RGGI Multifamily Carbon Emissions Reduction Program Impact Evaluation (2011-2012)

Final Report

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ABSTRACT

This report describes the impact evaluation of the Multifamily Carbon Emissions Reduction Program (the MCERP or, the Program). NYSERDA established the MCERP in 2011 to encourage early compliance with New York City's Local Law 43 (the law), which required that all multifamily buildings consuming #6 fuel oil convert to a cleaner alternative (e.g., natural gas, #2 fuel oil) by July 2015. The Program encouraged participation through incentives calculated on a per-ton CO_2e (equivalent CO_2) emissions reduction basis.

For an evaluation population of 117 completed projects, the Impact Evaluation Team assessed the lifetime carbon emissions reduction attributable to the Program. This overall evaluation objective included two main research components: (1) measurement-based engineering analysis on a sample of 32 completed projects to assess evaluated gross carbon emissions reduction by project, and (2) research on program influence through telephone surveys attempted among a census of participating building owners or managers. The Impact Evaluation Team hypothesized three key avenues for program influence: (a) accelerating compliance before the law's deadline, (b) encouraging the adoption of fuels cleaner than the minimally eligible #2 fuel oil, and (c) guiding customers to adopt supplementary efficiency measures at the time of the conversion project. Each influence mechanism was researched in this study.

The Impact Evaluation Team determined higher-than-anticipated project-level carbon emissions reduction, leading to a realization rate of 249%. The primary contributor of higher project-level savings was a prevalence of participants who eventually converted to firm natural gas but whose program-reported, 13-year savings reflected #2 fuel oil. Conversions from #6 fuel oil to natural gas save about five times more carbon emissions than conversions from #6 fuel oil to #2 fuel oil.

In terms of program influence, the Impact Evaluation Team determined that (a) participants converted approximately 8 months earlier than they otherwise would have; (b) the Program influenced participants to choose a cleaner fuel option more than a third of the time; and (c) many participants adopted supplementary efficiency measures at the time of the conversion, leading to a 36% increase in emissions savings. These three influences resulted in lifetime attributable carbon savings of 492,376 tons CO_2e compared to the Program's lifetime claim of 243,351 tons CO_2e.

Though the one-time Program has been discontinued, the MCERP's successes serve as an example to similar programs that might be developed in the future. The NYSERDA staff recognized the potential for additional carbon savings despite the impending legal deadline, and the Program achieved those additional savings through strategic incentive design and timely execution.

ACKNOWLEDGMENTS

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SECTION 1: EXECUTIVE SUMMARY

This report describes the impact evaluation of NYSERDA's Multifamily Carbon Emissions Reduction Program (the MCERP or, the Program). The MCERP was developed in 2011 to provide financial and technical support to multifamily building owners seeking to convert heating systems that consume #6 fuel oil to cleaner fuel alternatives. The Program encouraged early compliance with the City of New York's Local Law 43 legislation (the law) that mandated a phase-out of #6 fuel oil at multifamily heating systems by July 2015[1]. The MCERP was discontinued in December 2012 after allocating Regional Greenhouse Gas Initiative (RGGI) incentive funds to 190 conversion projects, all of which occurred downstate[2].

1.1 APPROACH

The primary purpose of this impact evaluation is to establish rigorous and defensible estimates of the carbon emissions reduction that can be attributed to the Program. The impact evaluation involved two distinct methodologies to determine program net emissions reduction:

1. **Site-specific analysis to determine evaluated gross emissions reduction** – The evaluators applied a multi-pronged engineering approach to assess the carbon emissions reduction (in tons of CO_2e[3]) for a sample of 32 participating multifamily facilities. The engineering approach included analysis of pre- and post-project utility bills, data collection on facility operating procedures, and measurement and verification[4] (M&V) of boilers affected by the fuel conversion project. Evaluated gross carbon emissions reduction led to a calculation of site-specific realization rates (RRs) for all sampled projects.

2. **Telephone surveys to quantify program influence leading to net emissions reduction** – The Impact Evaluation Team relied on a series of telephone interviews with participating owners/managers to assess self-reported Program influence on decisions made during the fuel conversion. The evaluators researched three key avenues of potential program influence: (a)

[1] "Rules Governing the Emissions from the Use of #4 and #6 Fuel Oil in Heat and Hot Water Boilers and Burners," NYC Department of Environmental Protection, January 2011. http://www.nyc.gov/html/dep/pdf/air/heating_oil_rule.pdf

[2] The MCERP was available to all eligible multifamily customers throughout New York State. However, due to the prevalence of oil-fired systems downstate, as well as the impact of New York City's legislation, only five applications came from outside of the New York City boroughs: four from Westchester County and one from Nassau County.

[3] Carbon emissions are expressed in tons of carbon dioxide equivalent, or CO_2e, throughout this report, in order to account for impacts of emitted gases other than CO_2, such as methane and nitrous oxide.

[4] Definitions of evaluation terms used throughout this report can be found in Appendix A.

accelerated compliance with fuel conversion legislation, (b) the decision to convert to a cleaner heating fuel than the minimally compliant option, and (c) any efficiency improvements implemented during the conversion process. Program influence on nonparticipating owners/managers was not researched in this study.

Since the Program was designed to encourage early adoption of a law with a deadline approximately four years after program initiation, the Impact Evaluation Team assessed the lifetime carbon emissions reduction attributable to the Program. This approach differs from traditional NYSERDA impact evaluations, which typically assess first-year savings. Throughout this report, results are presented as lifetime savings unless otherwise noted.

1.2 RESULTS

Table 1-1 summarizes the results of the impact evaluation.

Table 1-1. MCERP Impact Evaluation Summary of Results

Parameter	Value
A – Program-reported 13-year[1] emissions reduction (ton CO_2e)	243,351
B – Realization rate (RR)	2.49
C – Evaluated gross 13-year emissions reduction (ton CO_2e) (A × B)	605,944
i. Influence from accelerated compliance (ton CO_2e)[2]	30,673
ii. Influence on new fuel choice (ton CO_2e)[2]	335,757
iii. Influence from efficiency improvements (ton CO_2e)[2]	125,946
D – Evaluated net lifetime[3] emissions reduction (ton CO_2e) (i + ii + iii)	492,376
E – Relative precision of evaluated net savings at 90% confidence interval	6%

[1] The Program assumed 10 years of lifetime carbon emissions reduction per project in the project-level incentive calculator tool and tracking database. However, NYSERDA reported 13 years of lifetime carbon emissions reduction for MCERP projects in quarterly status reports to RGGI (e.g., http://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/RGGI/2014-Q4-RGGI-Status-Report.pdf). Therefore, since impact evaluations typically compare evaluated savings with reported savings, the Impact Evaluation Team has assumed 13 years of program-reported carbon emissions reduction.

[2] Detailed program influence savings calculations can be found in Section 4.3 and Appendix G. Abbreviated terminologies for these three influences, “acceleration savings,” “fuel choice savings,” and “efficiency savings,” appear throughout this report.

[3] The Impact Evaluation Team determined varying lifetimes for each of the three program influence contributors, as further discussed in Section 4.2. Overall, the Impact Evaluation Team determined a longer lifetime for fuel conversion projects than the 13 years assumed by the Program. This difference was factored into the net carbon emissions savings calculation.

The Impact Evaluation Team determined evaluated gross carbon emissions reduction 149% higher than reported by the Program. The primary contributor to higher emissions reduction was

misclassification of post-conversion fuel type by the Program. In 12 of the 32 projects sampled for engineering analysis, the evaluators determined that the facility had converted to primarily natural gas, not #2 fuel oil, as assumed in program-reported savings calculations[5]. Natural gas conversions lead to approximately five times greater carbon reduction than #2 fuel oil conversions per equivalent MMBtu; therefore, the evaluators determined significantly higher evaluated gross carbon emissions reduction for such projects.

The Program's three key avenues for influencing carbon emissions reduction each led to varying levels of net savings:

1. **Influence from accelerated compliance** – The Impact Evaluation Team determined that, on average, the Program caused participants to convert to a cleaner heating fuel approximately eight months earlier than they otherwise would have converted.
2. **Influence on new fuel choice** – The Program's incentive and technical guidance influenced 37% of participants' decisions to convert to a fuel cleaner than the minimally eligible #2 fuel oil. This factor is based on participants' ratings on the Program's influence on their fuel choice, relative to other influences, such as cost savings, ease-of-use, or sudden availability of natural gas infrastructure.
3. **Influence from efficiency improvements** – Although this is not reflected in the conversion project incentive, efficiency improvements undertaken at participating facilities at the time of the fuel conversion led to additional carbon emissions reduction attributable to the Program.

1.3 CONCLUSIONS

Through M&V and attribution research, the Impact Evaluation Team determined seven major findings summarized below. These findings are further discussed in Section 4.4.

1. Inconsistencies between the Program's fuel conversion classification and the actual new fuel type was the primary driver of the 249% RR.

[5]The Program recognized the complications in fuel switching for these customers. Many customers simply could not switch to natural gas at the time of program inception, often due to lack of gas infrastructure (piping) or delays in gas connections from the utility. Therefore, the Program applied a conservative classification for such customers, knowing their desire to switch to natural gas eventually but not knowing if gas would be an option during the incentive award window. A detailed review of the various fuel conversion options available to participants is provided in Section 3.2.1.

2. When calculating reported savings for each project, the Program conservatively assumed that #2 fuel oil is exclusively consumed[6] for projects classified as "dual fuel." Conversions from #6 fuel oil to firm natural gas save about five times more carbon emissions than conversions from #6 fuel oil to #2 fuel oil; therefore, the M&V sample featured several projects with RRs of approximately 500%.

3. The Program's savings calculator incorporated CO_2e emissions factors that have since been revised by both NYSERDA and the EPA, whereas evaluated CO_2e emissions reduction reflected values currently recommended by NYSERDA. This difference resulted in a 63% reduction in program RR. Appendix E provides additional details on the differences in CO_2e emissions factors between the Program's savings calculator and current NYSERDA recommendations.

4. The Program's reported savings reflect 13 years of reduced carbon emissions from the fuel conversion; however, this lifetime estimate was unrealistic due to the impending Local Law 43 deadline approximately 4 years after the Program began processing applications. Our research indicated that the Program accelerated conversions by approximately 8 months.

5. Through its project incentives and technical support, the Program was highly influential on participants' choice of new fuel type, with 37% of the additional carbon savings from conversions to firm or interruptible gas attributable to the Program. This factor is based on participant survey responses on the Program's fuel choice influence.

6. The Impact Evaluation Team determined an effective useful life (EUL) of 20 years for burner-related measures, such as burner retrofits associated with nearly all conversion projects. Therefore, the Program's lifetime savings from fuel choice influence perpetuate for the 20-year life of the burner measure.

7. The Program's technical support influenced participants to implement supplementary (non-incented) efficiency measures at the time of the fuel conversion. The Impact Evaluation Team determined that supplementary measures led to a 36% increase in realization rate among the sampled M&V projects.

The Program successfully achieved higher-than-anticipated carbon savings, despite the impending law deadline, which required downstate multifamily consumers of #6 fuel oil to

[6] This assumption relates to the previous footnote—many customers classified as "dual fuel" simply did not have the option of consuming natural gas at the time of program inception.

convert to a cleaner alternative by July 2015. The MCERP recognized and provided additional CO_2e savings opportunities through effective incentive design and timely execution. The Program influenced several participants to convert earlier than they otherwise would have, to choose a cleaner fuel than the minimum #2 fuel oil, and to implement supplementary efficiency measures at the time of the conversion project.

Though the MCERP is discontinued, the program serves as an example for possible future NYSERDA programs in the Clean Energy Fund[7] (CEF) landscape:

- **The Program acted quickly**. NYSERDA staff recognized the law's impending deadline and swiftly and effectively designed and rolled out the MCERP in 2011. This timeliness serves as an example to other time-critical programs that are developed in the future, such as those developed after natural disasters or in response to federal, state, or municipal mandates.
- **The Program's lifetime savings approach was appropriate**. The MCERP tracked project-level CO_2e savings over the life of the fuel conversion measure. As carbon emissions-based programs are expected to play a role in CEF, the Impact Evaluation Team recommends life-cycle program design and tracking for such programs.
- **Participants often adopted supplementary efficiency measures without an incentive**. The MCERP staff's technical guidance was influential in convincing participants to implement non-incented efficiency improvements at the time of the conversion. As NYSERDA programs potentially shift away from incentive-based design, the MCERP demonstrated that efficiency gains are possible through effective customer education and technical support from program staff.

[7] "Clean Energy Fund Information Supplement," NYSERDA, June 2015. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={FC3FBD53-FBAC-41FB-A40E-3DA0A5E0866A}

SECTION 2: INTRODUCTION

This section provides background information for NYSERDA's Multifamily Carbon Emissions Reduction Program (the MCERP or, the Program).

2.1 PROGRAM DESCRIPTION

The MCERP was developed in 2011 to provide financial assistance and technical support to owners of existing multifamily buildings seeking to convert heating systems from #6 fuel oil to cleaner fuel alternatives. Converting #6 fuel oil-fired burners to a cleaner fuel reduces carbon emissions, improves air quality, and produces positive public health benefits. The Program was positioned to encourage early compliance with the City of New York's Local Law 43 legislation that requires all multifamily buildings that burn #6 fuel oil to switch to a cleaner fuel alternative by July 2015[8]. Approved alternatives to #6 fuel oil included: natural gas, #2 fuel oil, biofuels/biodiesel blends, revenue-grade waste gas from landfills and digesters, propane, woody biomass, and renewable energy sources. Conversions to #4 fuel oil were not eligible to participate in the Program.

MCERP was solely funded by the Regional Greenhouse Gas Initiative (RGGI). The Program targeted any existing multifamily building (defined as having five or more units) in New York State with a heating system fueled by #6 fuel oil. New construction projects were not eligible to participate in MCERP. Each MCERP project's scope typically included a fuel conversion and/or burner retrofit but may also have included additional efficiency measures, such as the installation of a new boiler, boiler controls, or boiler tuning. During the application process, building owners used the Program's Carbon Emissions Reduction Incentive Calculator, which assigned project incentives based on tons of CO_2e reduced. The Program capped the incentive at 80% of the total project cost or $175,000, whichever was less.

The Program, discontinued as of December 31, 2012, allocated RGGI-funded incentives to 190[9] conversion projects affecting more than 300 multifamily buildings; and resulted in a reported

[8] "Rules Governing the Emissions from the Use of #4 and #6 Fuel Oil in Heat and Hot Water Boilers and Burners," NYC Department of Environmental Protection, January 2011. http://www.nyc.gov/html/dep/pdf/air/heating_oil_rule.pdf

[9] 117 of the 190 projects were completed at the inception of this evaluation; therefore, the evaluation population included only the 117 completed projects.

lifetime offset of more than 300,000 tons of CO_2e[10]. All MCERP projects occurred downstate, due to the prevalence of oil-fired systems in the NYC area[11]. MCERP funded both low-income and market-rate projects.

2.2 EVALUATION OBJECTIVES

The two primary objectives of this impact evaluation are:

1. Establish the evaluated gross CO_2e emissions reduction for a sample of completed, Program-sponsored projects, using a site-specific evaluation approach.
2. Using a self-reported survey approach, quantify the influence of the Program on participating multifamily facilities' conversion to a cleaner heating fuel from #6 fuel oil. The Impact Evaluation Team identified three key Program influence paths during this study: 1) acceleration of conversion prior to the mandated deadline, 2) the adoption of a cleaner fuel than the minimum for compliance, and 3) the implementation of energy efficiency measures concurrent with the Program-sponsored fuel conversion.

Table 2-1 summarizes this study's major outputs and methods used.

