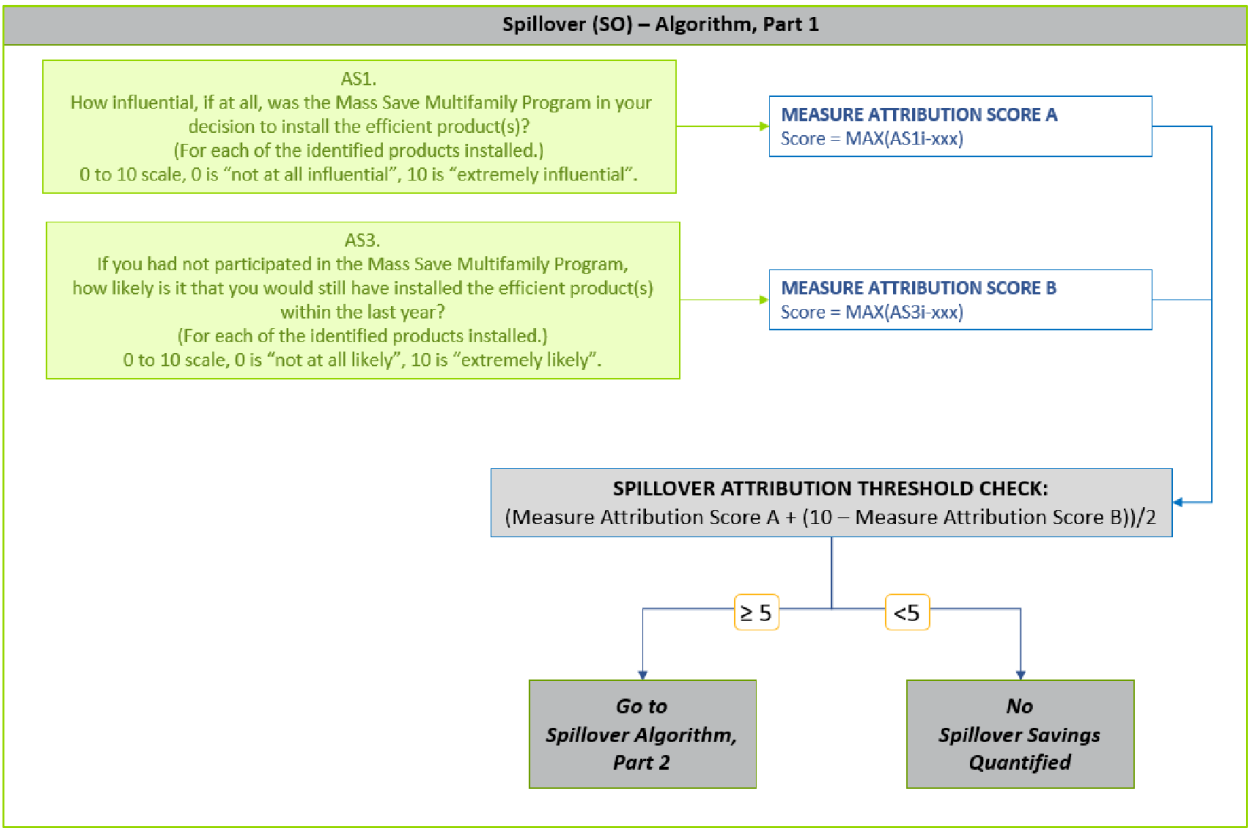
SO Attribution Threshold Check = ((max AS1) + (10 – (max AS3)))/2

If SO Attribution Threshold Check ≥ 5, then SO savings *were* attributed to the MMRP

If SO Attribution Threshold Check < 5, then SO savings *were not* attributed to the MMRP

A total of 183 SO actions were removed from the analysis because they scored less than 5 through the SO Attribution Threshold Check. Figure 8 illustrates the SO Attribution Threshold Check process, referred to as Part 1 of the SO algorithm.

Figure 8. SO Attribution Threshold Check



Source: Navigant analysis

4.4.1.3 Confirmation of SO Action Efficiency

Respondents were asked, "*[Question SOSCR3] How did you know that the product(s) you installed were energy efficient?*" to determine whether installed products resulted in energy savings,

The following options were provided to respondents:

1. Efficiency rating or label of equipment, such as an "ENERGY STAR®" logo
2. Equipment dealer/retailer said it was energy efficient
3. Personal experience
4. Met utility rebate requirements
5. Third party report, such as Consumer Reports
6. Recommendations from the contractor/installer
7. Did not rely on any specific type of information
8. Internet/website

88. Other, please describe: _____

98. Don't know

The analysis methodology assumes that some responses would not necessarily result in an energy efficient product installation, including personal experience, did not rely on any specific type of information, and don't know. Measures where the energy efficiency could not be confirmed were screened out of the SO savings calculation. If the respondent selected any of the other responses or if multiple responses were chosen and at least one confirmed the energy efficiency of the measure, the measures were included in the SO savings calculation

A total of 51 SO actions were removed from the analysis because the respondent did not demonstrate the efficiency of the installed product.

4.4.1.4 Program Overlap

Program overlap occurs when one program drives participation to another program. For the MMRP NTG analysis, this was a specific concern around overlap with the upstream lighting program. If a participant or nonparticipant is influenced by the MMRP to install additional LED lighting, it is highly likely those additional lighting products were purchased at a reduced rate provided through an upstream program incentive (through retailers such as Home Depot, Lowe's, Costco, etc.).

The survey identified instances where lighting savings were influenced by the MMRP, but bulbs were sourced from upstream lighting program retailers. This was achieved by asking respondents to identify where they purchased their lighting products and comparing those retailers to the list of upstream lighting program participating retailers provided by the PAs. The quantity of bulbs reported from each participating retailer is shown in Table 28.

To not double count savings between the MMRP SO and the upstream lighting program, LED lighting products obtained from upstream program retailers were removed from MMRP SO savings analysis, even if the lighting purchase was influenced by the MMRP. A total of 149 lighting actions were removed because they were obtained from a retailer participating in the upstream program.

Table 28. Bulb Purchases from Upstream Lighting Program Retailers

Upstream Retailers *(Removed from SO Analysis)*	Number of Reported Bulbs
Ace Hardware	61
Aubuchon Hardware	2,010
BJ's Wholesale	2,078
Costco	436
Dollar General	-
Dollar Tree	48
EFI	50
Home Depot	1,452
Lowe's	458
Staples	2
Stop & Shop	11
Target	45
True Value	42

Walgreens	-
Walmart	47
Wegman's	-
Whole Foods	-
Total Bulbs purchased from Upstream Retailers	**6,740**
Other Store _____	(see Table 29)

Source: Navigant analysis of NTG survey results

Table 29. Bulb Purchases from Non-Upstream Lighting Program Retailers

Non-Upstream Retailers *(Included in SO Analysis)*	Number of Reported Bulbs
Amazon	38
Berkshire Lighting Outlet	4
Best Buy	24
Carr Hardware	6
CVS	6
Delande Lighting	8
DoltBest	4
Electrician	28
Harvey Industries	1
HD Supply Online	1,150
Marine Home Center	12
Nesco	5
Ocean State Job Lot	41
Online	100
Unknown	2
Total Bulbs purchased from Non-Upstream Retailers	**1,429**

Source: Navigant analysis of NTG survey results

4.4.1.5 Summary of Reported SO Actions

Survey respondents' answers to SO activity questions indicated that 560 non-incentivized actions were taken in 2017. Of those actions, 149 lighting actions were removed because they were obtained from a retailer participating in the upstream lighting program. An additional 51 actions were removed from the SO analysis because the efficiency level and, therefore, savings, could not be confirmed. An additional seven actions were removed from the SO analysis because the respondent's answer to the open-ended question (*"[Question SO19] If incentives were available for the products you installed, why didn't you receive incentives?"*) indicated that the respondent may have received incentives. A further 183 actions were removed from the analysis due to the SO Attribution Threshold Check. Finally, the remaining lighting actions were removed to avoid any possible double-counting with the lighting ISR measured in the impact evaluation.

After removing actions for the stated reasons, 158 actions were included in the SO analysis, as illustrated in Table 30.

Table 30. SO Action Screening

Measure	Total Actions Reported (n)	Removed: Upstream Program Overlap (n)	Removed: Undefined Efficiency (n)	Removed: SO19 Response (n)	Removed: Attribution Threshold Check (n)	Removed: Avoiding double-counting with ISR (n)	Total Actions Included in Analysis (n)
CFL Lighting	39	-22	-3	-1	-8	-5	0
LED Lighting	145	-127	-5	-	-6	-7	0
Clothes Washer	33	-	-3	-	-20	-	10
Low-Flow Faucet Aerator	32	-	-5	-1	-15	-	11
Low-Flow Showerhead	46	-	-7	-1	-19	-	19
Programmable Thermostat	56	-	-9	-	-25	-	22
Smart Strip Plug Outlet	42	-	-5	-1	-17	-	19
Refrigerator	43	-	-3	-1	-19	-	20
Air Conditioning	16	-	-1	-	-9	-	6
Furnace	21	-	-1	-	-11	-	9
Boiler	17	-	-	-	-6	-	11
Air Source Heat Pump	13	-	-1	-2	-5	-	5
Gas Domestic Water Heater	24	-	-1	-	-12	-	11
Insulation	33	-	-7	-	-11	-	15
Total	**560**	**-149**	**-51**	**-7**	**-183**	**-12**	**158**

Source: Navigant analysis of NTG survey results

4.4.1.6 SO Analysis

The evaluation team estimated energy savings for each SO measure identified through the survey as savings/unit (condominium or apartment) or savings/piece of equipment (e.g., number of light bulbs). Savings estimates are sourced from the Massachusetts Technical Reference Manual (TRM), 2016-2018 Program Years (October 2015). The team used average per unit savings values from program year 2015 (sourced from the RES 42 database) to add context for measures with site-specific input requirements. Savings values are provided in Table 31.

Table 31. SO Savings Estimates

Measure	kWh	MMBtu	Savings units	Source

Measure	kWh	MMBtu	Savings units	Source
CFL Lighting, In-Unit	41.3	0.0	Per bulb	TRM p. 138, MF Retrofit Core Initiative, 2017 savings value
CFL Lighting, Common Area	367.0	0.0	Per bulb	TRM p. 138, MF Retrofit Core Initiative, 2017 savings value
LED Lighting, In-Unit	46.3	0.0	Per bulb	TRM p. 144, MF Retrofit Core Initiative, 2017 savings value
LED Lighting, Common Area	405.6	0.0	Per bulb	TRM p. 144, MF Retrofit Core Initiative, 2017 savings value
Clothes Washer (Elec. DHW)	302	0.0	Per unit (apartment/condo)	TRM p. 20, Electric – Residential Home Energy Services core initiative; assumption: 'Retire' values
Clothes Washer (NG, fuel oil, propane DHW)	224	0.4	Per unit (apartment/condo)	TRM p. 20, Gas – Residential Home Energy Services core initiative; assumption: 'Retire' values
Low-Flow Faucet Aerator (Elec. DHW)	97	0.0	Per unit (apartment/condo)	TRM p. 176, MF Retrofit Core Initiative
Low-Flow Faucet Aerator (NG, fuel oil, propane DHW)	0.0	0.9	Per unit (apartment/condo)	TRM p. 176, MF Retrofit Core Initiative
Low-Flow Shower Head (Elec. DHW)	129	0.0	Per unit (apartment/condo)	TRM p. 173, MF Retrofit Core Initiative
Low-Flow Shower Head (NG, fuel oil, propane DHW)	0.0	1.1	Per unit (apartment/condo)	TRM p. 173, MF Retrofit Core Initiative
Programmable Thermostat (AC[26] and elec. heat)	281	0.0	Per unit (apartment/condo)	TRM p. 100, MF Retrofit Core Initiative
Programmable Thermostat (AC and NG; fuel oil, or propane heat)	25	2.3	Per unit (apartment/condo)	TRM p. 100, MF Retrofit Core Initiative
Smart Strip Plug Outlet	75	0.0	Per smart strip	TRM p. 162, MF Retrofit Core Initiative
Refrigerator	468	0.0	Per refrigerator	RES 42 database: average savings per refrigerator
Central Air Conditioning	259	0.0	Per unit (apartment/condo)	TRM p. 65, MF Retrofit Core Initiative, assumption: 'retire' value
Furnace (NG)	0.0	8.1	Per unit (apartment/condo)	TRM p. pg. 119/121, MF Retrofit Core Initiative, assumption: 'Furnace w/ ECM 95%'
Boiler (NG)	0.0	11.4	Per unit (apartment/condo)	TRM p. 115/117, MF Retrofit Core Initiative, assumption: 'Boiler 90%' value
Boiler (propane)	0.0	11.4	Per unit (apartment/condo)	TRM p. 115/117, MF Retrofit Core Initiative, assumption: 'Boiler 90%' value

[26] Air conditioning

Measure	kWh	MMBtu	Savings units	Source
Air Source Heat Pump	450	0.0	Per unit (apartment/condo)	TRM p. 69, MF Retrofit Core Initiative, assumption: 'Heat Pump SEER 16.0, HSPH 8.5' value
Gas Domestic Hot Water	0.	3.6	Per unit (apartment/condo)	TRM p. 189, MF Retrofit Core Initiative
Insulation (Electric heat)	1684	0.	Per unit (apartment/condo)	TRM p. 56, MF Retrofit Core Initiative; RES 42, assumption: Used TRM prescriptive 209 kWh per unit savings (reduced furnace fan runtime & cooling) to estimate number of units impacted by insulation measures in the RES 42 data to calculate average MMBtu savings per unit. Reduced estimated savings by 50%, reflective of reported square footage of installed insulation.
Insulation (NG, propane heat)	105	6.8	Per unit (apartment/condo)	
Insulation (fuel oil heat)	112	8.3	Per unit (apartment/condo)	

Source: Navigant analysis

Survey respondents indicated the quantity of units impacted by their SO actions. Measure-level SO energy savings were calculated based on the per unit savings (Table 31) and multiplied by the total number of units impacted for both participating and nonparticipating stakeholders. The total respondent SO energy savings is the sum of all reported meaures, analyzed separately for program participants and program nonparticipants, as shown in Table 32.

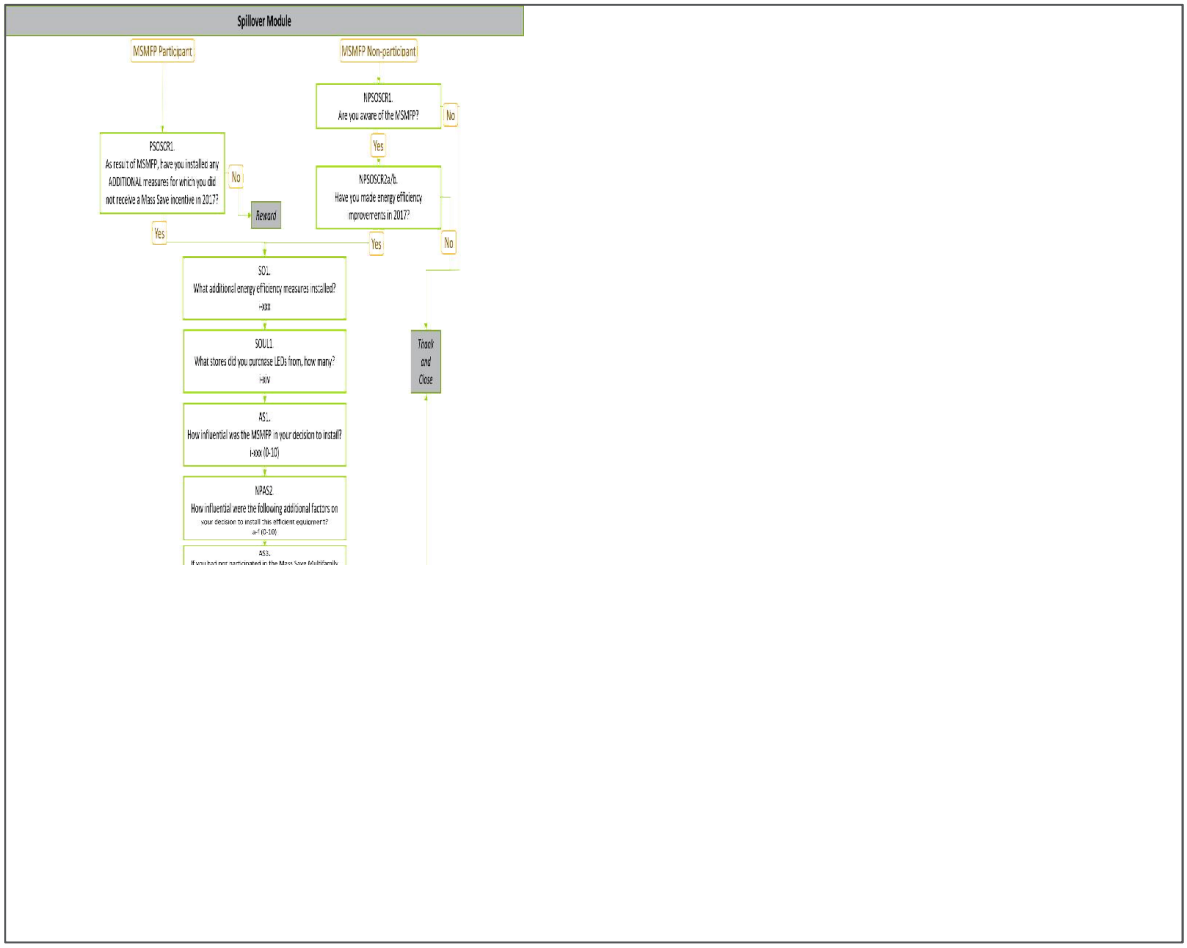
Table 32. Total SO Energy Savings Reported by Participants and Nonparticipants

Measure	Participant Units (condo/apt)	Participant Savings (kWh)	Participant Savings (MMBtu)	Nonpart. Units (condo/apt)	Nonpart. Savings (kWh)	Nonpart. Savings (MMBtu)
CFL	3	863	0	23	8,217	0
LED Lighting	626	137,011	0	590	64,774	0
Clothes Washer	26	2,240	4	473	105,952	166
Low-Flow Faucet Aerator	124	0	107	39	0	34
Low-Flow Shower Head	147	0	168	49	0	51
Programmable Thermostat	225	51,400	0	876	25	2
Smart Strip Plug Outlet	11	1,577	0	12	1,051	0
Refrigerator	107	49,616	0	477	223,274	0
Central Air Conditioning	19	4,921	0	24	6,216	0
Furnace	1	0	7	35	0	253
Boiler	112	0	68	38	3	365
Air Source Heat Pump	6	2,702	0	1	450	0
Gas Domestic Hot Water	2	0	4	10	0	0
Insulation	35	2,449	165	22	2,299	149
Total Respondent SO Energy Savings		**252,779**	**521**		**412,262**	**1,019**

Source: Navigant analysis

Figure 9 illustrates the process flow chart for the SO battery of questions.