Table 2-1. MCERP Impact Evaluation Scope and Objectives

Objectives	Outputs	Method Used
Evaluated gross CO_2e emissions reduction	Annualized first-year evaluated carbon emissions reduction based on fuel-specific impacts and associated CO_2e emissions factors by fuel type	Site-specific fuel impact assessment using a combination of billing analysis and on-site M&V approaches
Realization rate (RR)	Ratio of the sum of the weighted evaluated gross savings divided by the sum of the weighted Program-reported savings	
Program influence	Assessment of the Program's influence on the timing, new fuel type, and concurrent efficiency improvements of the project, as measured over the lifetime of the fuel conversion measure	Self-report telephone surveys leading to quantification and aggregation of Program influence factors
Statistical validity	The sample design targeted a 10% relative precision or better for Program net carbon emissions reduction at the 90% confidence interval	Stratified ratio estimation sample design

[10] This value differs from the evaluation population's total program-reported savings value of 243,351 tons of CO_2e, as several additional conversion projects were classified as completed between the evaluation planning period (December 2013) and the writing of this report.

[11] The MCERP was available to all eligible multifamily customers throughout New York State. However, due to the prevalence of oil-fired systems downstate, as well as the impact of New York City's legislation, only five applications came from outside of the New York City boroughs: four from Westchester County and one from Nassau County.

Although not required of RGGI programs, this report adheres to the requirements of the New York State Evaluation Guidelines (Evaluation Guidelines), including appendices, updated in November 2012 by the DPS and the Evaluation Advisory Group. It is intended to provide robust, timely, and transparent results. The impact methods are aligned with the guidelines of the State and Local Energy Efficiency Action Network (SEE Action) Energy Efficiency Program Impact Evaluation Guide.

2.3 PREVIOUS EVALUATIONS

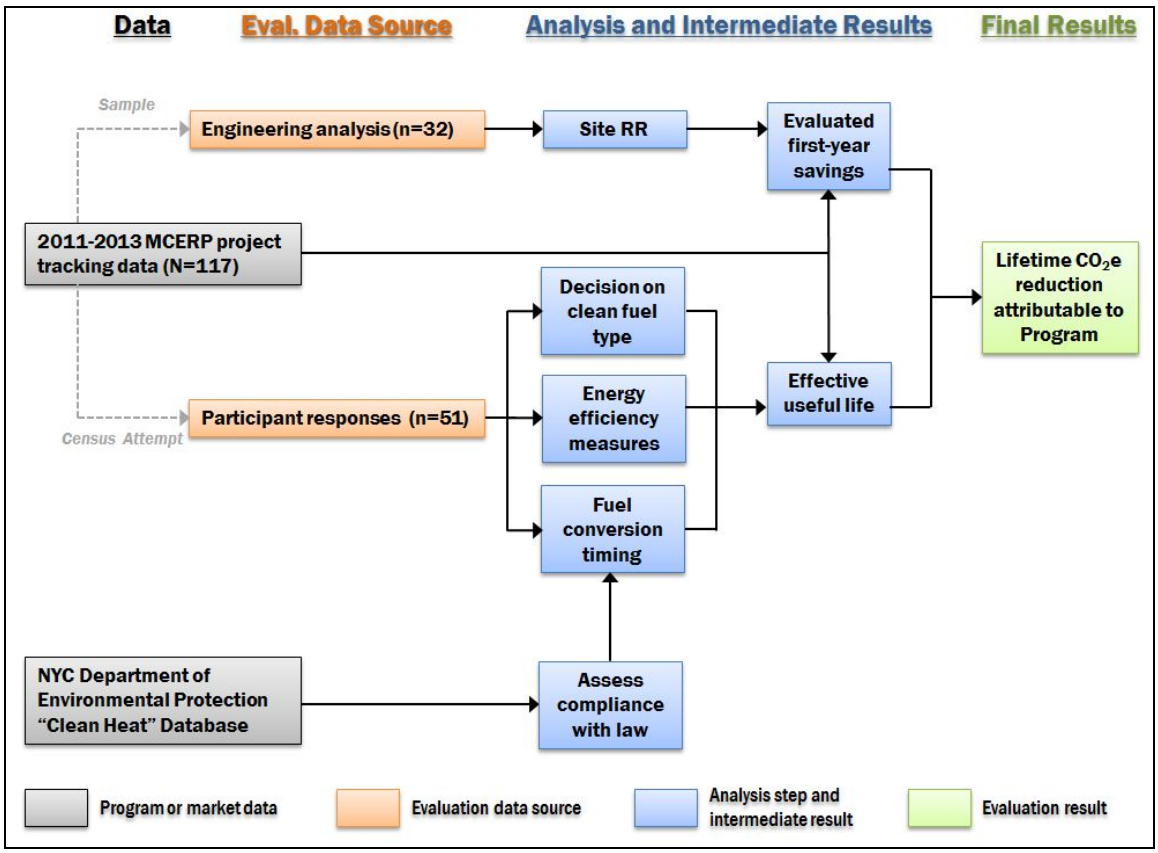
The Program has not been evaluated previously.

SECTION 3: METHODS

The impact evaluation of the Multifamily Carbon Emissions Reduction Program (the MCERP or, the Program) consisted of two primary components: (1) an engineering-based assessment of evaluated gross energy savings by fuel type and carbon emissions reduction, leading to the Program realization rate, and (2) a survey-based assessment of the Program's influence on key factors (timing, fuel decision, and energy efficiency) related to the conversion from #6 fuel oil to a cleaner fuel. The supporting methods used to research each of the two primary components are discussed in this section, including the engineering approach, sample design, and participant survey development.

Figure 3-1 summarizes the overall evaluation approach leading to the two primary research components. Details of each step in the framework are provided in this section.

Figure 3-1. MCERP Impact Evaluation Framework



3.1 EVALUATION METHODS TO CALCULATE REALIZATION RATE

A critical component of the evaluation was the development of rigorous estimates of project-specific realization rates (RRs) for program-reported carbon emissions reduction. As the Program received only RGGI funding, carbon emissions reduction (in tons of CO_2e), not energy savings

(in MMBtu), was the primary reported variable of interest for each completed project. However, in order to assess project-level carbon emissions reduction, the Impact Evaluation Team first calculated fuel-specific energy impacts for each sampled project[12]. The Impact Evaluation Team next compared the evaluated project-level carbon emissions reduction with program-reported project-level carbon emissions reduction in the form of a RR, defined by the following formula:

$$RR = \frac{CO2e\ emissions\ reduction_{evaluated}}{CO2e\ emissions\ reduction_{reported}}$$

where,

RR	= Project-level realization rate
$CO2e\ emissions\ reduction_{evaluated}$	= Project-level CO_2e emissions reduction evaluated through this study
$CO2e\ emissions\ reduction_{reported}$	= Project-level CO_2e emissions reduction as reported by the Program

Project-level RRs were statistically aggregated to determine the program-level RR, using the statistical sampling approach outlined in Section 3.2.

3.1.1 Levels of Rigor

Figure 3-2 provides an overview of how the evaluated projects were each assigned a level of engineering analysis rigor. The level of rigor assigned to each project was based on the evaluation manager's review, availability of monthly utility billing data, and consideration of the complexity of the fuel conversion and any associated energy efficiency improvements. The evaluation engineers initially surveyed each sampled site using a telephone questionnaire to gather relevant information considered when selecting each level of rigor. For all evaluation methods, the evaluators confirmed pre-project boiler operability in order to establish an early replacement baseline through the framework outlined in Appendix B.

[12] Fuel impacts (in MMBtu) were determined directly from utility bills (in the case of natural gas) or delivery invoices (in the case of fuel oils). Appropriate MMBtu-per-gallon factors were applied to fuel oil delivery data to determine accurate energy content values by fuel oil grade.

Figure 3-2. MCERP Evaluation Method for Assignment of Rigor

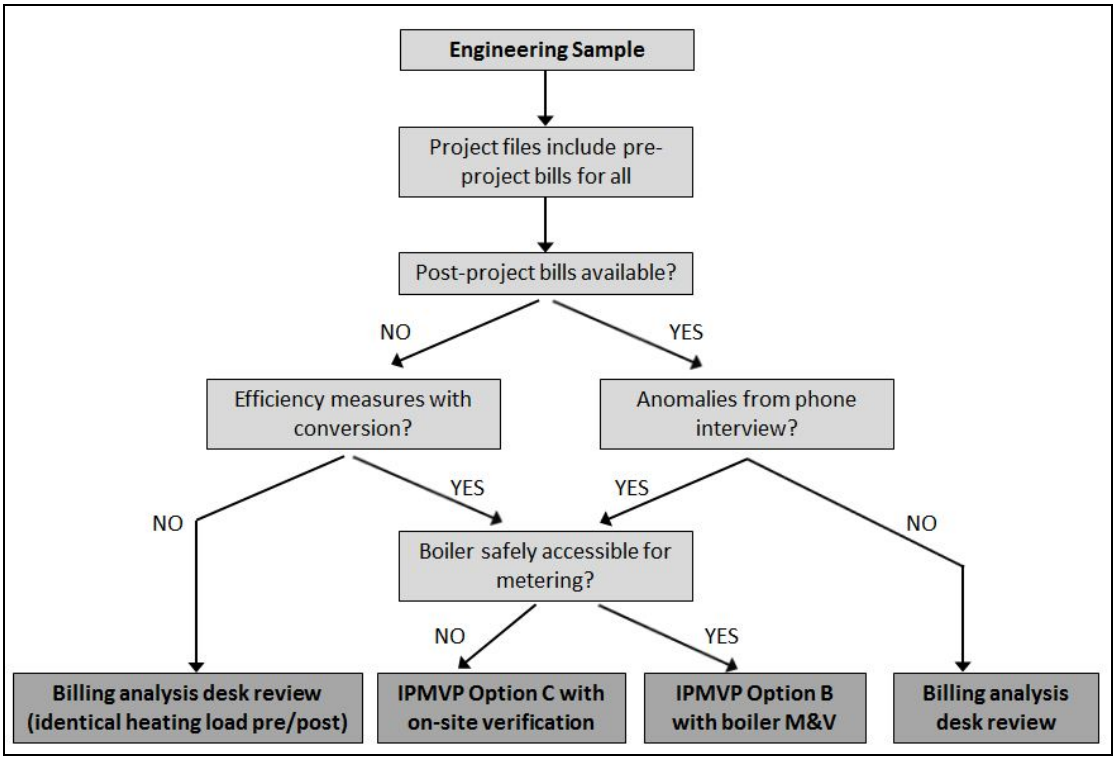


Table 3-1 further describes each level of rigor employed in the evaluation.

Table 3-1. MCERP Levels of Evaluation Rigor among Sampled Projects

Level of Rigor	Description of Analysis	Percent of Projects Receiving Level of Rigor
Billing analysis desk review	The evaluators analyzed project impacts by comparing the pre- and post-project utility bills for each affected fuel type. All billing analysis included normalization to typical weather using monthly degree days from the National Oceanic and Atmospheric Administration (NOAA) and typical meteorological year (TMY3) data. If sufficient post-project bills could not be obtained, but the evaluators determined from the phone interview that the facility experienced no changes to heating load since the project, then the pre-project bills were used to characterize the facility heating load in both the pre- and post-project cases.	53%
Billing analysis with on-site verification (IPMVP Option C)	The evaluators supplemented the above desk review approach with on-site verification for a selection of sampled projects. On-site verifications were reserved for projects with inconsistent billing data, meaningful changes to facility heating load, or other energy efficiency measures that coincided with the fuel conversion.	41%
On-site measurement and verification (IPMVP Option B)	Measurement and verification of converted boilers was reserved for two projects for which sufficient post-project billing data was not available and the impact of other efficiency measures could not be quantified without equipment performance monitoring. M&V included logging of boiler combustion air fan amperage, heating hot water supply and return temperatures, and boiler stack temperature, as well as spot measurement of boiler combustion efficiency. Long-term measurements covered a representative portion of boiler operation during the winter.	6%

3.2 ENGINEERING SAMPLE DESIGN

The sample frame constructed includes all MCERP projects completed as of December 2013, when the impact evaluation planning process was initiated. The Impact Evaluation Team employed stratified ratio estimation (SRE) when designing the MCERP engineering sample, as it allows for efficient design by generally requiring a lower sample size for a targeted level of precision. SRE is effective when there is a strong correlation between the program-reported savings and the evaluated gross savings. The evaluators expected a strong correlation between program-reported and evaluated gross carbon emissions reduction, after stratifying the population per the strategy outlined in Table 3-2.

Table 3-2. Summary of the MCERP Engineering Sampling Plan

Sampling Component	Sample Approach	Comments
Population	Program-reported data for all MCERP projects marked as complete as of December 2013 (117 in total)	Program-reported data was provided by NYSERDA.
Method	Stratified ratio estimation	Correlation between program-reported and evaluation savings was expected to be strong. However, since the program has not been evaluated previously, an error ratio of 0.6 was conservatively assumed in the sample design.
Primary variable to estimate	RR for annual carbon emissions reduction	Engineering analysis to establish evaluated gross savings. RR is calculated as the ratio of the evaluated gross carbon reduction to the program-reported carbon reduction.
Secondary variables to estimate	Fuel-specific impacts in MMBtu	In order to quantify the carbon emissions reduction for each fuel conversion project, the evaluators quantified the energy impacts for each affected fuel.
Primary sampling unit	Project	A “project” refers to any boiler fuel conversion incented by the Program, along with any energy efficiency improvements that occurred concurrently.
Upper-level stratification variables	Fuel conversion project type	The evaluators observed that the Program classified projects into two distinct fuel conversion types: conversion to firm natural gas or conversion to a combination of natural gas and #2 fuel oil. Since natural gas features approximately 30% lower carbon emissions than fuel oil, the sample was primarily stratified by fuel conversion type.
Lower-level stratification variables	Size	The sample was next stratified by project size, which was determined from the program-reported carbon emissions reduction in tons of CO_2e.

Sampling Component	Sample Approach	Comments
Post-hoc stratification	Post fuel type assumed in Program incentive calculation	Upon further review of project files, the evaluators determined that the Program's classification of fuel conversion type did not always reflect the actual new fuel type, likely due to the inability of certain customers to convert to natural gas at the time of the program application. When aggregating the engineering analysis results, the evaluators re-stratified the population to ensure that the actual fuel conversion type was appropriately represented. See Section 3.2.3.

3.2.1 Fuel Conversion Types

Among the population of completed MCERP projects, the Impact Evaluation Team observed that the Program classified each fuel conversion in one of two ways:

1. **Firm gas** – The facility converted its boiler(s) from consuming #6 fuel oil to exclusively consuming firm (uninterruptible) natural gas.
2. **Dual fuel** – The facility converted its boiler(s) from consuming #6 fuel oil to consuming some combination of natural gas and #2 fuel oil.

The evaluation population included only conversions from #6 fuel oil to natural gas, #2 fuel oil, or a combination thereof. The Program processed and incented each project in a similar manner, regardless of fuel conversion type. For example, the same incentive calculator spreadsheet was used for both firm gas and dual-fuel conversion types[13].

Upon review of projects within the evaluation population, the Impact Evaluation Team determined that participants had more conversion options than the two assumed by the Program. The Program's classifications were likely simplified to conservatively account for customers that might one day convert to natural gas but could not at the time of the MCERP application. To eliminate confusion among the different fuel conversion options as defined by the Impact Evaluation Team and the Program, Table 3-3 provides definitions for each conversion type and matches evaluator- and program-defined conversion classifications.

[13]Incentives were calculated as $30 per ton CO_2e reduced, regardless of the post-conversion fuel type. Therefore, for equivalent heating load, #6 oil-to-gas conversion incentives were theoretically about five times greater than #6 oil-to-#2 oil conversion incentives. Incentives were capped at $175,000 or 80% of the conversion project cost, whichever was less.