Figure 9. SO Module Flow Chart



Source: Navigant analysis

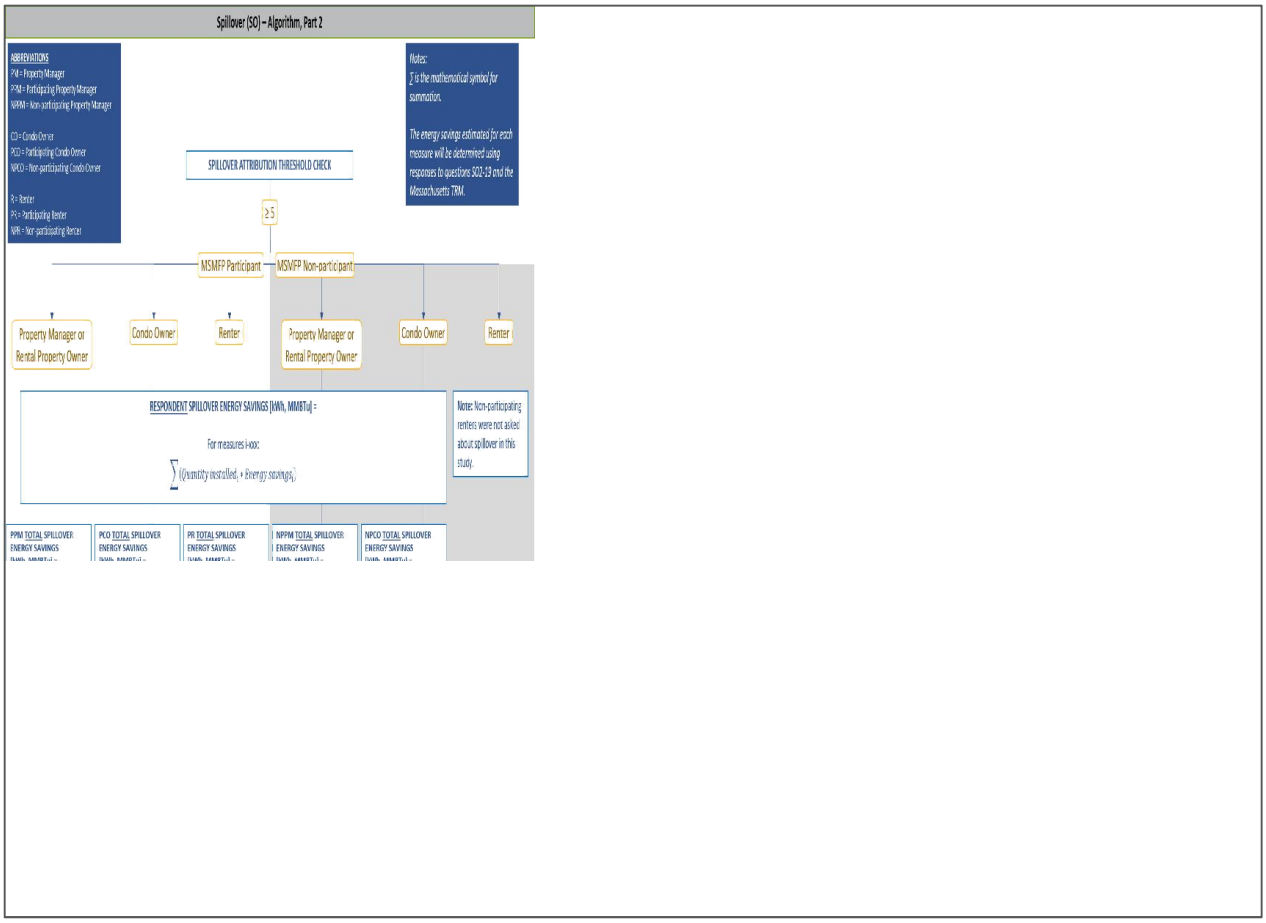
4.4.2 SO Algorithm

Total participant and nonparticipant SO energy savings were extrapolated from the total respondent energy savings based on the populations of total 2017 program units served (condominiums, rentals) and total statewide program nonparticipants (condominiums, rentals), respectively.

To develop the SO rates, total participant and total nonparticipant SO energy savings should each be divided by the total ex post gross 2017 MMRP energy savings (kWh and MMBtu). However, the ex post gross 2017 MMRP energy savings are not currently available. Therefore, provisional SO rates are presented here, based on calculations using the 2015 MMRP energy savings as a placeholder value. These provisional values will be updated when possible. The participant SO rate and nonparticipant SO rate were added together to arrive at the final program SO rate.

Figure 10 illustrates the algorithm for rolling up the SO energy savings.

Figure 10. SO Algorithm



Source: Navigant analysis

4.4.3 SO Results

The program-level SO rate for the MMRP was calculated to be 0.28. As illustrated in Figure 10, the SO rate is based on the sum of all reported energy savings resulting from actions influenced by, but occurring outside of, the MMRP. The results of each step of the SO rate rollup are presented in Table 33.

Table 33. SO Analysis Results

Result	Program Participant			Program Nonparticipant			Units
	Property Manager	Renter	Condo Owner	Property Manager	Renter	Condo Owner	
a) Total Respondent SO Energy Savings	109,900	751	4,289	341,770	-	2,182	kWh
	442	0	80	1,018	-	23	MMBtu fuel
(kWh converted to MMBtu for total)	**817**	**3**	**95**	**2,184**	**-**	**31**	**Total MMBtu**
b) Total Reported Units[27]	17,918	85	92	51,782	-	230	Condos/apts
c) Savings per Unit	6.1	8.8	46.6	6.6	-	9.5	kWh/unit
c = a / b	0.02	0	0.87	0.02	-	0.10	MMBtu fuel/unit
d) Total Population (Units)	14,013 [28]	14,013	21,021	362,915 [29]	-	108,103	Condos/apts
	85,946	123,805	979,927	2,395,302	-	1,025,358	kWh
e) Total SO Energy Savings	345	0	18,266	7,132	-	10,947	MMBtu fuel
e = c * d	639	423	21,610	15,307	-	14,446	Total MMBtu
		22,671			**29,753**		**Total MMBtu**
f) Total Ex Post Gross 2017 MMRP Energy Savings Placeholder Values[30]			27,096,611				kWh
			93,813				MMBtu fuel
(kWh converted to MMBtu for total)			**186,294**				**Total MMBtu**
g) SO Rate		0.12			0.16		-
g = e / f							
h) Program SO Rate			**0.28**				-
$h = g_{participant} + g_{nonparticipant}$							

Source: Navigant analysis, RES 43 database, RES 42 database, PA estimate

[27] Navigant, NTG survey responses. Property owner/manager calculated from the number of properties reported multiplied by an average of 34 units per property (National Grid 2017 tracking database); condo owners and renters represent one each.

[28] Total number of units (apartments or condominiums) served with at least one electric measure in 2017: 35,034. Preliminary PA estimate, January 29, 2018. Broken out between rental and condo based on MMRP participant buildings in RES 43 database (60% condo, 40% rental). Property managers and rental property owners are assumed to represent a number of units equal to the number of rental units.

[29] Total number of units (apartments or condominiums) in Massachusetts MF buildings (5+ units) per RES 43 database: 506,052. Nonparticipating units are this value less the number of participating units. Property managers and rental property owners are assumed to represent a number of units equal to the number of rental units.

[30] Placeholder value: 2015 reported savings to RES 42 database.

5. CONCLUSIONS AND RECOMMENDATIONS

This study resulted in a series of conclusions for the MMRP. Some of these quantitative, which affect the calculation of program savings, and some qualitative, identifying opportunities for improving program activities. The quantitative and qualitative recommendations from both the impact and NTG portions of this evaluation are discussed in this section.

5.1 Quantitative Recommendations

Finding 1: The vendor-reported common area HOU had no correlation with the logged HOU, as illustrated in Figure 2. The high variance led to low precision on the HOU realization rate. The findings around common area HOU resulted in different recommendations by PA, as the PAs use two separate practices for assigning ex ante common area HOU. Eversource uses space-by-space deemed HOU values as identified in the RES 42 *Preliminary Task 2b and 3 Findings Memo* (March 2017). All other PAs use vendor-reported HOU values, which are customized to the project and space.

> **Recommendation 1.1:** To update the 2017 MMRP common area lighting savings, Eversource should replace its currently used space-by-space deemed HOU values with the updated space-by space deemed HOU results from this study, as reported in Table 13.
>
> **Recommendation 1.2:** To update the 2017 MMRP common area lighting savings, all PAs other than Eversource should apply the found realization rates of 0.91 for interior lighting and 0.98 for exterior lighting to the common area HOU (also reported in Table 12).
>
> **Recommendation 1.3:** For all future program years (2018 and beyond), all PAs should switch to using the space-by-space deemed HOU values reported in Table 13. When the deemed HOU values are applied they should be a accompanied by a HOU realization rate of 1.0.

Finding 2: The evaluation team found ISRs of 1.0 for common areas[31] and 0.88 for in-unit areas (Table 14).

> **Recommendation 2.1:** The PAs should apply the ISRs retroactively to 2017 program savings and proactively to future program savings and planning.

Finding 3: The evaluation team found a FR ratio of 0.21 and a provisional SO ratio of 0.28,[32] resulting in a provisional program-level NTG ratio of 1.07 (Table 15).

[31] The common area ISR found through this study was 1.02, but the evaluation team recommends rounding this value to 1.0 for application to the MMRP savings.

[32] The spillover and therefore NTG ratios presented in this report are provisional. In the final step of the spillover ratio total participant and nonparticipant SO energy savings are divided by the ex post gross 2017 MMRP energy savings. The ex post gross 2017 MMRP energy savings were not available at the time that this report was published, therefore provisional values are provided in this document. The provisional values will be updated when the 2017 MMRP ex post gross energy savings are available.

Recommendation 3.1: The PAs should apply the NTG ratio proactively to future program savings and planning. The program-level NTG ratio identified in this study should be applied to gross electric and fuel savings from all measures in the MMRP.

When combined with the suggested improvement strategies from the RES 42 study, the quantitative recommendations from this study provide a complete recommendation for determining actual lighting savings from the ex ante savings estimates. The combined conclusions of these two studies and their application to the specific lighting variables are presented in Table 34. In addition, the NTG ratio determined through this study should be applied to the total MMRP savings (it is not specific to lighting).