Table 3-3. Comparison of Fuel Conversion Types between Evaluators and Program

Evaluation Fuel Conversion Type	Definition	Most Similar Program Fuel Conversion Classification
Firm gas	The facility converted its boiler(s) from consuming #6 fuel oil to exclusively consuming firm (uninterruptible) natural gas. Any oil-related equipment, such as a storage tank, was decommissioned as a result of such conversions.	Firm gas
Interruptible gas	The facility converted to interruptible natural gas with #2 fuel oil used as backup, as decided by the gas utility, typically on the coldest days of winter.	Dual fuel
Dual fuel	The facility converted to some combination of natural gas and #2 fuel oil. Facility management decides when to switch from natural gas to #2 fuel oil, or vice versa.	
#2 fuel oil	The facility converted to #2 fuel oil only. No natural gas connection was established.	

3.2.2 Upper- and Lower-Level Stratification

Since the carbon dioxide emissions of natural gas are approximately 30% lower than those of #2 fuel oil, the evaluators used upper-level stratifications of firm gas and dual fuel to ensure that both types of projects were appropriately represented in the engineering sample. Otherwise, firm gas conversions would have been overrepresented in the sample due to their higher relative CO_2e emissions reduction per project. Additionally, firm gas conversions were expected to differ from dual-fuel conversions in data availability—the evaluators anticipated that post-project monthly consumption data would be more accessible for firm natural gas boilers than for dual-fuel boilers, as two sets of bills are required to characterize the latter.

The MCERP has never been evaluated previously. Though the evaluators expected a strong correlation between program-reported and evaluated gross carbon emissions reduction within each upper-level stratum, an error ratio of 0.6 was chosen in the design of each stratum's sample, as no prior results were available that might indicate a closer correlation.

The lower-level stratification variable is project size. Size categories were based on the magnitude of program-reported carbon emissions reduction by project. Five size categories were defined per upper-level stratification category. Cutoffs were established using the method described in the *2004 California Evaluation Framework*.[14]

[14]TecMarket Works, et al. *The California Evaluation Framework.* Project Number: K2033910. Prepared for the California Public Utilities Commission and the Project Advisory Group. June, 2004. Pages 327 to 339 and 361 to 384.

For each upper-level stratification category, the project size was defined based on the program-reported carbon emissions reduction in tons of CO_2e. The largest size stratum in each segment is a census stratum. Three additional strata were defined to allow for random sampling of the medium-sized projects in each upper-level stratification category. Table 3-4 presents the evaluation engineering sample broken out by upper- and lower-level stratification variables.

Projects in the lowest size stratum accounted for less than 3% of the total energy savings for the upper-level stratification categories and were not evaluated. While nearly 20% of the MCERP population was classified in the lowest size stratum, these projects account for a small part of the overall program-reported savings and have little effect on the RR. The RR developed for the sample frame was applied to these smaller projects.

Table 3-4. MCERP Engineering Sample Upper- and Lower-Level Stratification Results

Upper-Level Stratum	Sampling Method	# of Projects in Population	Maximum CO_2e Emissions Reduction	% of Total CO_2e Emissions Reduction in the Stratum	# of Projects in Sample	% of Total CO_2e Emissions Reduction in Sample
Firm gas conversion	Census	6	12,268	21%	5	18%
	Random	35	4,676	28%	12	11%
	None	7	287	1%	0	0%
	Subtotal	**48**	**12,268**	**50%**	**17**	**29%**
Dual-fuel conversion	Census	2	14,946	11%	2	11%
	Random	51	4,007	37%	13	16%
	None	16	287	2%	0	0%
	Subtotal	**69**	**14,946**	**50%**	**15**	**27%**
Totals		**117**	**N/A**	**100%**	**32**	**56%**

3.2.3 Post-Hoc Stratification

Upon closely reviewing the project files and administering the initial telephone questionnaire for the engineering sample of 32 projects, the Impact Evaluation Team observed differences between the Program's classification of the fuel conversion type and the actual fuel conversion type. For example, the evaluators determined that 12 sampled projects were classified by the Program as "dual-fuel" conversions, but the post-project inspection documentation, interviews with the customer, and examination of utility bills indicated that the project resulted in a conversion to firm natural gas. The Impact Evaluation Team believes that the Program recognized these potential differences during the application submittal phase; however, due to unavailability of natural gas infrastructure for these customers at the time of the project application, the MCERP did not want to claim savings that potentially would not come to fruition during the life of the Program.

Further exacerbating the differences between classified and actual post-project fuel types were the assumptions made by the Program in the reported savings calculation tool for projects classified as dual-fuel. The Impact Evaluation Team found that the Program conservatively assumed in its reported savings calculation that dual-fuel projects consume only #2 fuel oil after project completion, as natural gas was not available for some customers at the time of the MCERP application.

Since converting from #6 fuel oil to natural gas saves about five times the amount of CO_2e emissions as converting to #2 fuel oil[15], the Impact Evaluation Team foresaw that these conservative classifications would have implications on the evaluation's aggregated results. If projects originally thought to be dual-fuel projects were actually firm gas projects, a wider scatter of RRs would be expected, thereby lowering the statistical precision of the evaluation's overall result. To mitigate this risk, the evaluators used post-hoc stratification to reclassify the sample by whether or not the fuel conversion was appropriately classified by the Program. The results of this post-hoc stratification on the engineering sample are presented in Table 3-5, which compares the post-project fuel type tracked in the Program's database, the post-project fuel type assumed in the Program's reported savings calculation, and the actual post-project fuel type determined by the Impact Evaluation Team. Further discussion on the Program's fuel conversion classifications can be found in Section 4.1.4.

Table 3-5. Results of Post-Hoc Stratification on Engineering Sample

Post- Fuel Type	Population Counts			Sample Counts		
	Program Classified	Reported Savings Reflect	Actual[1]	Program Classified	Reported Savings Reflect	Actual[1]
Firm gas	48	48	86	17	16	28
Dual fuel	69	0	29	15	0	2
#2 fuel oil	0	69	2	0	16	2

[1] Differences between classified and actual post-project fuels are likely due to customer inability to convert to natural gas at the time of project application, due to lack of natural gas infrastructure in their neighborhoods. Some customers were able to convert to natural gas by the time the fuel conversion project was completed.

As a result of the re-classification of projects by actual post fuel type, the Impact Evaluation Team made the following adjustments to the evaluation population:

- Firm gas: Thirty-eight additional firm gas projects were determined from review of site-specific inspection documents and utility bills. Twelve of these additional 38 projects showed up in the M&V sample.

[15]Per equivalent MMBtu. A hypothetical comparison of the carbon emissions savings of firm gas and dual-fuel conversions is presented in Appendix E.

- Dual fuel: Forty fewer program-classified dual-fuel projects were determined by the Impact Evaluation Team, who classified such projects as either dual-fuel or interruptible gas.
- # 2 fuel oil: Two participating facilities consume only #2 fuel oil. However, these two projects were included in the Program's dual-fuel classification. These two projects coincidentally showed up in the M&V sample.

3.3 NET SAVINGS EVALUATION METHODS

The MCERP operated within several different time constraints that influenced the Impact Evaluation Team's attribution research approach:

- The Program was initiated in 2011 and stopped accepting new applications on December 31, 2012.
- The Program incented early conversion to cleaner heating fuels to comply with city-level legislation that requires all multifamily buildings that burn #6 fuel oil to convert to a cleaner equivalent by July 2015.
- The Program incented fuel conversion projects that were estimated to feature an effective useful life (EUL) of 13 years. Therefore, the Program claimed 13 years of reported savings for each incented project[16].

The Impact Evaluation Team hypothesized that the timing factor—as determined by assessing when the conversion would have occurred without the Program—would considerably affect the program influence. In addition, the Program may have influenced participants to switch to fuel sources that release less carbon than the minimally compliant #2 fuel oil or to install measures that further reduce carbon emissions.

To accurately assess program-influenced impacts over time, the Impact Evaluation Team designed its attribution research around three key savings contributors:

1. **Accelerated fuel conversions –** The accelerated adoption of alternative heating fuels to replace #6 fuel oil prior to the July 2015 deadline and compared to the date they otherwise would have made the switch.

[16] Though the Program's savings calculator and tracking database feature 10 years of assumed fuel conversion measure life, the Program reported 13 years of lifetime carbon emissions reduction in quarterly RGGI reports (e.g., http://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/RGGI/2014-Q4-RGGI-Status-Report.pdf).

2. **Reduced-emission fuel choice –** The degree to which the Program influenced participants to replace #6 fuel oil with a less carbon-intensive fuel than either the minimally compliant fuel, #2 fuel oil, or the fuel they otherwise would have chosen.
3. **Additional efficiency measures –** Other efficiency measures affecting the boiler plant implemented as a result of the fuel conversion project.

The Program could theoretically earn attributable impacts a fourth way—from participating facilities that otherwise would not have complied with the fuel switch legislation. However, the Impact Evaluation Team determined that noncompliance was not widespread enough to greatly influence the Program's attributable savings[17].

Without substantial noncompliance, a traditional net-to-gross approach would result in inaccurately high rates of free ridership (FR), as Local Law 43 would require boiler fuel conversion anyway. Therefore, traditional FR questions about likelihood of conversion without the Program were not relevant for this study. Instead, the Impact Evaluation Team developed a methodology that appropriately quantifies the Program's effect on the three influence contributors identified above. This approach is a distinct departure from traditional NYSERDA impact evaluations, in that lifetime savings, not first-year savings, is the focus of the evaluation.

The Impact Evaluation Team developed a self-report telephone survey to gather information related to program influence on project timing, the participant's decision on new fuel type, and other concurrent efficiency improvements. The survey questions investigated program influence through project incentives as well as through technical guidance from NYSERDA staff. A copy of the participant survey can be found in Appendix C.

3.3.1 Attribution Sample Design

The Impact Evaluation Team attempted to survey all decision-makers (owners/managers) who participated in MCERP. A census attempt (i.e., contacting the primary decision-maker for all 117 completed projects) ensures that the richest possible data is gathered for a relatively small

[17]The Impact Evaluation Team interviewed representatives from the NYC Department of Environmental Protection (DEP) to assess the current state of compliance, less than a year away from the #6 fuel switch deadline. Of the original 5,300 multifamily buildings that consumed #6 fuel oil in New York City at the time when MCERP began accepting applications, 65% had already converted to alternative fuels. Of the remaining 35%, at the current rate of participation the DEP estimated that only 5% would still be noncompliant by the July 1, 2015 deadline, at which point they would face cease-and-desist orders from a judge.

population. With a census attempt, no SRE approach was required, as each participating customer's responses represented that particular project when attribution results were aggregated.

3.3.2 Spillover

The Impact Evaluation Team's research accounts for savings attributable to the Program but not necessarily reflected in the Program's fuel conversion incentive. The two main avenues for such savings are: (1) the adoption of a cleaner fuel than the minimally compliant #2 fuel oil, and (2) the implementation of energy efficiency measures that reduce the boiler's annual energy use. In traditional impact evaluations, such participant savings separate from the incentive would be considered inside spillover (ISO).

Two other traditional contributors to program spillover (SO) are outside spillover (OSO) and nonparticipant spillover (NPSO). Given the Program's narrow focus, relatively short time frame, and the lack of a plausible hypothesis that would lead to OSO or NPSO in the general marketplace, the Impact Evaluation Team did not research OSO or NPSO for this study.

3.3.3 Net Savings Calculation

The Impact Evaluation Team's research on the three key program influences were quantified into various factors that, when combined with the program realization rate and measure-specific EUL, lead to net lifetime carbon emissions savings values. Section 4.3 and Appendix G review these calculations in detail, including definitions for each parameter. The net savings formulas are summarized below for each program influence:

1. **Accelerated Compliance**

$$Acceleration\ savings = \left(\frac{Months\ acceleration}{Months\ of\ conversion\ EUL}\right) \times Reported\ savings \times RR \times EUL$$

2. **Fuel Choice Influence**

$$Fuel\ choice\ savings = \left(\frac{Months\ of\ conversion\ EUL - Months\ acceleration}{12}\right) \times FCI\ factor \times Reported\ savings \times RR$$

3. **Efficiency Measures**

$$Efficiency\ savings = \sum_{year=1+}^{20} Boiler/burner\ replacement\ savings + \sum_{year=1+}^{15} Other\ measure\ savings$$

The total net carbon emissions savings are defined as the sum of the three components above:

$$Program\ net\ savings = Acceleration\ savings + Fuel\ choice\ savings + Efficiency\ savings$$

SECTION 4: RESULTS AND CONCLUSIONS

Results from the MCERP impact evaluation's engineering analysis and program influence research are presented in Sections 4.1 and 4.2, respectively.

4.1 ENGINEERING ANALYSIS RESULTS

This section summarizes the results of the engineering analysis that led to evaluated gross carbon emissions reduction and the Program realization rate (RR).

4.1.1 Evaluated Gross Carbon Emissions Reduction

Table 4-1 presents the RR, defined as the ratio of evaluated gross carbon emissions reduction to the program-reported carbon emissions reduction. The table also presents the error ratio, which is the variance in the RR itself.

Table 4-1. Program-Reported and Evaluated Gross 13-Year CO_2e Emissions Reduction

Parameter	Program-Reported Lifetime[1] CO_2e Emissions Reduction	RR	Evaluated Gross 13-Year CO_2e Emissions Reduction	Relative Precision	Error Ratio
Carbon emissions reduction (ton CO_2e)	243,351	2.49	605,944	5.8%	0.29

[1] The Program assumed 10 years of lifetime carbon emissions reduction per project in the project-level incentive calculator tool and tracking database. However, NYSERDA reported 13 years of lifetime carbon emissions reduction for MCERP projects in quarterly status reports to RGGI (e.g., http://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/RGGI/2014-Q4-RGGI-Status-Report.pdf). Therefore, since impact evaluations typically compare evaluated savings with reported savings, the Impact Evaluation Team has assumed 13 years of program-reported carbon emissions reduction.

Figure 4-1 illustrates the evaluated gross annual carbon emissions reduction compared with that reported by the Program. Ideally, for a RR of 1, the evaluated gross emissions reduction would always match the program-reported emissions reduction. This ideal is shown as a solid black line on the chart. Actual findings are plotted as points on the graphs. A pattern of points below the ideal line illustrates an RR of less than 1; points above the line illustrate an RR greater than 1. The error ratio measures the amount of scatter in the point distribution. The higher the error ratio, the greater the amount of scatter between points.

Figure 4-1. Evaluated Gross vs. Program-Reported Annual CO_2e Emissions Reduction

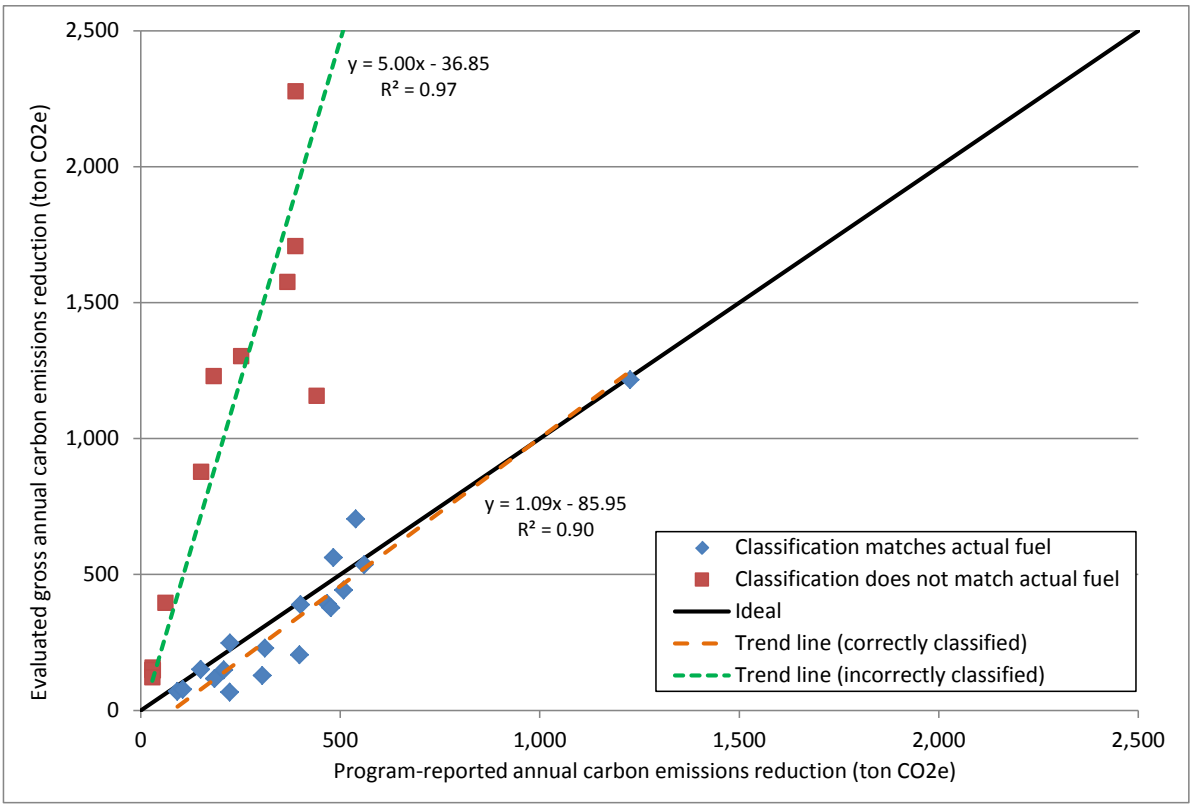


Figure 4-1 above categorizes site results by whether the Program's post-project fuel classification correctly matched the actual post-project fuel type. Mismatches were likely anticipated by the Program, as the natural gas infrastructure became available at several participating facilities between the application submittal and incentive award. As is evident in the figure, conservatively classified projects that did not match the actual post fuel type—representing facilities that eventually converted to firm natural gas, not #2 fuel oil as first assumed by the Program—featured evaluated gross annual emissions reduction about five times greater than the program-reported annual emissions reduction. Therefore, the slope of the red points' trend-line is equal to five. The correctly classified projects generally performed as expected and therefore do not deviate significantly from the ideal line.

4.1.2 Energy Impacts by Fuel Type

The Program did not track or report energy impacts resulting from fuel conversion projects. Though the facility heating load would not theoretically change as a result of the conversion, the removed fuel and the introduced fuel feature significant MMBtu savings and penalties, respectively. In order to quantify the carbon emissions reduction for each sampled project, the Impact Evaluation Team needed to quantify the energy impacts for all fuels affected by each

sampled conversion project. Figure 4-2 illustrates the cumulative positive and negative annual MMBtu impacts for each fuel type affected by projects in the M&V sample.

Figure 4-2. Annual MMBtu Impacts by Fuel Type for Sampled Projects

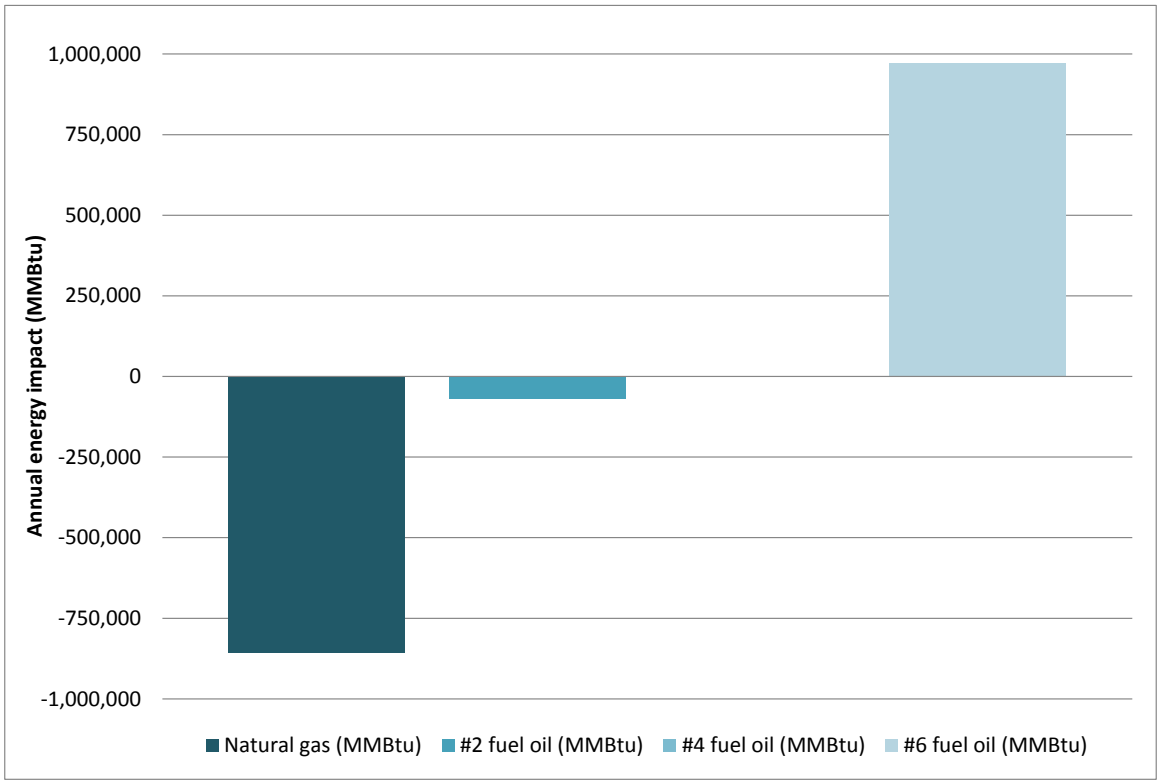


Figure 4-2 above illustrates that MCERP projects led to a 46,443 MMBtu/year reduction in total heating fuel consumption for the 32 projects included in the M&V sample[18].

4.1.3 Key Differences Influencing the Realization Rate

The Impact Evaluation Team next analyzed the reasons for the evaluated gross carbon emissions reduction being 149% higher than reported. This analysis began at the project level, where the evaluation engineers classified different contributors to individual project RRs into nine distinct categories. Next, the engineers estimated the CO_2e impacts (positive or negative) attributable to each category for each project in the engineering sample. Finally, this analysis was aggregated by carbon emissions impact (in tons of CO_2e) across the engineering sample, leading to program-level information on the reasons why the RR was 249%. The results of this analysis are presented

[18] This result cannot be extrapolated to the entire population because the Program did not report site-specific MMBtu impacts by fuel type.

in Table 4-2 with a description of each contributing category. Appendix D provides actual project examples of each difference category.

Table 4-2. Contributors to MCERP Realization Rate

Category		Description	Negative		Positive	
			# Projects	Impact on CO_2e RR	Impact on CO_2e RR	# Projects
Administrative	Difference between program calculated and program reported savings	The savings calculated using the CO_2e emissions reductions tool differed from the program reported savings.	16	-14%	24%	21
	Incorrect input: dollars instead of gallons	The applicant calculated savings using dollars spent on fuel instead of gallons consumed in the CO_2e emissions reduction tool.	1	-1%	0%	0
	Overlap with MPP savings	The affected facility was also a participant of the NYSERDA Multifamily Performance Program; this overlap was not properly	1	-1%	0%	0
Pre-/post-inspection	Difference between program classification and new fuel type	The post-project fuel type differed from the Program's fuel type classification, likely due to unavailability of a natural gas option at the time of project application.	1	-2%	268%	13
Baseline	Inaccurate pre-project characterization	The evaluators determined that the pre-retrofit billing data did not represent the facility's baseline.	1	-2%	2%	1
Analysis methodology	Inaccurate normalization of typical weather	The evaluators normalized the pre- and post-project utility billing data to TMY3 weather data.	10	-5%	6%	19
	Impacts from project measures not incented (program influence via spillover)	The evaluators included the energy effects of project measures which were installed in conjunction with the fuel oil conversion.	4	-7%	43%	11
	Residual impacts due to changes in building heating load	The evaluators included the energy effects of changes in the building heating load.	6	-9%	11%	7
	Updated CO_2e emissions values	The evaluators used the most recent fuel emissions data approved by NYSERDA.	31	-63%	1%	1
Totals			**71**	**-106%**	**355%**	**73**

Table 4-2 highlights a number of key contributors to the 249% RR for carbon emissions reduction. Some notable contributing categories include the following:

- **Updated CO_2e emissions values** occurred most frequently, as the latest CO_2e emissions values recommended by NYSERDA featured lower carbon content per MMBtu than the factors incorporated in the Program's incentive calculator. Further information on this difference can be found in Appendix E.
- **Impacts from project measures not incented** reflect the carbon emissions reduction due to energy efficiency measures that occurred concurrently with the fuel conversion project.
- **Inaccurate normalization of typical weather** featured a high number of both positive and negative occurrences. The Program incentive reflected a building heat load determined from a three-year average of #6 fuel oil delivery bills. To account for year-to-year fluctuations in weather, the evaluators normalized both pre- and post-project bills using typical meteorological year (TMY) degree day data. Although this category was frequently

identified, its impact on the overall result was minimal, as equal magnitudes of positive and negative CO_2e impacts were observed.

4.1.4 Differences in Fuel Conversion Classification

The most impactful difference was predicted by the Impact Evaluation Team during M&V sample post hoc stratification. The Program's conservative classification of fuel conversion type was the primary contributor to the high realization rate, leading to 166% greater CO_2e savings than reported by the Program. The Impact Evaluation Team acknowledges that the program staff anticipated that several participating facilities would eventually convert to firm natural gas; however, delays in establishing the natural gas connection prevented such facilities from demonstrating firm gas use at the time of the Program's post-project inspection. The Program therefore conservatively classified such projects as dual-fuel, because #2 fuel oil was still consumed at the time of the Program's incentive payout.

This occurrence was the primary reason for the higher-than-expected firm gas counts outlined in Section 3.2.3. The Impact Evaluation Team investigated all 117 projects in the population to confirm the permanent post-project fuel type. This investigation consisted of:

- Review of all project files, including post-project inspection forms and photos, to determine if a gas connection was established and all fuel oil-related apparatus was disconnected,
- Request and review of monthly natural gas bills and fuel oil delivery data to determine which fuel(s) covered the building's apparent heating load, and
- Inclusion of a question in the attribution telephone survey on current heating fuel type(s) consumed at the facility.

For the 32 projects in the M&V sample, the Impact Evaluation Team accounted for all post-project fuels in each analysis. Therefore, for projects that featured a combination of fuel types after the conversion, such as those with a delay in firm gas connection or those with interruptible gas connections, the partial #2 fuel oil consumption is accounted for in each project's lifetime savings analysis.

4.2 PROGRAM ATTRIBUTION RESULTS

Telephone surveys were administered in the fall of 2014 and responses were collected from decision-makers (owners/managers) representing 51 of the 117 projects in the evaluation population. The survey included some initial questions on familiarity with Local Law 43, its deadline and penalties, and the ways in which participants learned about MCERP. Appendix C includes a copy of the

telephone survey. The overall objective of the survey, however, was to gather information on the Program's influence due to accelerated compliance, cleaner fuel type, and efficiency improvements through a number of open-ended and multiple-choice questions. Each of these three contributors is addressed in subsequent sections. Though these sections provide summaries of survey responses, a more comprehensive list of survey results can be found in Appendix F.

4.2.1 Influence through Accelerated Compliance

The Impact Evaluation Team asked decision-makers a number of questions related to conversion timing, in order to quantify the effect of the Program on converting before the July 2015 deadline. A summary of these questions and the general findings is provided in Table 4-3.

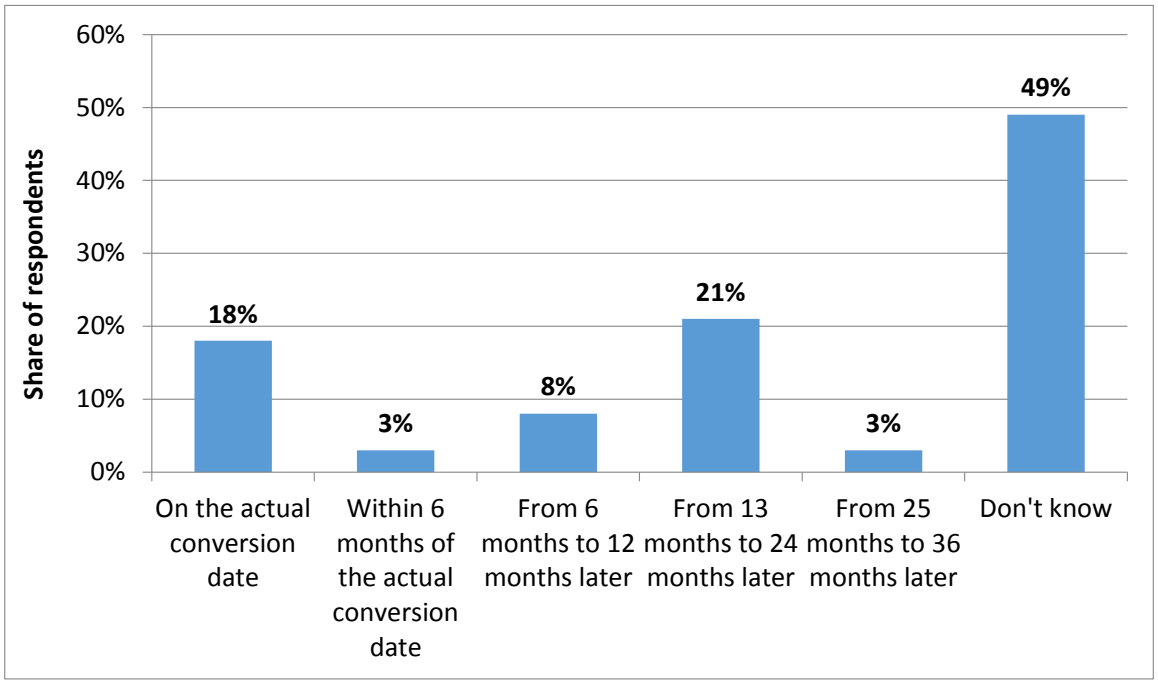
Table 4-3. Summary of Compliance- and Timing-Related Survey Responses

Survey Question Topic	# of Respondents	Finding
Penalties associated with Local Law 43	19	95% of respondents indicated that they were aware of the penalties associated with failure to comply with the law.
Compliance plans if Program did not exist[1]	30	61% of respondents said they would have complied but did not offer specifics, while 39% stated they would have specifically complied by converting to #2 fuel oil or #4 fuel oil.
Program impact on conversion timing[1]	41	66% of respondents said the Program caused them to convert earlier than they otherwise would have (without the Program). 15% stated that the Program did not influence when their conversion occurred.
Hypothetical conversion date if Program did not exist (in months after actual conversion date)	39	Nearly half of respondents could not offer an estimate, while 18% of respondents said the conversion date would have been the same. See Figure 4-3.

[1] These questions were open-ended, but the Impact Evaluation Team has combined similar responses together for simplicity.

Figure 4-3 illustrates the responses to the last question topic listed in Table 4-3 regarding fuel conversation date.

Figure 4-3. Hypothetical Conversion Date if Program Did Not Exist



The Impact Evaluation Team analyzed these timing-based responses in order to calculate a program acceleration effect in months. In this analysis, responses were weighted by program-reported CO_2e emissions reduction before aggregation. Across the 20 respondents who provided specific answers on how much later they would have converted[19], the Impact Evaluation Team determined that **the Program accelerated conversions by 7.9 months**. Therefore, since the evaluation population features an average actual conversion date of October 2012 (per Program tracking data), these facilities would have converted in June 2013, on average, if the Program did not exist. During this period of approximately 8 months, the evaluated gross carbon emissions savings are fully attributable to the Program.