Table 34. Summary of Lighting Savings Recommendations

Variable	Common Area	In-Unit
Delta Watts (ΔW)	Use vendor-reported ΔW *(Recommendation from RES 42)*	Use vendor-reported ΔW *(Recommendation from RES 42)*
Quantity	Apply ISR of 1.0 *(Finding from this study, RES 44)*	Apply ISR of 0.88 *(Finding from this study, RES 44)*
HOU	2017, Eversource: Use deemed HOU (Table 13). 2017, all other PAs: Apply realization rate of 0.91 for interior spaces and 0.9 for exterior spaces. 2018 and beyond, all PAs: Use deemed HOU (Table 13) *(Finding from this study, RES 44)*	Apply 2.2 hours/day from the NERHOU study[33] *(Recommendation from RES 42)*
Occupancy Sensors	NOTE: Occupancy sensor savings should be applied, as stated in the Massachusetts TRM (30% savings) on top of the HOU recommended through this study.	

Source: Navigant analysis from RES 42 and RES 44

5.2 Qualitative Considerations and Recommendations

Finding 4: The evaluation team found that, in general, QA/QC processes had improved for the MMRP since the implementation of the RES 42 suggested improvement strategies, which included providing site-specific locations for lighting installations. However, paperwork used by the implementation vendors to track measure installation still varies tremendously.

Consideration 4.1: The PAs should consider continuing to implement the suggested improvement strategies from the RES 42 study, specifically those that focus on improving data clarity between the implementation and QA/QC vendors.

Consideration 4.2: The PAs should consider encouraging a greater level of consistency in ICs' documentation. This could even go as far as recommending a standard template for all implementation vendors to use. This would increase data clarity and consistency across the PAs.

[33] NMR Group, Inc. (2014) *Northeast Residential Lighting Hours-of-Use Study*.

Finding 5: During the lead vendor interviews, two of the three implementation vendors reported issues with QA/QC inspections occurring while the installation was in progress, before all measures had been installed. The PAs indicate that *in process* QA/QC visits are important to review existing conditions. However, it seems that there is confusion as to what type of visit is supposed to occur and what data is meant to be collected in each instance.

> **Recommendation 5.1:** The PAs should work with the implementation and QA/QC vendors to identify the correct flag in the project database to ensure clarity around whether QA/QC visits can both occur when a project is *in process* and after completion. In addition, the PAs should work with the implementation and QA/QC vendors to clarify what data should be collected at each type of site visit.

Finding 6: The evaluation team found that almost half of renters surveyed, all of whom live in 2017 MMRP participating buildings, did not know that their building had participated in the program.

> **Consideration 6.1:** The PAs should consider facilitating improved outreach from ICs to building residents to continue to increase program awareness. In addition, the PAs should consider opportunities to address the MMRP offering directly to renters, so that they become more active participants in the program.

APPENDIX A. NET-TO-GROSS SURVEY

Survey Introduction

Thank you for taking this survey. The Sponsors of Mass Save® believe that your feedback is a critical part of improving their energy efficiency programs. This survey is being conducted for Mass Save by Navigant, a third-party independent evaluator. We're reaching out to residents and owners of multifamily buildings to get feedback about the energy efficiency of apartments and condominiums in Massachusetts. Your responses will inform program enhancements to better serve multifamily buildings.

The Mass Save Multifamily Program improves the energy efficiency of buildings by installing products such as efficient lighting in multifamily buildings in both common areas (like hallways and mail rooms) and in individual units. The survey is focused on activities in the 2017 calendar year.

We anticipate that the survey should take you no more than 15 minutes to complete. Your answers will be kept anonymous. Upon completing the survey, you will be asked to provide your contact information so that we can send you a $25 gift card as a token of our appreciation for your time.

[PROGRAMMING NOTE: All questions are mandatory, unless otherwise noted.]

Identification

ID0

Please select the option where you have the most responsibility for energy efficiency purchasing decisions::

a) Property Manager
b) Rental Property Owner
c) Condominium Owner
d) Renter

PM IDENTIFICATION QUESTIONS
{IF ID0 = A OR B, ASK SCR1a, OTHERWISE SKIP TO ID1b}

SCR1a

Are you responsible for making decisions on lighting and other equipment at the property/properties you own or manage?

1. Yes {CONTINUE TO ID1a}
2. No {SKIP TO DIFFERENT CONTACT}

ID1a

How many multifamily properties do you own or manage?

Note: Please count a single property with more than one building as "1".
____ [RECORD #]

ID2a

Have any of your properties participated in the Mass Save Multifamily Program?

1. Yes {CONTINUE TO ID3a}
2. No {SKIP TO NPSOSCR1}

ID3a

How recently did any of your properties participate in the Mass Save Multifamily Program?

1. 2017
2. 2016 {SKIP TO NPSOSCR1}
3. 2015 {SKIP TO NPSOSCR1}
4. 2014{SKIP TO NPSOSCR1}
5. 2013 {SKIP TO NPSOSCR1}
6. Before 2013 {SKIP TO NPSOSCR1}

ID4a

How many of your properties participated in the Mass Save Multifamily Program in 2017?

____ [RECORD # PARTICIPATED]

ID5a

What efficient product(s) were installed as part of the Mass Save Multifamily Program in 2017?
NOTE: Common areas include building entrance, hallways, mail rooms, etc.

Note: Select all that apply.

[1=Yes, 2=No, 98=Don't Know]

i. Efficient Lighting (CFLs, LEDs) – in common areas
ii. Efficient Lighting (CFLs, LEDs) – in individual units
iii. Air Sealing & Insulation (window and door sealing, ceiling insulation) – in common areas
iv. Air Sealing & Insulation (window and door sealing, ceiling insulation) – in individual units
v. Products to Conserve Hot Water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in common areas
vi. Products to Conserve Hot Water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in individual units
vii. Heating Systems (Boilers, furnaces)
viii. Domestic Hot Water systems (indirect water heater storage tanks or on-demand systems)
ix. Refrigerators
x. Thermostats (either programmable or 'Smart')

RESIDENT IDENTIFICATION QUESTIONS
RESIDENT (RENTER) SCREENER
{IF ID0 = D, ASK SCR1b, OTHERWISE SKIP TO SCR1c}

SCR1b

Are you the person in your household who usually makes the decisions about lightbulbs and other equipment in your apartment?

1. Yes {CONTINUE TO ID1b}
2. No {SKIP TO DIFFERENT CONTACT}

RESIDENT (CONDO OWNER) SCREENER
{IF ID0 = C, ASK SCR1c, OTHERWISE SKIP TO ID1b}

SCR1c

Are you the person who usually makes the decisions about lightbulbs and equipment for your condominium?

1. Yes {CONTINUE TO ID1b}
2. No {SKIP TO DIFFERENT CONTACT}

{IF ID0 = C OR D, ASK ID1b, OTHERWISE SKIP TO PC1a}

ID1b

The Mass Save Multifamily Program improves the efficiency of buildings by installing products such as efficient lighting in multifamily buildings in both common areas (like hallways and mail rooms) and in individual units. Did your building participate in the Mass Save Multifamily Program in 2017?

1 Yes
2 No {IF ID0 = C, SKIP TO NPSOSCR1} {IF ID0 = D, SKIP TO THANK AND CLOSE}

RESIDENT (RENTER)-ONLY
{IF ID0 = D, ASK ID2b, OTHERWISE SKIP TO ID2c}

ID2b

Was efficient lighting (CFLs, LEDs) installed in your unit as part of the Mass Save Multifamily Program?

1 Yes
2 No {SKIP TO NPSOSCR1}

CONDO OWNER-ONLY

ID2c

What efficient product(s) were installed in your condominium unit as part of the Mass Save Multifamily Program?

Note: Select all that apply.

[1=Yes, 2=No, 98=Don't Know]

i. Efficient Lighting (CFLs, LEDs)
ii. Air Sealing & Insulation (window and door sealing, ceiling insulation)
iii. Products to Conserve Hot Water (low-flow showerheads, aerators, pipe insulation, efficient water heaters)

Free-Ridership

{IF ID3a=1 OR ID2b=1 OR ID2ci-iii =1, ASK PC1a, OTHERWISE SKIP TO NPSOSCR1}

PM & CONDO OWNER QUESTION
{IF ID0 = A OR B OR C, ASK PC1a, OTHERWISE SKIP TO PC1b}

PC1a

Please rate the importance of each factor that may have influenced your decision to have energy efficient product(s) installed at this property through the Mass Save Multifamily program.

Note: Please use a scale from 0 to 10 where 0 means "not at all important" and 10 means "extremely important".

[SCALE of 0-10; 96=Not Applicable, 98=Don't Know]

i. The free lighting products
ii. The rebates for other energy efficiency improvements
iii. Recommendations from the auditor/contractor/Mass Save representative
iv. Information from the Mass Save Multifamily program or other marketing materials
v. The no-cost project management and installation
vi. Recommendation from someone else who participated
vii. Recommendation from professional association

RESIDENT (RENTER) QUESTION
{IF ID0 = D, ASK PC1b, OTHERWISE SKIP TO PI1}

PC1b

Please rate the importance of each factor that may have influenced your decision to have energy efficient products installed in your apartment.

Note: Please use a scale from 0 to 10 where 0 means "not at all important" and 10 means "extremely important".

[SCALE of 0-10; 96=Not Applicable, 98=Don't Know]

i. The free light bulbs
ii. Recommendations from Mass Save Multifamily Program
iii. Information from the Mass Save Multifamily Program or other marketing materials
iv. The no-cost installation
v. Recommendation from someone else who participated
vi. Recommendation from the landlord / property owner

PI1

How likely is it that you would have had the efficient product(s) installed if the Mass Save Multifamily Program did not exist?

Note: Please use a scale that ranges from 0 to 10, where 0 is "not at all likely" and 10 is "extremely likely".