4.2.2 Influence on Fuel Choice

The telephone survey next addressed the Program's influence on facilities' choice of new fuel type through incentives and technical support. The objective of this research was to quantify the amount of CO_2e emissions reduction from conversions to natural gas, above and beyond the Program's minimally eligible #2 fuel oil, that was attributable to the Program. The Impact

[19]Forty-nine percent of respondents could not offer an estimate in months and responded with "do not know." The Impact Evaluation Team recognizes that the lower-than-desired response rate contributes to the uncertainty of the acceleration finding. However, we believe that the acceleration period finding is reasonable, given the incentive dollars offered and the three-year window between program implementation and the conversion deadline.

Evaluation Team asked questions related to post-project fuel type, reasons the fuel was chosen, and program influence on fuel choice. The responses to these questions are summarized in Table 4-4 and Appendix F.

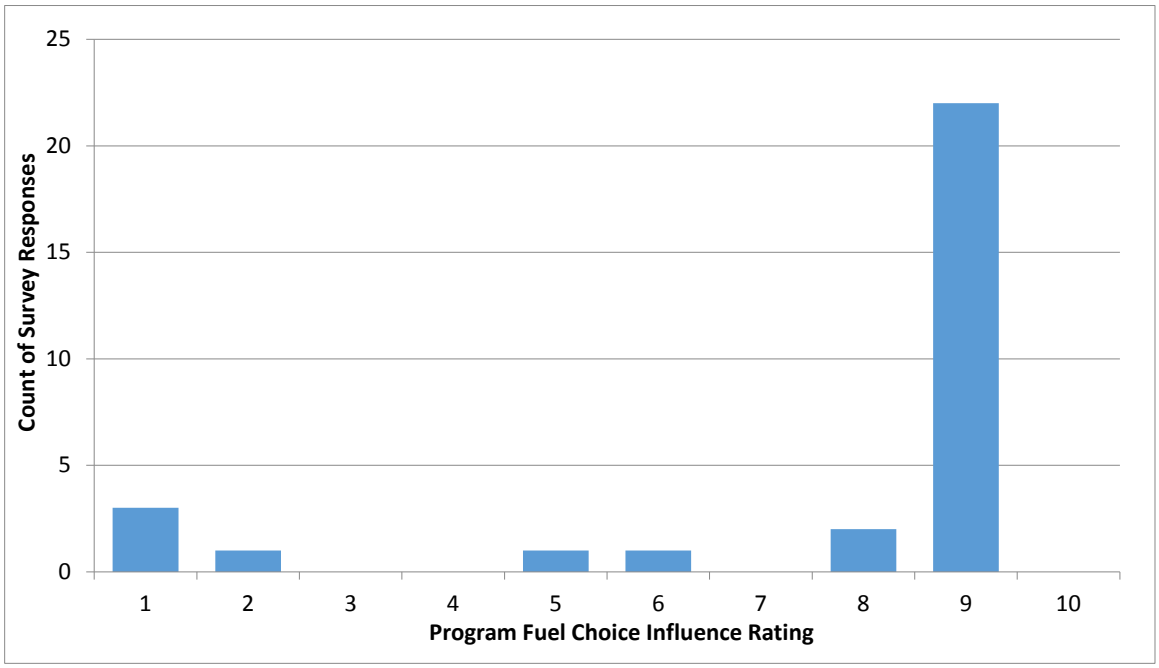
Table 4-4. Summary of Survey Responses Related to Fuel Choice

Survey Question Topic	# of Respondents	Finding
Post-project heating fuel type	50	Nearly all respondents (96%) indicated that they are consuming primarily natural gas, either through firm or interruptible accounts.
Reasons for choosing natural gas[1]	48	Of the respondents indicating that they consumed primarily natural gas, 36% indicated they chose gas because it was the cleanest option, while 28% said it was the cheapest to operate. It should be noted that this question did not yet address the effect of the Program's influence (via incentives and technical support) on the decision to switch to natural gas.
Program influence on fuel choice	29	79% of respondents indicated that the Program influenced their choice to convert to a fuel cleaner than the minimum #2 fuel oil. 21% indicated they chose the same fuel that they would have if the Program did not exist.
Program influence on fuel choice (0-to-10 scale)	39	See Figure 4-4. This question quantifies the Program's influence in order to account for other possible influences, such as cost savings, ease-of-use, or sudden availability of natural gas infrastructure.
Reasons for program influence on fuel choice[1]	37	68% of respondents indicated that the Program's incentives made it more affordable to convert to a cleaner fuel or brought the project to a level where the management board agreed to move forward.

[1] These questions were open-ended, but the Impact Evaluation Team has combined similar responses together for simplicity.

Figure 4-4 provides a breakdown to participant responses to a question regarding the Program's influence on fuel selection on a scale of 0 (no influence) to 10 (full influence).

Figure 4-4. Participant Ratings of Program's Influence on Fuel Choice



As the figure illustrates, the majority of respondents indicated high influence from the Program on their new heating fuel choice. Of the 30 respondents, 24 (80%) indicated scores of 8 or higher, with 22 (73%) respondents indicating a 9 on the 10-point scale. These ratings, as further discussed in Section 4.3, were weighted by facility heating load in order to determine the overall fuel choice influence factor applied to lifetime CO_2e savings. Therefore, despite the prevalence of ratings of 8 or higher, the overall fuel choice influence factor was much lower after weighting was applied.

The Impact Evaluation Team used this information to quantify the emissions reduction attributable to the Program from conversions to natural gas. As MCERP participants were required to convert to #2 fuel oil at the very least, the calculation considers fuel choice influence above and beyond a baseline of #2 fuel oil. The fuel choice calculation also does not include carbon savings from efficiency improvements, as described in the next section, in order to avoid double-counting those carbon savings.

After aggregating responses, the Impact Evaluation Team determined that the Program influenced the fuel choice decision for 49% of incremental carbon emissions savings from firm gas conversions and 31% of incremental savings from interruptible gas conversions. **The Program's overall fuel choice influence factor is 37%,** after combining data for both firm and interruptible conversions.

4.2.3 Influence on Efficiency Improvements

The Program influenced participants a third way, although not through incentive dollars. Program technical support during the conversion project led to some facilities undertaking efficiency improvements to the facility heating system at the time of the fuel conversion project. Common efficiency measures included boiler replacements, burner replacements, and boiler controls installations. Table 4-5 indicates the prevalence of additional efficiency measures, as well as the effective useful life (EUL) for each of these measures, among the 32 projects in the M&V sample.

Table 4-5. Information on Supplemental Efficiency Measures

Measure	Number of Instances (32 sampled projects)	EUL (Years)
Replace boiler	4	20[a]
Install high-efficiency burner	9	20[a]
Install boiler controls	5	15[b]
Insulate steam piping	3	15[b]
Building envelope improvements	3	15[b]

[a] "The Bottom of the Barrel: How the Dirtiest Heating Oil Pollutes Our Air and Harms Our Health," M.J. Bradley and Associates, Chapter 4, page 2. http://www.edf.org/sites/default/files/10072_EDF_BottomBarrel_Ch4.pdf

[b] "Appendix M: Guidelines for Early Replacement Conditions," New York Department of Public Service, page 11. http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/06f2fee55575bd8a852576e4006f9af7/$FILE/Appendix%20M%20final%205-05-2011.pdf

The additional carbon emissions reduction resulting from these efficiency improvements was not factored in to the Program's incentive calculator or reported savings by project. Therefore, these additional savings are most appropriately classified as inside spillover (ISO). Spillover savings were quantified by the engineering team for the 32 sites in the M&V sample. Table 4-2 indicates that **these supplementary measure savings led to a 36% increase in realization rate**.

4.3 CALCULATION OF EVALUATED LIFETIME SAVINGS

The Impact Evaluation Team defines lifetime net savings as the sum of contributions from the three program influences addressed in the preceding sections.

$$Program\ net\ savings = Acceleration\ savings + Fuel\ choice\ savings + Efficiency\ savings$$

where,

Program net savings = Carbon emissions reduction attributable to the Program

Acceleration savings = Carbon emissions reduction attributable to the Program through accelerated compliance

Fuel choice savings = Lifetime carbon emissions reduction attributable to the Program through influence on new fuel choice

Efficiency savings = Lifetime carbon emissions reduction attributable to the Program from supplementary efficiency measures not reflected in project incentives

The three savings components vary in EUL and savings derivation. Table 4-6 summarizes the EUL and savings magnitude for each influence component. Further details on the component-level savings calculations can be found in Appendix G.

Table 4-6. MCERP Attributable Savings by Component

Net Savings Component	EUL	Lifetime Savings Magnitude (Tons CO_2e)
Accelerated conversion	7.9 months	30,673
Fuel choice influence	20 years[1,2]	335,757
Efficiency improvements	15–20 years[1,2,3]	125,946
Total attributable lifetime savings		**492,376**

[1] Fuel choice influence and efficiency savings are eligible after the 7.9-month acceleration period expires.

[2] "The Bottom of the Barrel: How the Dirtiest Heating Oil Pollutes Our Air and Harms Our Health," M.J. Bradley and Associates, Chapter 4, page 2. http://www.edf.org/sites/default/files/10072_EDF_BottomBarrel_Ch4.pdf

[3] "Appendix M: Guidelines for Early Replacement Conditions," New York Department of Public Service, page 11. http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/06f2fee55575bd8a852576e4006f9af7/$FILE/Appendix%20M%20final%205-05-2011.pdf

Figure 4-5 illustrates the Program's attributable carbon savings by component and by year.

Figure 4-5. MCERP Attributable Carbon Savings by Component by Year

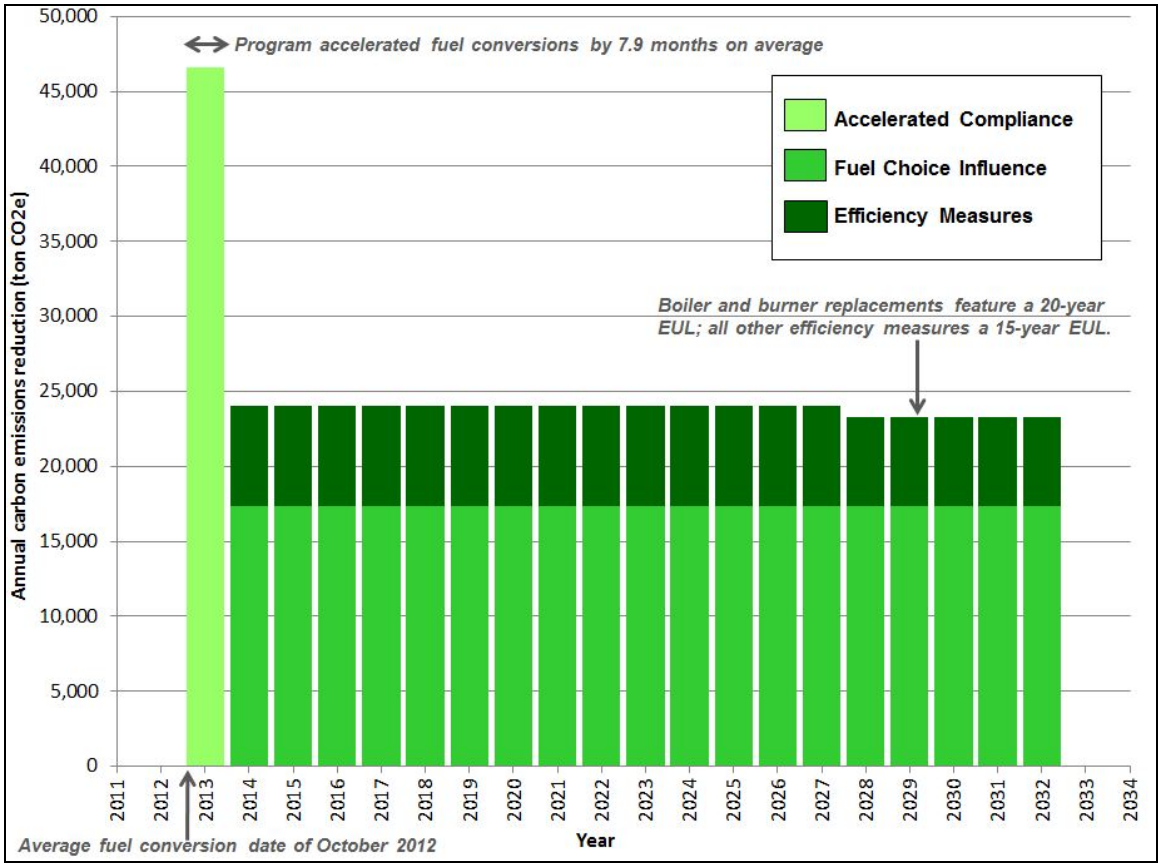


Table 4-7 summarizes the results of the impact evaluation study, including M&V and attribution research findings.

Table 4-7. MCERP Impact Evaluation Summary of Results

Parameter	Value
A – Program-reported 13-year[1] emissions reduction (tons CO_2e)	243,351
B – Realization rate (RR)	2.49
C – Evaluated gross 13-year emissions reduction (tons CO_2e) (A × B)	605,944
D – Evaluated net lifetime[2] emissions reduction (tons CO_2e)	492,376
E – Relative precision of evaluated net savings at 90% confidence interval	6%

[1] The Program assumed 10 years of lifetime carbon emissions reduction per project in the project-level incentive calculator tool and tracking database. However, NYSERDA reported 13 years of lifetime carbon emissions reduction for MCERP projects in quarterly status reports to RGGI (e.g., http://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/RGGI/2014-Q4-RGGI-Status-Report.pdf). Therefore, since impact evaluations typically compare evaluated savings with reported savings, the Impact Evaluation Team has assumed 13 years of program-reported carbon emissions reduction.

[2] The Impact Evaluation Team determined varying lifetimes for each of the three program influence contributors, as further discussed in Section 4.2 and presented in Table 4-6. Overall, the Impact Evaluation Team determined a longer lifetime for fuel conversion projects than the 13 years reported by the Program. This difference was factored into the net carbon emissions savings calculation.

4.4 FINDINGS AND CONCLUSIONS

This section summarizes major findings from this impact evaluation study and outlines lessons learned for future NYSERDA programs that may share commonalities with MCERP.

4.4.1 Major M&V Findings

The Impact Evaluation Team's three major M&V findings are revisited below.

1. Inconsistencies between program fuel conversion classification and the actual new fuel type was the primary driver of the 249% RR. Though the Program anticipated that several participating facilities would eventually convert to firm natural gas, delays in establishing the gas connection led to the Program's classification of these projects as dual-fuel.
2. When calculating project incentives and reported savings, the Program conservatively assumed 100% #2 fuel oil is consumed for dual-fuel projects. This conservative approach was used due to the inability of some customers to convert to natural gas at the time of project application, mostly due to lack of gas infrastructure in their neighborhoods. Conversions from #6 fuel oil to firm natural gas save about five times more carbon emissions than conversions from #6 fuel oil to #2 fuel oil. The Impact Evaluation Team therefore calculated an RR of approximately 500% for several projects in the M&V sample.
3. The Program's reported savings calculator incorporated CO_2e emissions factors that have since been revised by both NYSERDA and the EPA. The Impact Evaluation Team used the latest emissions factors recommended by NYSERDA. These differences are outlined in Appendix E and led to a 63% reduction in realization rate.

4.4.2 Major Attribution Findings

The Impact Evaluation Team's four major attribution findings are summarized below.