[PROGRAMMING NOTE: All measures relevant to the survey respondent will be shown on a single page. A numerical entry will be available for each measure so that the respondent can enter 0-10 for each measure.]

[RECORD 0 to 10; 98=Don't know]

i. {IF ID5ai=1} Efficient Lighting (CFLs, LEDs, lighting controls) – in common areas (entrance, hallway, mail room, etc.)
ii. {IF ID5aii=1} Efficient Lighting (CFLs, LEDs) – in individual units
iii. {IF ID5aiii=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) – in common areas (entrance, hallway, mail room, etc.)
iv. {IF ID5aiv=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) – in individual units
v. {IF ID5av=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in common areas (entrance, hallway, mail room, etc.)
vi. {IF ID5avi=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in individual units
vii. {IF ID5avii=1} Heating Systems (Boilers, furnaces)
viii. {IF ID5aviii=1} Domestic Hot Water systems (indirect water heater storage tanks or on-demand systems)
ix. {IF ID5aix=1} Refrigerators
x. {IF ID5ax=1} Thermostats (either programmable or 'Smart')
xi. {IF ID2b=1} Efficient Lighting (CFLs, LEDs) in your apartment
xii. {IF ID2ci=1} Efficient Lighting (CFLs, LEDs) in your condominium
xiii. {IF ID2cii=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) in your condominium
xiv. {IF ID2ciii=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) in your condominium

PT1

Did the Mass Save Multifamily Program cause you to have any efficient product(s) installed sooner than if the program did not exist?

1. (Yes, installed sooner than planned)
2. (No, did not change timing of installation)
88. Other, please describe: _____
98. (Don't know)

PM & CONDO OWNER QUESTION
{IF ID0 = A OR B OR C AND IF PT1=1, ASK PT2a, OTHERWISE SKIP TO PT2b}

PT2a

If the Mass Save Multifamily program did not exist, what is the likelihood that you would have installed these energy efficient products within 6 months?

[PROGRAMMING NOTE: 0-10 scale for measures below, 0 is "Not at all", 10 is "Extremely Likely".]

i. {IF ID5ai=1} Efficient Lighting (CFLs, LEDs, lighting controls) – in common areas (entrance, hallway, mail room, etc.)
ii. {IF ID5aii=1} Efficient Lighting (CFLs, LEDs) – in individual units
iii. {IF ID5aiii=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) – in common areas (entrance, hallway, mail room, etc.)
iv. {IF ID5aiv=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) – in individual units
v. {IF ID5av=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in common areas (entrance, hallway, mail room, etc.)
vi. {IF ID5avi=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in individual units
vii. {IF ID5avii=1} Heating Systems (Boilers, furnaces)
viii. {IF ID5aviii=1} Domestic Hot Water systems (indirect water heater storage tanks or on-demand systems)
ix. {IF ID5aix=1} Refrigerators
x. {IF ID5ax=1} Thermostats (either programmable or 'Smart')
xi. {IF ID2b=1} Efficient Lighting (CFLs, LEDs) in your apartment
xii. {IF ID2ci=1} Efficient Lighting (CFLs, LEDs) in your condominium
xiii. {IF ID2cii=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) in your condominium
xiv. {IF ID2ciii=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) in your condominium

RESIDENT (RENTER) QUESTION
{IF ID0 = D AND IF PT1=1, ASK PT2b, OTHERWISE SKIP TO PI2}

PT2b

If the Mass Save Multifamily program did not exist, what is the likelihood that you would have installed the efficient lighting in your unit within 6 months?

[PROGRAMMING NOTE: 0-10 scale, 0 is "Not at all", 10 is Extremely Likely".]
[RECORD #]

PI2

Did the Mass Save Multifamily Program cause you to have more efficient products installed than you would have if the program did not exist?

[PROGRAMMING NOTE: All measures relevant to the survey respondent will be shown on a single page. Check boxes will be available for each measure so that the respondent can select "Yes", "No", or "Don't know".]

[1=Yes, 2=No, 98=Don't Know]

i. {IF ID5ai=1} Efficient Lighting (CFLs, LEDs, lighting controls) – in common areas (entrance, hallway, mail room, etc.)
ii. {IF ID5aii=1} Efficient Lighting (CFLs, LEDs) – in individual units
iii. {IF ID5aiii=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) – in common areas (entrance, hallway, mail room, etc.)
iv. {IF ID5aiv=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) – in individual units
v. {IF ID5av=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in common areas (entrance, hallway, mail room, etc.)
vi. {IF ID5avi=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in individual units
vii. {IF ID5avii=1} Heating Systems (Boilers, furnaces)
viii. {IF ID5aviii=1} Domestic Hot Water systems (indirect water heater storage tanks or on-demand systems)
ix. {IF ID5aix=1} Refrigerators
x. {IF ID5ax=1} Thermostats (either programmable or 'Smart')
xi. {IF ID2b=1} Efficient Lighting (CFLs, LEDs) in your apartment
xii. {IF ID2ci=1} Efficient Lighting (CFLs, LEDs) in your condominium
xiii. {IF ID2cii=1} Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) in your condominium
xiv. {IF ID2ciii=1} Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) in your condominium

{IF PI2i-xiv=1, ASK PI3, OTHERWISE SKIP TO **Error! Reference source not found.**}

PI3

What percentage of the efficient product(s) installed by the Mass Save Multifamily Program would you have had installed in 2017 if the Mass Save Multifamily Program did not exist?

Note: Please enter the number you would have installed as a 1-100 percentage of the efficient product(s) that were installed through the program.

[PROGRAMMING NOTE: All measures relevant to the survey respondent will be shown on a single page. A numerical entry will be available for each measure so that the respondent can enter 0-10 for each measure.]

[___ ENTER PERCENTAGE]

i. {IF ID5ai=1} % of the Efficient Lighting (CFLs, LEDs, lighting controls) – in common areas (entrance, hallway, mail room, etc.)
ii. {IF ID5aii=1} % of the Efficient Lighting (CFLs, LEDs) – in individual units
iii. {IF ID5aiii=1} % of the Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) – in common areas (entrance, hallway, mail room, etc.)
iv. {IF ID5aiv=1} % of the Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) – in individual units
v. {IF ID5av=1} % of the Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in common areas (entrance, hallway, mail room, etc.)

vi. {IF ID5avi=1} % of the Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) – in individual units
vii. {IF ID5avii=1} % of the Heating Systems (Boilers, furnaces)
viii. {IF ID5aviii=1} % of the Domestic Hot Water systems (indirect water heater storage tanks or on-demand systems)
ix. {IF ID5aix=1} % of the Refrigerators
x. {IF ID5ax=1} % of the Thermostats (either programmable or 'Smart')
xi. {IF ID2b=1} % of the Efficient Lighting (CFLs, LEDs) in your apartment
xii. {IF ID2ci=1} % of the Efficient Lighting (CFLs, LEDs) in your condominium
xiii. {IF ID2cii=1} % of the Air Sealing & Insulation (window and door sealing, wall or ceiling insulation) in your condominium
xiv. {IF ID2ciii=1} % of the Products to conserve hot water (low-flow showerheads, aerators, pipe insulation, efficient water heaters) in your condominium

Spillover

{IF ID3a= 1 OR ID2b=1 OR ID2ci-iii =1, ASK PSOSCR1 ,OTHERWISE SKIP TO NPSOSCR1}

PSOSCR1

As a result of your buildings' participation with the Mass Save Multifamily Program, have you installed any ADDITIONAL energy efficient products for which you did not receive a Mass Save incentive in 2017?

[{IF ID0 = A OR B} Note: This does not include actions that your tenants may have taken through the program. Please answer only for properties in Massachusetts.]

1. Yes
2. No {SKIP TO REWARD}

PMs WITH NO PARTICIPATING BUILDINGS: {IF ID0 = A OR B AND ID3a = 2, ASK NPSOSCR1, OTHERWISE SKIP TO SO1}

NON-PARTICIPATING CONDO OWNERS: {IF ID0 = C AND ID2b = 2, ASK NPSOSCR1, OTHERWISE SKIP TO SO1}

NPSOSCR1

Are you aware of the Mass Save Multifamily Program?

1. Yes
2. No {SKIP TO THANK AND CLOSE}

PM & CONDO OWNER QUESTION

{IF NPSOSCR1=1 AND ID0 = A OR B OR C, ASK NPSOSCR2a, OTHERWISE SKIP TO NPSOSCR2b}

NPSOSCR2a

Have you made any energy efficiency improvements in your building common spaces or individual units in 2017 for which you did not receive a Mass Save incentive in 2017? This could include for example, weatherization improvements or having efficient lighting or other efficient equipment installed?

1. Yes
2. No {SKIP TO THANK AND CLOSE}

RESIDENT (RENTER) QUESTION

{IF NPSOSCR1=1 AND ID0 = D, ASK NPSOSCR2b, OTHERWISE SKIP TO SO1}

NPSOSCR2b

Have you made any energy efficiency improvements in your apartment in the past year? (for example, install CFL or LED lightbulbs or other efficient equipment)

1. Yes
2. No {SKIP TO THANK AND CLOSE}

{IF (ID3a= 1 OR ID2b=1 OR ID2ci-iii =1) AND PSOSCR1=1, ASK SO1, OTHERWISE SKIP TO REWARD}
{IF (ID0 = A OR B AND ID3a = 2) OR (IF ID0 = C AND ID2b = 2) AND (NPSOSCR2a=1 OR NPSOSCR2b=1), ASK SO1, OTHERWISE SKIP TO THANK AND CLOSE}

SO1

What additional energy efficient products did you install for which you **did not** receive a Mass Save incentive?

Note: Please select at least one option. Select all that apply.

[{IF ID0 = A OR B} Note: If you're a property owner or manager, note this does not include actions that your tenants may have taken through the program. Please answer only for properties in Massachusetts.]

[1=Yes, 2=No]

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns for each of the 29 measures listed below. These 4 columns will each provide a checkbox toggle. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

i. Compact Fluorescent Lighting
ii. LED Lighting
iii. Clothes Washer
iv. Electric Clothes Dryer
v. Gas Clothes Dryer
vi. Low Flow Faucet Aerator
vii. Low Flow Showerhead
viii. Programmable Thermostat
ix. Smart Strip Plug Outlet
x. Refrigerator
xi. Freezer
xii. Other Kitchen Appliance
xiii. Dishwasher
xiv. Dehumidifier
xv. Television
xvi. Energy Star Office Equipment (computer, fax, copier, scanner, printer)
xvii. {IF ID0 = A OR B OR C} Central A/C
xviii. {IF ID0 = A OR B OR C} Furnace
xix. {IF ID0 = A OR B OR C} Boiler
xx. {IF ID0 = A OR B OR C} Air Source Heat Pump
xxi. {IF ID0 = A OR B OR C} Electric Water Heater
xxii. {IF ID0 = A OR B OR C} Gas Water Heater
xxiii. {IF ID0 = A OR B OR C} Solar Water Heater
xxiv. {IF ID0 = A OR B OR C} Heat Pump Water Heater
xxv. {IF ID0 = A OR B OR C} Whole House Fan
xxvi. {IF ID0 = A OR B OR C} Insulation
xxvii. {IF ID0 = A OR B OR C} Windows

xxviii. {IF ID0 = A OR B OR C} Doors
xxix. {IF ID0 = A OR B} Energy management or control systems
xxx. Other, please describe: _____

{IF SO1ii=1, ASK SOUL1, OTHERWISE SKIP TO AS1}

SOUL1

What store(s) did you purchase your efficient lightbulbs from, and how many bulbs did you actually install from each store?

Note: Please select all that apply.
[PROGRAMMING NOTE: Please allow respondents to select any of the 16 stores listed below. If they do select the store, please add another column in which they should enter an integer.]

i. Ace Hardware
ii. Aubuchon Hardware
iii. BJ's Wholesale
iv. Costco
v. Dollar General
vi. Dollar Tree
ii. Home Depot
iii. Lowes
iv. Staples
v. Stop & Shop
vi. Target
vii. True Value
viii. Walgreens
ix. Walmart
x. Wegman's
xi. Whole Foods
xii. Other Store _____
xiii. Other Store _____
xiv. Other Store _____

AS1

How influential, if at all, was the Mass Save Multifamily Program in your decision to install these efficient product(s) for which you did not receive an incentive?

Note: Please use a scale that ranges from 0 to 10 where 0 indicates "not at all influential" and 10 indicates "extremely influential".

[RECORD 0-10; 98=Don't Know]

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns for each of the 29 measures listed below. These 4 columns will each provide a checkbox toggle. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

i. {IF SO1i=1} Compact Fluorescent Lighting
ii. {IF SO1ii=1} LED Lighting
iii. {IF SO1iii=1} Clothes Washer
iv. {IF SO1iv=1} Electric Clothes Dryer
v. {IF SO1v=1} Gas Clothes Dryer
vi. {IF SO1vi=1} Low Flow Faucet Aerator

vii. {IF SO1vii=1} Low Flow Showerhead
viii. {IF SO1viii=1} Programmable Thermostat
ix. {IF SO1ix=1} Smart Strip Plug Outlet
x. {IF SO1x=1} Refrigerator
xi. {IF SO1xi=1} Freezer
xii. {IF SO1xii=1} Other Kitchen Appliance
xiii. {IF SO1xiii=1} Dishwasher
xiv. {IF SO1xiv=1} Dehumidifier
xv. {IF SO1xv=1} Television
xvi. {IF SO1xvi=1} Energy Star Office Equipment (computer, fax, copier, scanner, printer)
xvii. {IF ID0 = A OR B OR C} AND {IF SO1xvii=1} Central A/C
xviii. {IF ID0 = A OR B OR C} AND {IF SO1xviii=1} Furnace
xix. {IF ID0 = A OR B OR C} AND {IF SO1xix=1} Boiler
xx. {IF ID0 = A OR B OR C} AND {IF SO1xx=1} Air Source Heat Pump
xxi. {IF ID0 = A OR B OR C} AND {IF SO1xxi=1} Electric Water Heater
xxii. {IF ID0 = A OR B OR C} AND {IF SO1xxii=1} Gas Water Heater
xxiii. {IF ID0 = A OR B OR C} AND {IF SO1xxiii=1} Solar Water Heater
xxiv. {IF ID0 = A OR B OR C} AND {IF SO1xxiv=1} Heat Pump Water Heater
xxv. {IF ID0 = A OR B OR C} AND {IF SO1xxv=1} Whole House Fan
xxvi. {IF ID0 = A OR B OR C} AND {IF SO1xxvi=1} Insulation
xxvii. {IF ID0 = A OR B OR C} AND {IF SO1xxvii=1} Windows
xxviii. {IF ID0 = A OR B OR C} AND {IF SO1xxviii=1} Doors
xxix. {IF ID0 = A OR B} AND {IF SO1xxix=1} Energy management or control systems
xxx. {IF SO1xxx=1} Other, please describe: _____

NPAS2

How influential were the following additional factors on your decision to install the efficient equipment for which you did not receive an incentive?

Note: Please rate on a scale of 0-10 where 0 is “not at all influential” and 10 is “extremely influential”.

[RECORD RESPONSE 0-10 FOR SUB-QUESTIONS A-F]

a) {IF ID1b = 1} Your building’s decision to participate in the Mass Save Multifamily Program
b) Recommendations you received from a contractor who referenced the Mass Save Multifamily Program recommendations
c) Recommendations you received from a retailer
d) Recommendations you received from a friend whose building participated in the Mass Save Multifamily Program
e) Personal experience with a previous Mass Save rebate program
f) Other, please describe: _____ [RECORD FACTOR & SCORE 0-10]

AS3

If the Mass Save Multifamily Program did not exist, how likely is it that you still would have installed the efficient product(s)for which you did not receive an incentive within the last year?

Note: Please use a scale that ranges from 0 to 10 where 0 indicates “not at all likely” and 10 indicates “extremely likely”

[RECORD 0-10; 98=Don’t Know]

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns for each of the 29 measures listed below. These 4 columns will each provide a checkbox toggle. The 4 columns will be labeled as

follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

i. {IF SO1i=1} CFLs
ii. {IF SO1ii=1} LED Lighting
iii. {IF SO1iii=1} Clothes Washer
iv. {IF SO1iv=1} Electric Clothes Dryer
v. {IF SO1v=1} Gas Clothes Dryer
vi. {IF SO1vi=1} Low Flow Faucet Aerator
vii. {IF SO1vii=1} Low Flow Showerhead
viii. {IF SO1viii=1} Programmable Thermostat
ix. {IF SO1ix=1} Smart Strip Plug Outlet
x. {IF SO1x=1} Refrigerator
xi. {IF SO1xi=1} Freezer
xii. {IF SO1xii=1} Other Kitchen Appliance
xiii. {IF SO1xiii=1} Dishwasher
xiv. {IF SO1xiv=1} Dehumidifier
xv. {IF SO1xv=1} Television
xvi. {IF SO1xvi=1} Energy Star Office Equipment (computer, fax, copier, scanner, printer)
xvii. {IF ID0 = A OR B OR C} AND {IF SO1xvii=1} Central A/C
xviii. {IF ID0 = A OR B OR C} AND {IF SO1xviii=1} Furnace
xix. {IF ID0 = A OR B OR C} AND {IF SO1xix=1} Boiler
xx. {IF ID0 = A OR B OR C} AND {IF SO1xx=1} Air Source Heat Pump
xxi. {IF ID0 = A OR B OR C} AND {IF SO1xxi=1} Electric Water Heater
xxii. {IF ID0 = A OR B OR C} AND {IF SO1xxii=1} Gas Water Heater
xxiii. {IF ID0 = A OR B OR C} AND {IF SO1xxiii=1} Solar Water Heater
xxiv. {IF ID0 = A OR B OR C} AND {IF SO1xxiv=1} Heat Pump Water Heater
xxv. {IF ID0 = A OR B OR C} AND {IF SO1xxv=1} Whole House Fan
xxvi. {IF ID0 = A OR B OR C} AND {IF SO1xxvi=1} Insulation
xxvii. {IF ID0 = A OR B OR C} AND {IF SO1xxvii=1} Windows
xxviii. {IF ID0 = A OR B OR C} AND {IF SO1xxviii=1} Doors
xxix. {IF ID0 = A OR B} AND {IF SO1xxix=1} Energy management or control systems
xxx. {IF SO1xxx=1} Other, please describe: _____

SOSCR3

How did you know that the product(s) you installed were energy efficient?

Note: Select all that apply

[PROGRAMMING NOTE: Please allow respondents to select all that apply (1-98) for each of the measures i-xxx.]