1. The Program's reported savings reflect 13 years of reduced carbon emissions from the fuel conversion; however, this lifetime estimate was unrealistic due to the impending Local Law 43 deadline approximately 4 years after the Program began processing applications. Our research on accelerated compliance indicated that the Program accelerated fuel conversions approximately 8 months sooner than the participants hypothetically would have converted without the Program. During this 8-month period the full evaluated gross savings are attributable to the Program.
2. The Program was influential in participants' choice of new fuel type. Program incentives made capital-intensive conversions to natural gas financially viable for many participants.

Further, the Program's technical support provided clear options for participants interested in learning more about cleaner-than-minimum fuels. This influence led to 37% of the incremental carbon emissions savings from conversions to firm or interruptible gas to be attributed to the Program. This factor is based on participant survey responses on the Program's fuel choice influence, weighted by facility heating load.

3. The Impact Evaluation Team estimated an effective useful life (EUL) for burner-related measures, such as burner retrofits associated with nearly all conversion projects, to be 20 years. Therefore, the Program's lifetime savings from fuel choice influence perpetuate for the 20-year life of the burner measure.

4. The Program's technical support influenced participants to implement supplementary efficiency measures at the time of the fuel conversion. These additional measures were not considered in the Program's calculations of incentive or reported CO_2e savings. Therefore, these additional savings are most appropriately categorized as spillover (SO) and are therefore attributable to the Program. The Impact Evaluation Team determined that supplementary measures led to a 36% increase in realization rate among the sampled M&V projects.

4.4.3 Lessons Learned for Future Similar Programs

The impact evaluation's net savings result of 492,376 tons of lifetime carbon emissions reduction, as compared with 243,351 tons CO_2e as reported by the Program, indicates that the Program successfully achieved higher-than-anticipated carbon savings. Despite the impending Local Law 43 deadline, which required all downstate multifamily consumers of #6 fuel oil to convert by July 2015, the MCERP recognized and provided additional CO_2e savings opportunities for participating customers, through strategic incentive design and timely execution. The Program's incentives and technical support encouraged participants to convert 8 months earlier than they otherwise would have, to choose a cleaner-than-minimum fuel more than a third of the time, and to often implement supplementary efficiency measures at the time of the fuel conversion project.

Although the MCERP is now defunct, the one-time program may share some similarities with future NYSERDA programs in the Clean Energy Fund[20] (CEF) landscape. The findings from this study may serve as examples to future similar programs:

- **The Program acted quickly.** Although the MCERP did not predict every project's savings perfectly, credit is due to the NYSERDA staff for recognizing the law's impending deadline and swiftly and effectively designing and rolling out the Program in 2011. This timeliness serves as an example for other time-critical programs in the future, such as those developed after a natural disaster or as a result of federal, state, or municipal mandates.
- **The Program's lifetime savings approach was appropriate.** Although the Impact Evaluation Team's EUL recommendations differed from the Program's, the MCERP appropriately tracked project savings over the life of the measure. As carbon emissions-based programs are expected to play a role in CEF, the Impact Evaluation Team recommends life-cycle program design and tracking for such programs.
- **Participants often adopted supplementary efficiency measures without an incentive.** Technical support from MCERP staff proved to be very valuable to participants considering efficiency improvements at the time of the conversion. As NYSERDA programs potentially shift away from incentive-based design, the MCERP demonstrated that efficiency gains are possible with effective customer education and technical guidance from the program staff.

[20]Clean Energy Fund Information Supplement," NYSERDA, June 2015. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={FC3FBD53-FBAC-41FB-A40E-3DA0A5E0866A}

APPENDIX A: GLOSSARY OF TERMS[1]

accelerated conversion – The Program's influence on participating customers to convert their heating systems earlier than they otherwise would have without the MCERP.

appendix M[2] – An appendix to the New York Technical Manual (NYTM) that provides guidance to program administrators and evaluators for the use of early replacement baseline versus normal replacement baseline. Appendix M does not directly apply to most of the projects in this evaluation population; however, its guidance allows evaluators to define preexisting equipment as the evaluation baseline when appropriate.

applicant – The Impact Evaluation Team uses this generic term to describe the entity estimating each project's reported savings.

billing analysis – Estimation of program savings through the analysis of utility consumption records comparing consumption prior to program participation and following program participation. This term encompasses a variety of types of analysis, from simple pre-/post- comparison to complex regressions that involve weather normalization.

census – All individuals in a group. In evaluations of energy efficiency programs census typically refers to all projects in a stratum of program projects.

dual-fuel – Refers to facilities that feature more than one heating fuel option (e.g., natural gas and #2 fuel oil). The customers, not the utility, decide when each of the fuels is consumed.

early replacement – The replacement of equipment before its effective useful life has been reached.

equivalent carbon dioxide (CO_2e) – A measurement of emissions reduction that accounts not only for CO_2 reduction, but also for other emitted gases (e.g., methane, nitrous oxide), for which emissions are converted to equivalent CO_2 emissions.

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

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[1] NYSERDA generally follows and uses the terms as defined in the "Northeast Energy Efficiency Partnerships Glossary of Terms," found at http://neep.org/uploads/EMV%20Forum/EMV%20Products/EMV_Glossary_Terms_Acronyms.pdf. This glossary defines those terms absent from the Northeast Energy Efficiency Partnerships (NEEP) report or provides more specific definitions to generalized NEEP terms.

[2] Appendix M can be found at: http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/06f2fee55575bd8a852576e4006f9af7/$FILE/Appendix%20M%20final%205-05-2011.pdf

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

where,

n is the sample size

w_i is the population expansion weight associated with each sample point i

x_i is the program reported savings for each sample point i

y_i is the evaluated gross savings for each sample point i, the constant gamma, $\gamma = 0.8$ (typically), and the error for each sample point $e_i = y_i - bx_i$, where b is the program realization rate

evaluated gross savings – The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated, as calculated by program evaluators.

evaluated net savings – The total change in load that is attributable to an energy efficiency program, as calculated by program evaluators. This change in load may include, implicitly or explicitly, the effects of free drivers, free riders, energy efficiency standards, changes in the level of energy service, and other causes of changes in energy consumption or demand.

firm gas – A natural gas account that allows only natural gas to be consumed throughout the year. A firm gas account cannot be interrupted by the utility.

free rider, free ridership (FR) – A free rider is a program participant who would have implemented the program measure or practice in the absence of the program. Free ridership refers to the percentage of savings attributed to customers who participate in an energy efficiency program but would have, at least to some degree, installed the same measure(s) on their own if the program had not been available.

fuel choice influence – The Program's influence on participating customers' decisions to convert to a fuel cleaner than the minimally eligible #2 fuel oil.

interruptible gas – A natural gas account that relies on other fuel(s) as backup, which can be activated by the utility, typically on the coldest days of the year.

IPMVP Option A – This M&V option involves the partial measurement of isolated equipment affected by the evaluated measure. Relevant equipment variables are spot-measured when possible or stipulated when necessary.

IPMVP Option B – This M&V option involves full measurement of the isolated equipment affected by the evaluated measure. No stipulations are allowed. Both short-term and continuous data monitoring are included under Option B.

IPMVP Option C – This M&V option involves the use of utility meters to assess the performance of a total building. Option C addresses measure impacts in aggregate, not individually, if the affected equipment is connected to the same meter.

IPMVP Option D – This M&V option involves the use of computer modeling to determine facility or equipment energy use. Option D requires calibration with actual utility consumption data for either the pre-project or post-project period.

net to gross, net-to-gross ratio (NTG, NTGR) – NTG is the relationship between net energy and/or demand savings – where net is measured as what would have occurred without the program or what would have occurred naturally – and gross savings (often evaluated savings). The NTGR is a factor represented as the ratio of net savings actually attributable to the program divided by program gross savings. For NYSERDA programs the NTGR is defined as 1 minus free ridership plus spillover.

New York Technical Manual (NYTM) – An abbreviation of New York State's 2010 measure savings guidance document, "New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs."[3]

nonparticipants/nonparticipating – Any customer or contractor who was eligible but did not participate in the program under consideration. Nonparticipating contractors can include (1) contractors that have never participated in the program and (2) contractors that formerly participated, prior to the year(s) being evaluated, but have not participated since.

normal replacement – The replacement of equipment that has reached or passed the end of its measure-prescribed energy useful life.

realization rate (RR) – The ratio of the evaluated gross savings to the Program's reported savings. The RR represents the percentage of program-estimated savings that the evaluator estimates as being actually achieved based on the results of the evaluation M&V analysis. The RR calculation for carbon savings for a sampled project is shown below:

$$RR = \frac{CO_2e_{evaluated}}{CO_2e_{reported}}$$

[3] http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/766a83dce56eca35852576da006d79a7/$FILE/TechManualNYRevised10-15-10.pdf

where,

RR is the realization rate

$CO_2e_{evaluated}$ is the evaluation M&V CO_2e savings (by evaluation M&V contractor)

$CO_2e_{reported}$ is the CO_2e savings claimed by program

relative precision – Relative precision reflects the variation due to sampling as compared to the magnitude of the mean of the variable being estimated. It is a normalized expression of a sample's standard deviation from its mean. It represents only sampling precision, which is one of the contributors to reliability and rigor, and should be used solely in the context of sampling precision when discussing evaluation results.

Relative precision is calculated as shown below. It must be expressed for a specified confidence level. The relative precision (*rp*) of an estimate at 90% confidence is given below:

$$rp = 1.645 \frac{sd(\mu)}{\mu}$$

where,

μ is the mean of the variable of interest

sd(μ) is the standard deviation of μ

1.645 is the *z* critical value for the 90% confidence interval

For the 90% confidence interval, the error bound is set at 1.645 standard deviations from the mean. The magnitude of the *z* critical value varies depending on the level of confidence required.

RGGI – The Regional Greenhouse Gas Initiative (RGGI) is a market-based regulatory program designed to reduce greenhouse gas emissions throughout New York, New England, Maryland, and Delaware. The MCERP is solely supported through RGGI funds.

spillover (SO) – Refers to the energy savings associated with energy efficient equipment installed by consumers who were influenced by an energy efficiency program, but without direct financial or technical assistance from the program. SO includes additional actions taken by a program participant as well as actions undertaken by nonparticipants who have been influenced by the program. Sometimes SO is referred as "market effects." Market effects are program-induced impacts or program-induced changes in the market over time. These market effects may be current or may occur after a program ends. When market effects occur after a program ends, they are referred to as "momentum" effects or as "post-program market effects." SO is often a narrower definition because it

does not include impacts that accrue due to program-induced market structure change and seldom looks for effects that occur well after program intervention or effects that occur after a program ends. This evaluation addresses participant inside spillover.

inside spillover (ISO) – Occurs when, due to the project, additional actions are taken to reduce energy use at the same site, but are not included as program savings, such as when, due to the program, participants add efficiency measures to the same building where program measures were installed, but they did not participate in the program for these measures.

outside spillover (OSO) – Occurs when an actor participating in the program initiates additional actions that reduce energy use at other sites that are not participating in the program. This can occur when a firm installs energy efficiency measures they learned about through the program at another of their sites without having that other site participate in a NYSERDA program. OSO is also generated when participating vendors install or sell energy efficiency to nonparticipating sites because of their experience with the program.[4]

nonparticipant spillover (NPSO) – The reduction in energy consumption and/or demand from measures installed and actions taken at nonparticipating sites due to the program's existence but not due to participation in the program and not induced by program participants – either building owners/managers or program performance partners. These actions could be due to program-induced decision-making of nonparticipating building owners or encouragement of nonparticipating vendors or contractors because of program influence.

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

[4] This definition is one that NYSERDA has used throughout its history with energy efficiency programs. There may be other states where the latter circumstance of participating vendors influencing nonparticipating sites is defined as a type of nonparticipant spillover.

APPENDIX B: MCERP EVALUATION BASELINE FRAMEWORK

The Multifamily Carbon Emissions Reduction Program, by design, targets a reduction in the facility's pre-project CO_2 emissions. Therefore, in all MCERP retrofit projects the preexisting conditions serve as the project baseline. The Program's baseline framework poses a challenge to determining true evaluation baseline and M&V savings for sampled projects. Due to the extensive data collection and verification performed by Program staff during the application process, the evaluators anticipated that nearly all sampled projects would feature an evaluation baseline reflecting the preexisting systems.

In preparation for this evaluation baseline framework, the evaluators referenced the approach used by the concurrent impact evaluation of the Multifamily Performance Program (MPP). In particular, the MPP baseline framework is guided by the New York Technical Manual's (NYTM) Appendix M process for determining the appropriate dual baseline weighting for savings calculations over the life of the early replacement measure. However, evaluated gross savings in this study reflect first-year savings only.

A follow-up order to the NYTM, issued October 18, 2010, addresses the "special circumstances" for which an early replacement baseline might be considered even for replacement of equipment that has exceeded its effective useful life (EUL). According to the order,

> *Special circumstance replacements relate only to commercial and industrial machinery and multifamily central systems, but not to lighting equipment. . . . Special circumstance replacements would typically address equipment operated by customers which are influenced by initial costs more than by life cycle economics, customers lacking capital, customers with split incentives (such as landlord cost for tenant benefit), customers with short time horizons, and other factors which tend to prevent long range economic decision-making with regard to the installation of high efficiency equipment . . . the general outline of criteria regarding the equipment in place to be determined onsite will be:*
>
> - *Equipment age significantly exceeds its effective-useful-life;*
> - *Energy consumption significantly exceeds that of current high efficiency models;*
> - *There is a history of significant repair or replacement with used equipment; and*
> - *The prospective next repair or replacement is likely to initially be much less expensive than replacement with new higher efficiency machinery.*
>
> *Equipment fitting these criteria would be subject to a form of dual baseline TRC screening which will reflect the concept that the equipment, while past its effective-useful-life, would likely operate*

> *for several additional years, and will allow energy savings for that period to be calculated against the in-place equipment. Under this approach, first year savings would be reported as the difference between the existing equipment's electric usage and that of the high efficiency equipment which replaces it.*

The DPS baseline guidance on multifamily central equipment was used to define preexisting equipment as the evaluation baseline when deemed appropriate. This was accomplished by the evaluation engineers asking a series of questions while on-site to determine whether or not the replaced equipment had reached the end of its life. The site-specific evaluation survey was intended to confirm (or, in a few cases, disprove) the Program's early replacement claim. The question battery included the following:

B1. How old was the preexisting equipment? Provide estimate/range if unknown.

B2. Was the preexisting equipment operable at the time of equipment replacement?

If no, skip to B8.

B3. Were any equipment components replaced in the past ten years (e.g., boiler burner)?

B4. Were any major patches required to keep the equipment operable over the past ten years?

B5. How often was the equipment inspected or recommissioned in the preexisting configuration?

B6. Please describe the maintenance procedure for the preexisting equipment.

B7. Please estimate how long the preexisting equipment would have operated had it not been replaced as a result of the project?

End.

B8. Please describe the performance issues with the preexisting equipment.

B9. If the equipment had not been replaced as a result of the project, would you have repaired the preexisting equipment to prolong its life?

End.

After considering responses to the questions, reviewing the application materials, and accounting for the Appendix M special circumstances applicability and overall framework, the engineer judged whether the replaced equipment was replaced early or at the end of its life. For all 32 projects in the engineering sample, the evaluators confirmed that the affected preexisting boilers were sufficiently operable to qualify for Appendix M's special circumstance exception. Therefore, the evaluation baseline reflected the preexisting boiler(s) for all sampled fuel conversion projects.

APPENDIX C: PARTICIPANT ATTRIBUTION SURVEY

This appendix provides a copy of the participating owner/manager attribution survey.

Participating Property Owners/Managers – Professional Interview Guide

Introduction/Screening

Hello. This is _____ calling from Abt SRBI, on behalf of the New York State Energy Research and Development Authority, NYSERDA. May I please speak with *[PROGRAM CONTACT]*?