1. Efficiency rating or label of equipment, such as an “ENERGY STAR®” logo
2. Equipment dealer/retailer said it was energy efficient
3. Personal experience
4. Met utility rebate requirements
5. Third party report, such as Consumer Reports
6. Recommendations from the contractor/installer
7. Did not rely on any specific type of information
8. Internet/website
9. Other, please describe: _____

99. DON'T KNOW]

i. {IF SO1i=1} Compact Fluorescent Lighting
ii. {IF SO1ii=1} LED Lighting
iii. {IF SO1iii=1} Clothes Washer
iv. {IF SO1iv=1} Electric Clothes Dryer
v. {IF SO1v=1} Gas Clothes Dryer
vi. {IF SO1vi=1} Low Flow Faucet Aerator
vii. {IF SO1vii=1} Low Flow Showerhead
viii. {IF SO1viii=1} Programmable Thermostat
ix. {IF SO1ix=1} Smart Strip Plug Outlet
x. {IF SO1x=1} Refrigerator
xi. {IF SO1xi=1} Freezer
xii. {IF SO1xii=1} Other Kitchen Appliance
xiii. {IF SO1xiii=1} Dishwasher
xiv. {IF SO1xiv=1} Dehumidifier
xv. {IF SO1xv=1} Television
xvi. {IF SO1xvi=1} Energy Star Office Equipment (computer, fax, copier, scanner, printer)
xvii. {IF ID0 = A OR B OR C} AND {IF SO1xvii=1} Central A/C
xviii. {IF ID0 = A OR B OR C} AND {IF SO1xviii=1} Furnace
xix. {IF ID0 = A OR B OR C} AND {IF SO1xix=1} Boiler
xx. {IF ID0 = A OR B OR C} AND {IF SO1xx=1} Air Source Heat Pump
xxi. {IF ID0 = A OR B OR C} AND {IF SO1xxi=1} Electric Water Heater
xxii. {IF ID0 = A OR B OR C} AND {IF SO1xxii=1} Gas Water Heater
xxiii. {IF ID0 = A OR B OR C} AND {IF SO1xxiii=1} Solar Water Heater
xxiv. {IF ID0 = A OR B OR C} AND {IF SO1xxiv=1} Heat Pump Water Heater
xxv. {IF ID0 = A OR B OR C} AND {IF SO1xxv=1} Whole House Fan
xxvi. {IF ID0 = A OR B OR C} AND {IF SO1xxvi=1} Insulation
xxvii. {IF ID0 = A OR B OR C} AND {IF SO1xxvii=1} Windows
xxviii. {IF ID0 = A OR B OR C} AND {IF SO1xxviii=1} Doors
xxix. {IF ID0 = A OR B} AND {IF SO1xxix=1} Energy management or control systems
xxx. {IF SO1xxx=1} Other, please describe: _____

{IF ANY OF SOSCR3i-xxx=1-88, ASK SO2, OTHERWISE SKIP TO THANK AND CLOSE}

SO2

How many of the efficient product(s) were installed?

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns for each of the 29 measures listed below. These 4 columns will each provide a checkbox toggle. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

i. {IF SO1i=1} Compact Fluorescent Lighting
ii. {IF SO1ii=1} LED Lighting
iii. {IF SO1iii=1} Clothes Washer
iv. {IF SO1iv=1} Electric Clothes Dryer
v. {IF SO1v=1} Gas Clothes Dryer
vi. {IF SO1vi=1} Low Flow Faucet Aerator
vii. {IF SO1vii=1} Low Flow Showerhead

viii. {IF SO1viii=1} Programmable Thermostat
ix. {IF SO1ix=1} Smart Strip Plug Outlet
x. {IF SO1x=1} Refrigerator
xi. {IF SO1xi=1} Freezer
xii. {IF SO1xii=1} Other Kitchen Appliance
xiii. {IF SO1xiii=1} Dishwasher
xiv. {IF SO1xiv=1} Dehumidifier
xv. {IF SO1xv=1} Television
xvi. {IF SO1xvi=1} Energy Star Office Equipment (computer, fax, copier, scanner, printer)
xvii. {IF ID0 = A OR B OR C} AND {IF SO1xvii=1} Central A/C
xviii. {IF ID0 = A OR B OR C} AND {IF SO1xviii=1} Furnace
xix. {IF ID0 = A OR B OR C} AND {IF SO1xix=1} Boiler
xx. {IF ID0 = A OR B OR C} AND {IF SO1xx=1} Air Source Heat Pump
xxi. {IF ID0 = A OR B OR C} AND {IF SO1xxi=1} Electric Water Heater
xxii. {IF ID0 = A OR B OR C} AND {IF SO1xxii=1} Gas Water Heater
xxiii. {IF ID0 = A OR B OR C} AND {IF SO1xxiii=1} Solar Water Heater
xxiv. {IF ID0 = A OR B OR C} AND {IF SO1xxiv=1} Heat Pump Water Heater
xxv. {IF ID0 = A OR B OR C} AND {IF SO1xxv=1} Whole House Fan
xxvi. {IF ID0 = A OR B OR C} AND {IF SO1xxvi=1} Insulation (how many individual units or common areas were insulated?)
xxvii. {IF ID0 = A OR B OR C} AND {IF SO1xxvii=1} Windows
xxviii. {IF ID0 = A OR B OR C} AND {IF SO1xxviii=1} Doors
xxix. {IF ID0 = A OR B} AND {IF SO1xxix=1} Energy management or control systems
xxx. {IF SO1xxx=1} Other, please describe: _____

{IF SO1iii=1 OR SO1vi=1 OR SO1vii=1 OR SO1xiii OR SO1xxix=1, ASK SO3, OTHERWISE SKIP TO SO4}

SO3

What fuel heats the domestic hot water?

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns that have a dropdown including the items below. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

a) Electricity
b) Natural gas
c) Propane gas
d) Fuel Oil
e) Don't Know
f) N/A

{IF (SO1xxi=1 OR SO1xxii=1 OR SO1xxiii=1 OR SO1xxiv=1, ASK SO4, OTHERWISE SKIP TO SO5}

SO4

What type of water heater(s) did the new water heater(s) replace?

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns that have a dropdown including the items below. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

a) Electric Water Heater
b) Gas Water Heater

c) Solar Water Heater
d) Heat Pump Water Heater
e) Don't Know

{IF (SO1viii=1 OR SO1xviii=1 OR SO1xix=1 OR SO1xxvi=1 OR SO1xxvii=1 OR SO1xxviii=1 OR SO1xxix=1), ASK SO5, OTHERWISE SKIP TO SO6}

SO5

You indicated you've installed products such as new thermostats, windows, doors, or insulation. What fuel heats the space(s) where those improvements were made?

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns that have a dropdown including the items below. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

a) Electricity
b) Natural gas
c) Propane gas
d) Fuel Oil
e) Don't Know

{IF (SO1xvii=1, ASK SO6, OTHERWISE SKIP TO SO7}

SO6

Approximately how many square feet of windows were installed?

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns that allow for a numerical entry. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

i. [ENTER #]

{IF (SO1xviii=1, ASK SO7, OTHERWISE SKIP TO SO8}

SO7

How many exterior doors were installed?

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns that allow for a numerical entry. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

i. [ENTER #]

{IF (SO1xxvi=1, ASK SO8, OTHERWISE SKIP TO SO9}

SO8

Approximately how many square feet of insulation were installed in each location?

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns that allow for a numerical entry. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units.]

[ENTER # for each location]

i) Living space or common space walls
ii) Ceilings or attics
iii) Basement walls

{IF ID0 = C}
{IF (SO1iii=1 OR SO1vi=1 OR SO1vii=1 OR SO1xiii=1 OR SO1xxi=1 OR SO1xxiii=1 OR SO1xxiii=1 OR SO1xxiv=1, ASK SO9, OTHERWISE SKIP TO SO10}

SO9

How many bedrooms are in your condominium?

i. [ENTER #]

{IF (SO1viii=1, ASK SO10, OTHERWISE SKIP TO SO11}

SO10

What does the programmable thermostat you installed control?

Note: Select all that apply.

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns that have a dropdown including the items below. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

a) Heating
b) Air conditioning
c) Both Heating and air conditioning
d) Don't Know

{IF (SO1xxix=1, ASK SO11, OTHERWISE SKIP TO SO12}

SO11

What is controlled by the EMS or control system you installed?

Note: Select all that apply.

[PROGRAMMING NOTE: if ID0 = A OR B, display 2 columns that have a dropdown including the items below. The 4 columns will be labeled as follows: Participating buildings – common areas, Non-Participating buildings – common areas]

a) Heating
b) Air conditioning
c) Both Heating and air conditioning
d) Other _____
e) Don't Know

{IF ID0 = A OR B}
{IF (SO1iii=1 OR SO1vi=1 OR SO1vii=1 OR SO1xiii=1 OR SO1xxi=1 OR SO1xxii=1 OR SO1xxiii=1 OR SO1xxiv=1), ASK SO12, OTHERWISE SKIP TO SO13}

SO12

If the domestic hot water system installed in the common area serves individual apartments, how many bedrooms (total) are in the apartments affected by water conservation improvements and/or water heater improvements?

[PROGRAMMING NOTE: if ID0 = A OR B, display 4 columns that allow for a numerical entry. The 4 columns will be labeled as follows: Participating buildings – common areas, Participating buildings – in individual units, Non-Participating buildings – common areas, Non-Participating buildings – in individual units]

i. [ENTER #]

{IF ID0 = A OR B}

{IF (SO1iii=1 OR SO1iv=1 OR SO1v=1 OR SO1xvii=1 OR SO1xviii=1 OR SO1xix=1 OR SO1xx=1 OR SO1xxi=1 OR SO1xxii=1 OR SO1xxiii=1 OR SO1xxiv=1 OR SO1xxix=1), ASK SO13, OTHERWISE SKIP TO SO14}

SO13

How many apartments are in the buildings where these products were installed?

[PROGRAMMING NOTE: if ID0 = A OR B, display 2 columns that allow for a text entry. The 2 columns will be labeled as follows: Participating buildings, Non-Participating buildings]

i. {IF SO1iii=1} Clothes Washer
ii. {IF SO1iv=1} Electric Clothes Dryer
iii. {IF SO1v=1} Gas Clothes Dryer
iv. {IF SO1xvii=1} Central A/C
v. {IF SO1xviii=1} Furnace
vi. {IF SO1xix=1} Boiler
vii. {IF SO1xx=1} Air Source Heat Pump
viii. {IF SO1xxi=1} Electric Water Heater
ix. {IF SO1xxii=1} Gas Water Heater
x. {IF SO1xxiii=1} Solar Water Heater
xi. {IF SO1xxiv=1} Heat Pump Water Heater
xii. {IF SO1xxix=1} Energy management or control systems
xiii.

{IF ID0 = A OR B}

{IF (SO1iii=1 OR SO1iv=1 OR SO1v=1, ASK SO14, OTHERWISE SKIP TO SO15}

SO14

If the efficient laundry equipment was installed in a common laundry room, how many appliances including the new appliances just installed, serve the entire building?

[PROGRAMMING NOTE: if ID0 = A OR B, display 3 columns that allow for a numerical entry. The 3 columns will be labeled as follows: Participating buildings – common areas, , Non-Participating buildings – common areas,. Appliances not installed in common laundry. Rows will display SO1iii, SO1iv, or SO1v, corresponding to a '1' selection.]

i. {IF SO1iii =1} Clothes Washer
ii. {IF SO1iv =1} Electric Clothes Dryer
iii. {IF SO1v =1} Gas Clothes Dryer

{IF ID0 = A OR B}

{IF (SO1xvii=1 OR SO1xviii=1 OR SO1xix=1 OR SO1xx=1 OR SO1xxi=1 OR SO1xxii=1 OR SO1xxiii=1 OR SO1xxiv=1 OR SO1xxix=1), ASK SO15, OTHERWISE SKIP TO REWARD}

SO15

If any of the following energy efficient improvements were installed in individual apartments, how many apartments were impacted?

[PROGRAMMING NOTE: if ID0 = A OR B, display 2 columns that allow for a numerical entry. The 2 columns will be labeled as follows: Participating buildings, Non-Participating buildings]

i. {IF SO1iii=1} Clothes Washer
ii. {IF SO1iv=1} Electric Clothes Dryer
iii. {IF SO1v=1} Gas Clothes Dryer
iv. {IF SO1viii=1} Programmable Thermostat
v. {IF ID0 = A OR B OR C} AND {IF SO1xvii=1} Central A/C
vi. {IF ID0 = A OR B OR C} AND {IF SO1xviii=1} Furnace

vii. {IF ID0 = A OR B OR C} AND {IF SO1xix=1} Boiler
viii. {IF ID0 = A OR B OR C} AND {IF SO1xx=1} Air Source Heat Pump
ix. {IF ID0 = A OR B OR C} AND {IF SO1xxi=1} Electric Water Heater
x. {IF ID0 = A OR B OR C} AND {IF SO1xxii=1} Gas Water Heater
xi. {IF ID0 = A OR B OR C} AND {IF SO1xxiii=1} Solar Water Heater
xii. {IF ID0 = A OR B OR C} AND {IF SO1xxiv=1} Heat Pump Water Heater
xiii. {IF ID0 = A OR B OR C} AND {IF SO1xxv=1} Whole House Fan
xiv. {IF ID0 = A OR B OR C} AND {IF SO1xxvi=1} Insulation (how many individual units or common areas were insulated?)
xv. {IF ID0 = A OR B OR C} AND {IF SO1xxviii=1} Doors
xvi. {IF ID0 = A OR B} AND {IF SO1xxix=1} Energy management or control systems
xvii. {IF SO1xxx=1} Other, please describe: _____

{IF (SO1ii=1, ASK SO16, OTHERWISE SKIP TO SO19}

SO16

If the LEDs you purchased cost $3.50 more each, do you think you would have:

1. Purchased the same number of bulb(s) {SKIP TO SO19}
2. Purchased fewer bulbs {SKIP TO SO18}
3. Purchased no bulbs {SKIP TO SO19}
4. Purchased a different type of bulb {CONTINUE TO SO17}

8. Other: (specify)

SO17

Which type of bulb would you have selected instead?

1 Traditional Incandescent
2 Halogen
3 CFLs
4 LED
5 Energy Saving Incandescent
8. Other: _____

SO18

How many bulbs would you have purchased if the LEDs you purchased had cost $3.50 more each?

[RECORD #]

SO19

If incentives were available for the products you installed, why didn't you receive incentives?

[OPEN-ENDED]

Survey Close Out

DIFFERENT CONTACT

[PROGRAMMING NOTE: This question is optional.]

Thank you for your responses. This survey must be completed by someone who is responsible for energy decisions. Can you please provide the contact information (email address) for the person or people who were involved with the decision-making process?

_____ Name, Email address 1
_____ Name, Email address 2

REWARD

[PROGRAMMING NOTE: This question is optional.]

Thank you for completing the survey. The Sponsors of Mass Save value your feedback and appreciate your time. To receive your $25 gift card, please enter your contact information here. The gift card will be emailed to you within 3-4 weeks.

_____ Name
_____ Email address

{IF ID0 ENTERED IDENTIFIES A PARTICIPATING RENTER OR CONDO OWNER OR ID2b=1 OR ID2ci-iii =1, ASK RESIDENT ADDITIONAL REWARD 1, OTHERWISE SKIP TO FOLLOW-UP}

RESIDENT ADDITIONAL REWARD 1

Our team is conducting in-home site visits to review lighting installed in condos and apartment units. The site visit will take 10-15 minutes and you will receive an additional $10 gift card for your participation. If selected, our team would contact you to set up a date and time to visit your home. Would you be willing to participate in a site visit?

i. Yes
ii. No

{IF RESIDENT ADDITIONAL REWARD 1=YES, ASK RESIDENT ADDITIONAL REWARD 2, OTHERWISE SKIP TO FOLLOW-UP}

RESIDENT ADDITIONAL REWARD 2

Thank you for indicating that you would be willing to participate in a 15-minute site visit. To assist us, please enter your physical address below.

_____ } Please enter your physical address (including unit or apartment number)
(Phone/Email)_ Please select your preferred method of being contacted.

FOLLOW-UP

Would it be ok for a survey team representative to contact you with any follow-up questions?

1. Yes
2. No

THANK AND CLOSE

Thank you for your responses.

APPENDIX B. LEAD VENDOR INTERVIEW GUIDE

B.1 Implementation Vendor Questions

Documentation

1. Have your project documentation requirements and procedures changed since early 2016? (If not addressed in answer, probe specifically for: recording product installation locations, documentation provided to PA, communications with QAQC vendor, etc.)
2. What were the drivers for these changes?
3. What have been the results of these changes?

PROGRAM AND MEASURE AWARENESS

4. When a building owner / manager or condo board decides to participate in the Multifamily Retrofit program, how is this information communicated to residents?
    a. Does any outreach happen before/during/after building audits?
    b. Does any outreach happen before/during/after measure installation?
5. Does *[vendor]* provide any outreach materials to let residents know about project activities, the energy efficiency measures installed, or other Mass Save programs?

    [FYI: in the RES 44 NTG survey, over half of renters in 2017's participating buildings were not aware that their building had participated in the Multifamily program.]
6. How are residents notified about in-unit visits prior to the audit/installation visits?
    a. Can you describe how successful that strategy is?
7. Do you find that residents are aware of the energy efficiency measures available to them through the program prior to the audit/installation visits?
    a. Do you think they would have installed these measures on their own without the program?
8. Do you find that property owners/managers are aware of the energy efficiency measures available to them through the program prior to the audit/installation visits?
    a. Do you think they would have installed these measures on their own without the program?
9. To what extent do you think program recommendations tend to affect the decisions by property owners / managers to install measures?
10. How often are products left with a renter / condo owner for them to install instead of having the program directly install the products?
    a. What messaging does the program provide renters/owners when products are left for renter/owner installation?

FAILED MEASURES

11. Are you aware of any measures that failed QC inspection in 2017?

12. Has the communication about failed measures changed since 2016?
13. What were the most common causes of failed measures?
14. How were the failed measures resolved?

OTHER

15. Are you aware of any buildings that tried to participate, but were unable to because of the building type or size?
    a. How was this communicated to the interested party (either the resident or property owner/manager)?
16. How does *[vendor]* explain the program follow-up site visit requirements (QC visit, possible evaluation visit) to the property manager/owner?
17. To the best of your knowledge, does *[vendor]* or the property manager/owner explain the program follow-up site visit requirements (QC visit, possible evaluation visit) to residents?
18. Is there anything else you'd like to share about your experience with the Multifamily program over the last year?

B.2 QA/QC Vendor Questions

DOCUMENTATION

1. Is vendor documentation higher/lower/same quality since 2016?
2. Does vendor documentation differ between simple buildings (regular layouts) and more complex, varied buildings?
3. Have you failed any measures in 2017?
4. What was the nature of the failures?
5. What are the most common reasons for measure failures?
6. Has the communication of failed measures changed since 2016?
7. Are you aware of whether any failed measures were resolved by the implementation contractor?
8. What reports do you provide to vendors, PA's?
9. What feedback to you receive from the PA's or implementation contractors about your QA QC reports?

PRODUCTS LEFT FOR RESIDENTS

10. How often do you find the program has left products for the condo owner / renter to install themselves, instead of installing them directly?
    a. Have you found a different in – service rate between products that are left behind and those that are direct installed?

PRE-ONSITE PROTOCOL

11. Is the property owner/manager generally aware that they should expect a follow-up QC visit?
12. How are residents notified about follow-up in-unit visits prior to the QC visits?

13. What is the specific experience/qualification of auditors.
    a. Can they identify HVAC equipment, boiler, controls, insulation installation errors, and safety issues?
    b. Would you share resumes of your inspection staff? [They will only be used to review experience.]

ONSITE PROTOCOL

14. How are failed measures identified while onsite?
15. How are failed measures documented while onsite?
16. What do inspectors do if they cannot get in the designated apartment?

POST ONSITE PROTOCOL

17. What happens to failed measures after an onsite visit?
18. How do QAQC failed measure results get communicated to the PA's??
19. How do QAQC failed measure results get communicated to the vendors?
20. In your role as the QAQC vendor, do you have any role in following-up on failed measures with either the PA or implementation contractor??
21. Is there anything else you'd like to share about your experience with the Multifamily program over the last year?