[WHEN RESPONDENT COMES ON THE LINE] Hello. This is _____ calling from Abt SRBI, on behalf of the New York State Energy Research and Development Authority, or NYSERDA. I am calling to learn about the fuel conversion project you undertook and your experience with the NYSERDA energy efficiency program at your multifamily property.

Our records show that your firm received an incentive from NYSERDA's Multifamily Carbon Emission Reduction Program associated with your firm's recent conversion from #6 fuel oil to *[NEW FUEL]*. This incentive was to encourage you to undertake this conversion earlier than required by NYC law, as well as to help offset a portion of the cost of this conversion.

Our firm is conducting research for NYSERDA, the information you provide will be used to improve NYSERDA's programs and will be kept confidential to the extent permitted by law.

SC1. Are you the person most knowledgeable about the decision to participate in the program? *[IF NOT, ASK TO BE TRANSFERRED TO MOST KNOWLEDGEABLE PERSON OR RECORD NAME & NUMBER.]*

1	Yes, that would be me	SC2
2	Yes, let me transfer you to _____.	SC1c.
3	No, that person is not available right now	SC1a.
4	Unable to refer someone who can help	Thank and terminate
77	No, other reason (specify)	Thank and terminate
88	Refused	Thank and terminate
99	Don't know	Thank and terminate

SC1a. *[IF RECOMMENDED CONTACT IS NOT CURRENTLY AVAILABLE]*

When would be a good day and time for us to call back?

77	Record day of the week, time of day and date to call back	SC1b
88	Refused	Thank and terminate
99	Don't know	Thank and terminate

SC1b. Is there a phone extension or phone number you recommend we use when we call back?

77	Record extension or phone number, &PHONE	Thank and terminate
88	Refused	Thank and terminate

99	Don't know	Thank and terminate

SC1c. Our records show that your firm recently received an incentive from NYSERDA's Multifamily Carbon Emission Reduction Program associated with your firm's recent conversion from #6 fuel oil to a cleaner fuel alternative. This incentive was to encourage you to undertake this conversion earlier than required by NYC law, as well as to help offset a portion of the cost of this conversion. We are calling to do a follow-up study about your participation in NYSERDA's program. Throughout the remainder of the survey, we will refer to the Multi-family Carbon Emission Reduction Program as the Program, and to the New York State Energy Research and Development Authority as NYSERDA.

I was told that you are the person most knowledgeable about the decision to participate in the Carbon Emission Reduction program, is that correct?

1	Yes	SC1d
2	No	Thank and terminate
88	Refused	Thank and terminate
99	Don't know	Thank and terminate

Our firm is conducting research for NYSERDA The information you provide will be used to improve NYSERDA's programs and will be kept confidential to the extent permitted by law.

[ASK ALL.]

SC1d. This survey will take about 10 minutes. Is now a good time?

1	Yes, continue	SC2
2	No	*[SCHEDULE Callback]*

Screener for Address

SC2 Our records show your multi-family property is located at *[ADDRESS]* in *[CITY]*. Is that correct? *[CONTINUE IF ADDRESS REPORTED BY RESPONDENT IS SIMILAR ENOUGH, SUCH AS MATCHING STREET NAME AND/OR MATCHING STREET NAME AND BUILDING NUMBER IS IN SAME BLOCK]*

1	Yes	SC3a.
2	Yes, but we use a different official address	Record, continue SC3a.
3	No	SC2a.
88	Refused	Thank and terminate
99	Don't know	Thank and terminate

SC2a. May I have your correct address?

77	Record corrected address	COMPARE

COMPARE {Are these addresses similar or totally different?

Computer Address - &ADDRESS

Corrected Address - &CORRECT

1	Similar	SC3a.
2	Totally different	Thank and terminate

Comment: The questions in this survey will refer to your "property," which means ALL of the buildings and tenants located at *[ADDRESS]* in *[CITY]*.

Terminate: We were attempting to reach *[PROGRAM CONTACT]* at *[ADDRESS]* in *[CITY]* and since that does not match your address, then we must have misdialed the telephone number. Those are all the questions that we have for you today, on behalf of NYSERDA. Thank you for your time and cooperation.

Introduction

[EXPLAIN:] The Multifamily Carbon Emissions Reduction Program (the "Program") provided financial assistance to owners of multifamily buildings seeking to convert their heating systems from the use of #6 fuel oil to less carbon-intense fuels or renewable energy sources.

[*IF NEEDED:* Cleaner fuels for buildings that currently use #6 fuel oil include natural gas, #2 fuel oil, biofuels/biodiesel blends, waste gas from landfills and digesters, propane, woody biomass, and renewable energy sources such as solar thermal and geothermal systems.]

[EXPLAIN:] I would like to ask you a series of questions to get a sense of how NYSERDA's program may have influenced the timing and economics of this conversion that you were required to do.

Awareness of Conversion Requirement

A1. Were you aware that New York City had adopted a local law to encourage multifamily buildings to convert to cleaner fuels?

1 Yes

2 No

3 DK/refused

A2. What can you tell me about this local New York City law *(DO NOT READ: With regard to your requirement to convert to a cleaner fuel?*)

1 Record verbatim

2 DK/refused

A3. How did you learn about this law?

1 Record verbatim

2 DK/refused

A4. When did you learn about this law?

1. Record verbatim
2 DK/refused

A5. Were you also aware that your building was required to convert to a cleaner fuel through a local New York City law before you started working with NYSERDA on this conversion project? Would you say you were…

1 Aware and had definite retrofit plans with funding
2 Aware but hadn't made plans yet
3 Familiar but hadn't really thought through the process or set aside funds, or
4 Not aware
5 DK/Refused

[*EXPLAIN IF NEEDED*: The NYC Clean Heat, Local Law 43 requires all buildings that burn #6 fuel oil to switch to a cleaner equivalent by July 2015. The specific dates for conversion are based on when the boiler inspection certificates expire. You elected to complete this conversion on time, while taking advantage of NYSERDA's program and incentives. According to the New York City Clean Heat database, your property at *[ADDRESS]* was required to convert on or before *[CONVERSION DATE]*. This date is when your boiler permit expires.]

New Fuel

NF1 Now that you have completed this conversion, what fuel type are you now using at this facility?

1. Firm natural gas
2. Interruptible natural gas with #2 fuel oil backup
3. #2 fuel oil
4. Another fuel (record verbatim)
5. DK/refused

[IF NF1 = 2 and 4 THEN ASK, ELSE NF3]

NF2 What percentage of your fuel usage is *[FUEL1]* and what percent is *[FUEL2]* in a typical year?

% Record percentages (range of 0 to 100) for *[FUEL1]* and *[FUEL2] [MAKE SURE THEY TOTAL 100%]*
1 DK/refused

NF3 Why did you select this particular fuel choice? *[DO NOT READ. MULTIPLE RECORD]*

1 It was the cheapest option for conversion

2 It's the cheapest option to operate

3 It's the most reliable option

4 It's the cleanest option

5 Other (record verbatim)

6 DK/refused

Impact on the Conversion

Now, , I want to understand what your firm's plans were with regards to complying with the NYC Clean Heat, Local Law 43 regulation.

FR1 Before you started working with NYSERDA's program, when were you planning to convert the boiler plant from #6 oil to a cleaner fuel, if at all? Was it….

1 Before the conversion date of *[CONVERSION DATE]*

2 Around the time of the conversion date

3 After the conversion date, by applying for an extension, paying the fines, or other reason

4 Your company had no plans to convert

5 DK/refused

[IF FR1 = 4 THEN END OF SURVEY].

[IF FR1 = 1 or? 3, THEN ASK, ELSE FR2]

FR1a When would you have completed the conversion?

1. RECORD DATE *[MONTH/DAY/YEAR]*

2. DK/refused

[IF FR1 = 4, 5, We had no Plans to convert or DK/Refused THEN ASK, ELSE FR2].

FR1b What were your plans with regard to compliance with Local Law 43?

1 Do nothing (i.e., do not convert)

2 Other (record verbatim)

3 DK/refused

[IF FR1b = 1 THEN END OF SURVEY, ELSE CONTINUE].

FR2 When did you first learn about NYSERDA's program, was it BEFORE or AFTER you made the decision to convert as required on or before *[CONVERSION DATE]*?

1 Before

2 After

3 At the same time

4 DK/refused

[IF FR2 = 1,3,4 THEN ASK. ELSE SKIP TO FC1].

I would now like to talk about how the incentive provided through NYSERDA's Program might have influenced the timing of your project.

FR3 In your opinion did the incentives offered through NYSERDA's Program influence you to complete the conversion project EARLIER than you otherwise would have, or did it have no influence on when you completed the project?

1 Caused to convert earlier

2 Did not influence when conversion occurred

3 Would not have converted at all without the Program

4 DK/refused

[ASK FR3a IF FR3=3]

FR3a Just to confirm, is it correct to say that if NYSERDA's Program and incentives had not been available, you would not have completed the project at all?

1 Yes

2 No

3 DK/refused

[IF FR3a=1 THEN ASK. ELSE FR3b.]

FR3aa Given the compliance requirement, what would you have done instead? *[DO NOT READ.]*

1 Petitioned the Department of Environmental Protection for temporary relief from meeting the deadline due to exceptional circumstances

2 Something else *(record verbatim)*

3 DK/refused

FR3ab Were you aware of the penalties associated with failure to comply with the law?

1 Record verbatim

[ASK FR3b IF FR3=1 OR IF FR3a=2,3. ELSE SKIP TO FC1]

FR3b If NYSERDA's Program and incentives had not been available, when would you have completed the project relative to when you did the conversion? Would you say . . .*[DO NOT READ.]*

1 On the compliance date

2 Within 6 months of when you did the conversion

3 From 6 to 12 months later

4 From 13 to 24 months later

5 From 25 to 36 months later

6 From 37 months to 60 months later

7 From 61 months to 120 months later

8 More than 120 months later

9 DK/refused

[ASK FR3c IF FR3b=6,7 or 8. ELSE SKIP TO FC1]

FR3c Why do you think it would have been *[FR3b MENTION]*?

1 Record verbatim

2 DK/refused

FR4 Did the technical information provided through NYSERDA's program influence the timing of your project in any way?

1 Yes, it allowed me to complete my project sooner than I otherwise would have

2 No, it did not affect the timing of my project

3 DK/refused

[ASK IF FR4 = 1,2, ELSE SKIP TO FR4b]

FR4a How, specifically, did the technical information provided through NYSERDA's program influence the timing of your project? *[DO NOT READ; RECORD ALL MENTIONS]*

1 The program gave me all the information I needed and accelerated my decision regarding which fuel to select

2 The program gave me all the information I needed and accelerated my decision regarding which equipment to select

3 Other reason related to technical information provided *(record verbatim)*

4 DK/refused

FR4b On a 0-to-10 scale, where 0 represents no influence on your fuel choice, and 10 signifies a very high level of influence on your fuel choice, how much influence did the technical information provided through NYSERDA's program have on the timing of your project?

[Record 0-to-10 score]

11 DK/refused

FR4c How much earlier did the program information allow you to install your project? Was it. . .

1 Up to 6 months earlier

2 7 to 12 months earlier

3 13 to 18 months earlier

4 More than 19 months earlier

5 DK/Refused

Impact on Fuel Choice

[IF NF1=3 (#2 FUEL OIL) SKIP TO SO1. ELSE ASK.]

Next, I'd like to learn how NYSERDA's program may have affected your choice of which clean fuels to convert to.

FC1 Did NYSERDA's program incentive influence your choice of clean fuels in any way?

1 Yes, it influenced my choice of a cleaner fuel than the cheapest alternative (#2 oil)

2 No, I chose the same fuel that I would have selected if NYSERDA's program and incentive had not been available

3 DK/refused

[IF FC1=1, THEN ASK, ELSE SKIP TO FC1b]

FC1a How, specifically, did NYSERDA's program incentive influence this fuel choice? *[DO NOT READ; RECORD ALL MENTIONS]*

1 The program incentive made it more affordable to convert to a cleaner fuel choice than #2 oil

2 Other reason related to program incentive (record verbatim)

3 DK/refused

FC1b On a 0-to-10 scale, where 0 represents no influence on your fuel choice, and 10 signifies a very high level of influence on your fuel choice, how much influence did NYSERDA's program incentive have on your decision of which clean fuel to select?

[Record 0-to-10 score]

11 DK/refused

FC2 Did the technical information provided through NYSERDA's program influence your choice of clean fuels in any way?

1 Yes, it influenced my choice of a cleaner fuel than the cheapest alternative (#2 oil)

2 No, I chose the same fuel that I would have selected if NYSERDA's program and incentive had not been available

3 DK/refused

[IF FC2=1, THEN ASK, ELSE SKIP TO FC2b]

FC2a How, specifically, did the technical information provided through NYSERDA's program influence this fuel choice? *[DO NOT READ; RECORD ALL MENTIONS]*

1 The program provided me information on alternative fuel choices and/or conversion costs

2 Other reason related to technical information provided (record verbatim)

3 DK/refused

FC2b On a 0-to-10 scale, where 0 represents no influence on your fuel choice, and 10 signifies a very high level of influence on your fuel choice, how, much influence did the technical information provided through NYSERDA's program have on your decision of which clean fuel to select?

[Record 0-to-10 score]

11 DK/refused

Installation of Additional Measures

SO1 Did your firm install any additional energy efficiency measures affecting the boiler plant or convert fuels of any other non--#6 oil boilers as a result of the fuel conversion project with NYSERDA?

1 Yes

2 No

3 DK/refused

[IF SO1 = 3 THEN ASK SO1a. ELSE SO1ab.]

SO1a. Some examples of the additional energy efficiency measures affecting the boiler plant are replacing the burner, upgrading to a high-efficiency boiler, or upgrading the boiler controls. Did you install any of these?

1 Yes

2 No

3 DK/refused

[IF SO1 = 1 OR SO1a = 1 THEN ASK. ELSE END OF SURVEY.]

SO1ab. What specific equipment did you install?

1 *[RECORD MEASURE NAME(S), QUANTITIES AS A VERBATIM.]*

SO1b. When did you install this equipment?

1 *[RECORD INSTALLATION DATE(S) AS A VERBATIM.]*

SO1bb Would you have installed these additional energy efficiency measures affecting the boiler plant on your own if you hadn't received technical guidance from NYSERDA during the fuel conversion project?

1 Yes

2 No

3 DK/refused

[IF SO1bb = 1 THEN ASK. ELSE SO1c.]

SO1bbb When would you have installed them?

1 Record verbatim

2 DK/refused

SO1c. Can you please describe the specific ways that NYSERDA's program and incentive affected your decision to install these additional energy efficiency measures?

1 Record verbatim

2 DK/refused

SO2. Finally, Is there anything else you would like to tell me about the program? *[RECORD.]*

[END OF SURVEY.] That completes the survey. On behalf of NYSERDA, thank you very much.

APPENDIX D: EXAMPLES OF KEY DRIVERS INFLUENCING REALIZATION RATE

As is common in similar impact evaluations, nearly all of the 32 projects in the engineering sample featured evaluated carbon emissions reduction that differed from the program-reported emissions reduction. The evaluators investigated and analyzed the site-specific reasons behind these deviations in realization rate. By categorizing and aggregating these differences, as well as estimating the CO_2 impact of each, the evaluators were able to identify the categories that contributed most significantly to the high program realization rate.

Table D-1 provides a detailed review of each of the difference categories with site-specific examples. Please note that a single project can feature multiple key differences; therefore, the total number of positive and negative instances is greater than the sample of 32 projects.

Table D-1. Site-Specific Examples of Key Drivers in Emissions Reduction Realization Rate

Key Drivers in Emissions Reduction Realization Rate with Site-Specific Examples			Negative		Positive	
Category		**Actual Project Example**	**# Projects**	**Impact on CO_2e RR**	**Impact on CO_2e RR**	**# of Projects**
Administrative	Difference between program calculated and program reported savings	The program reported 3,675 tons of CO_2e savings while the program's incentive calculator indicated 3,800 tons of CO_2e savings. There was no documentation explaining why there was a decrease in reported savings.	16	-14%	24%	21
	Incorrect input: dollars instead of gallons	The applicant input the dollars spent on fuel oil per month rather than gallons of fuel oil consumed per month in the program calculator to determine savings for this project. The evaluators used the billing data to determine the actual pre-project annual fuel oil consumption.	1	-1%	0%	0
	Overlap with MPP savings	The oil delivery data analyzed by the applicant represents the facility's energy consumption before participation in MPP. The evaluators used the more appropriate post-MPP natural gas billing data, resulting in a reduced facility heating load and lower CO_2e savings.	1	-1%	0%	0
Pre-/post-inspection	Difference between program classification and new fuel type	The post-project bills and interviews with the facility staff indicated that the facility consumes only firm natural gas, not #2 fuel oil, in the post-installation case. Natural gas emits approximately five times less CO_2e per MMBtu than #2 fuel oil.	1	-2%	268%	13
Baseline	Inaccurate pre-project characterization	The evaluators determined that the pre-conversion billing data was not representative of the current operation at the facility. As-built natural gas billing data was used to characterize the baseline energy consumption.	1	-2%	2%	1
Analysis methodology	Inaccurate normalization of typical weather	The evaluators found that the pre-project #6 fuel oil billing data occurred during a period with lower-than-average heating degree days. When extrapolated to typical conditions, the heating load increased, resulting in greater carbon savings associated with the conversion project.	10	-5%	6%	19
	Impacts from project measures not incented (program influence via spillover)	The applicant's savings methodology did not incorporate energy savings from other measures performed at the site. The evaluators' weather-based utility-bill analysis captured energy impacts from the burner replacement and associated efficiency improvements.	4	-7%	43%	11
	Residual impacts due to changes in building heating load	The evaluators' utility billing analysis found lower energy use post-project. A combination of small changes (changes in heating setpoint, slight fluctuations in occupancy, etc.) could have contributed to the lower energy consumption. Lower post-project energy usage results in increased CO_2e savings.	6	-9%	11%	7
	Updated CO_2e emissions values	The evaluators used the most recent CO_2e emissions values provided by NYSERDA, which differed from the values assumed during the implementation of the program.	31	-63%	1%	1
Totals			**71**	**-106%**	**355%**	**73**

APPENDIX E: CO_2E EMISSIONS FACTORS BY FUEL TYPE

The Impact Evaluation Team referenced the most recent carbon dioxide (CO_2e) emissions factors available during the evaluation planning process. However, these emissions factors differed from the emissions factors reflected in the Program's incentive calculator spreadsheet and slightly differed from the Environmental Protection Agency's (EPA's) recommendations as of April 2014[1].

Tables E-1 compares the emissions factors among those used in the Program's incentive calculator, the latest recommended by EPA, and the latest recommended by NYSERDA[2] used by the evaluators.

Table E-1. Comparison of CO_2e Emissions Factors

Fuel Type	MCERP Emissions Factors (Short ton CO_2e/MMBtu)[a]	EPA Emission Factors (Short ton CO_2e/MMBtu)[b]	Evaluation Emission Factors (Source: NYSEDA) (Short ton CO_2e/MMBtu)[c]
Natural gas	0.05863	0.05849	0.05857
#2/distillate fuel oil	0.08107	0.08153	0.08189
#6/residual fuel oil	0.08729	0.08278	0.08314
B100 (biodiesel)	0.04054	0.08139	0.04095
B2 #6/residual fuel oil	0.08649	N.D.[d]	0.08241
Steam	0.06965	0.07311	0.06965
Propane	0.06992	0.06930	0.06847

[a] As referenced from the Program's project-level savings and incentive calculator, which incorporated emissions equivalents from EPA's 1990-2006 inventory, EIA thermal conversion factor documentation (http://www.eia.doe.gov/mer/pdf/pages/sec12_a_doc.pdf and http://www.eia.doe.gov/aer/pdf/pages/secnote13.pdf) and PlaNYC's Inventory of NYC Greenhouse Gas Emissions (http://www.nyc.gov/html/om/pdf/2010/pr412-10_report.pdf).

[b] "Emissions Factors for Greenhouse Gas Inventories," EPA, April 2014. http://www.epa.gov/climateleadership/documents/emission-factors.pdf

[c] The NYSERDA Evaluation staff emailed the Impact Evaluation Team a memorandum on May 20, 2014, that indicated revisions to the emissions factors used in calculating greenhouse gas impacts across all programs. These revised factors cited the EPA's state inventory tool, which can be found at the following web address: http://www.epa.gov/statelocalclimate/resources/tool.html.

[d] No data from EPA on the biodiesel-fuel oil blend.

While options for B100 (biodiesel), B2-#6 fuel oil blend, steam, and propane are provided in Table E-1, these fuels were not consumed at any of the 32 facilities sampled for evaluation review. Tables E-2 and E-3 illustrate differences between the sets of emissions factors when reflected in carbon emissions reduction from a hypothetical fuel conversion project. Each table assumes a hypothetical boiler heat load of 10,000 MMBtu per year.

[1] "Emissions Factors for Greenhouse Gas Inventories," EPA, April 2014. http://www.epa.gov/climateleadership/documents/emission-factors.pdf

[2] The NYSERDA Evaluation staff emailed the Impact Evaluation Team a memorandum on May 20, 2014, that indicated revisions to the emissions factors used in calculating greenhouse gas impacts across all programs. These revised factors cited the EPA's state inventory tool, which can be found at the following web address: http://www.epa.gov/statelocalclimate/resources/tool.html.

Table E-2. Comparison of Hypothetical Emissions Reduction for Conversion from #6 Fuel Oil to Natural Gas

Factor Source	Tons CO_2e Emissions Reduction	Tons CO_2e Difference from MCERP	% Difference from MCERP	Realization Rate
MCERP calculator	286.60	0	0%	100.0%
EPA 2014 recommendation[1]	242.95	-43.65	-15.2%	84.8%
NYSERDA 2014 Recommendation[2]	245.70	-40.90	-14.3%	85.7%

Table E-3. Comparison of Hypothetical Emissions Reduction for Conversion from #6 Fuel Oil to #2 Fuel Oil

Factor Source	Tons CO_2e Emissions Reduction	Tons CO_2e Difference from MCERP	% Difference from MCERP	Realization Rate
MCERP calculator	62.20	0	0%	100.0%
EPA 2014 recommendation[1]	12.57	-49.63	-79.8%	20.2%
NYSERDA 2014 recommendation[2]	12.50	-49.70	-79.9%	20.1%

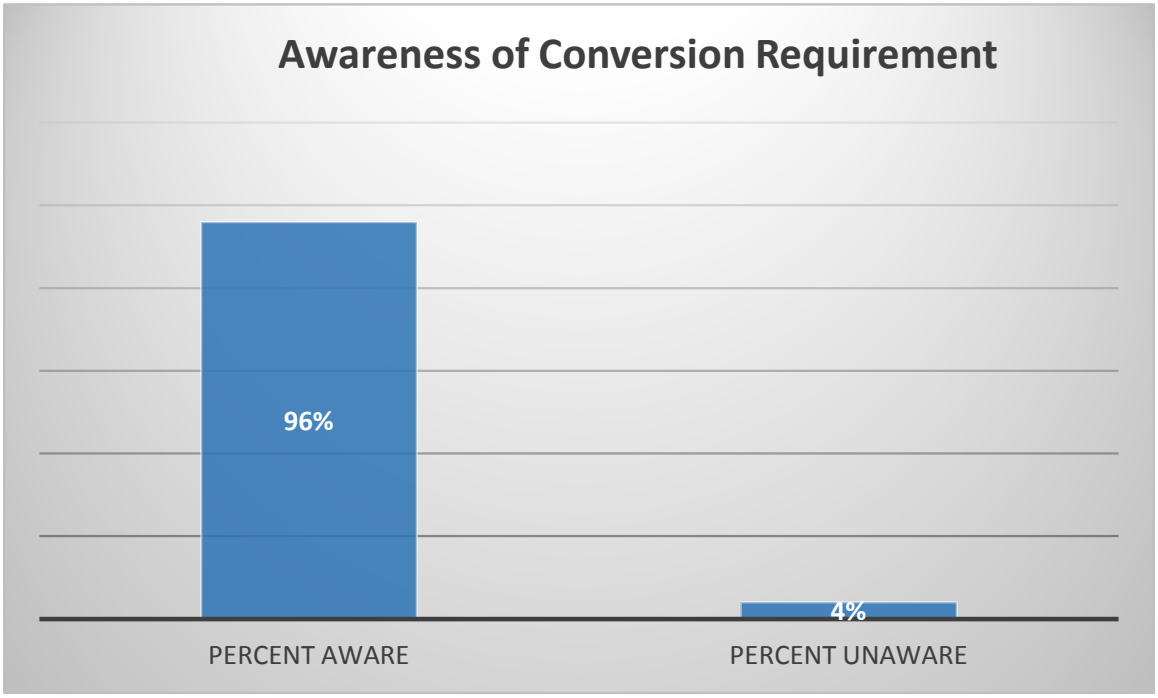
As Tables E-2 and E-3 illustrate, emissions factor assumptions have an effect on greenhouse gas emissions reduction from the fuel conversion projects. The cumulative effect of emissions factor differences on program realization rate is represented by the category "Updated CO_2e Emissions Values" in Table 4-2 and in Appendix D.

APPENDIX F: RESULTS OF ATTRIBUTION SURVEYS

The Impact Evaluation Team attempted a telephone survey census of all decision-makers (owners/managers) associated with the 117 projects in the evaluation population. Surveys were completed with decision-makers representing 51 of those projects. The figures[1] below summarize the results of key questions in the telephone survey, a copy of which is located in Appendix C.

Awareness of Conversion Requirement

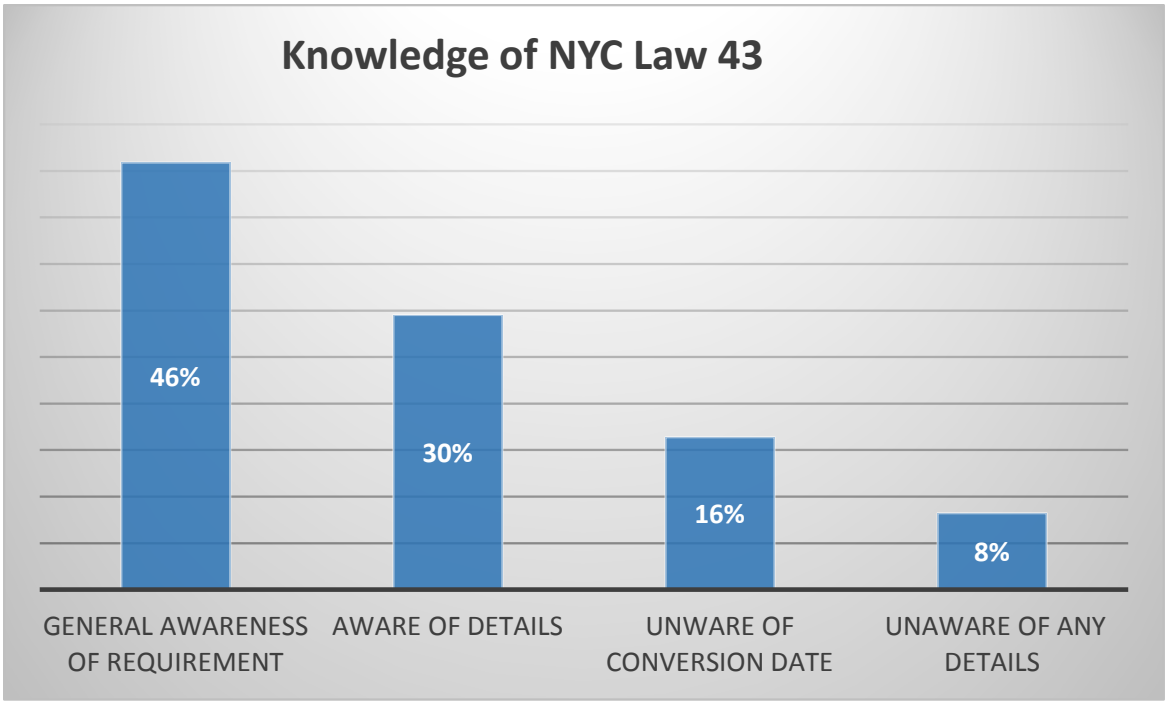
General awareness of the conversion requirement was high, with 96% indicating awareness that NYC had adopted a local law to require multifamily buildings to convert to cleaner fuels.



Knowledge of Local Law 43

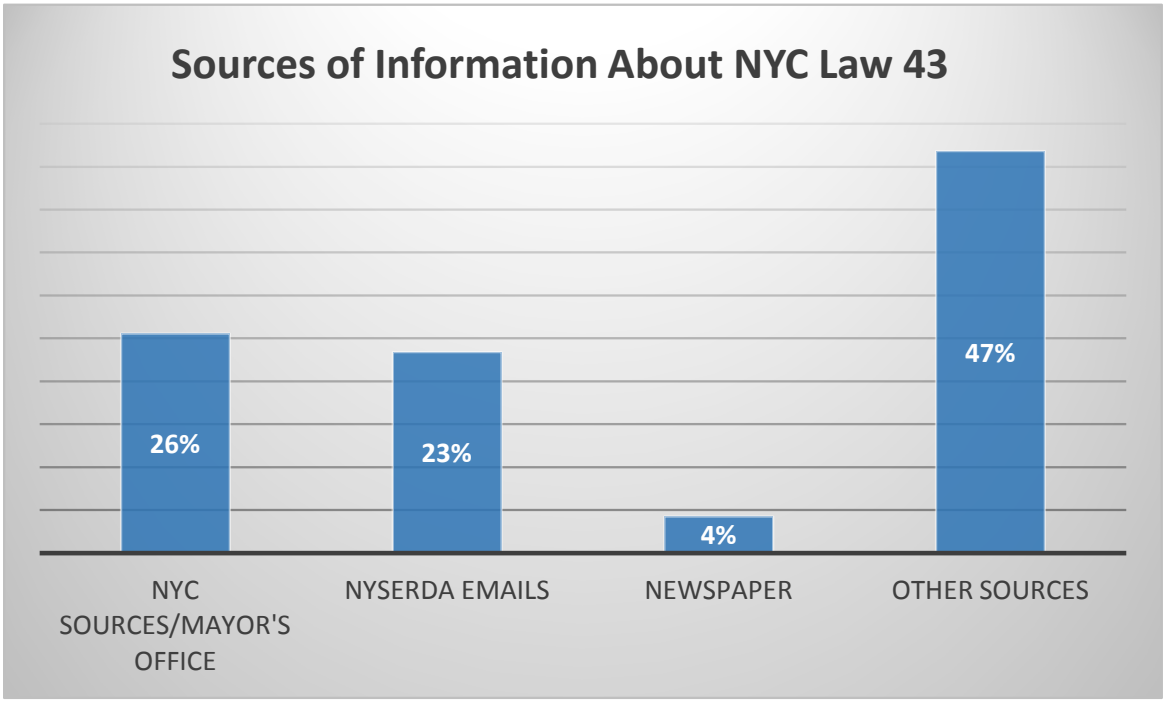
Although general knowledge of the law was widespread, only a minority were able to provide specific details on the requirements and timing of their building's conversion.

[1] The percentages in each figure represent shares of decision-makers and are not weighted by project CO_2 savings or building size. Please note that many questions offered "skip" options, so not all questions were answered by the 51 decision-makers completing the survey.



Sources of Information about Local Law 43

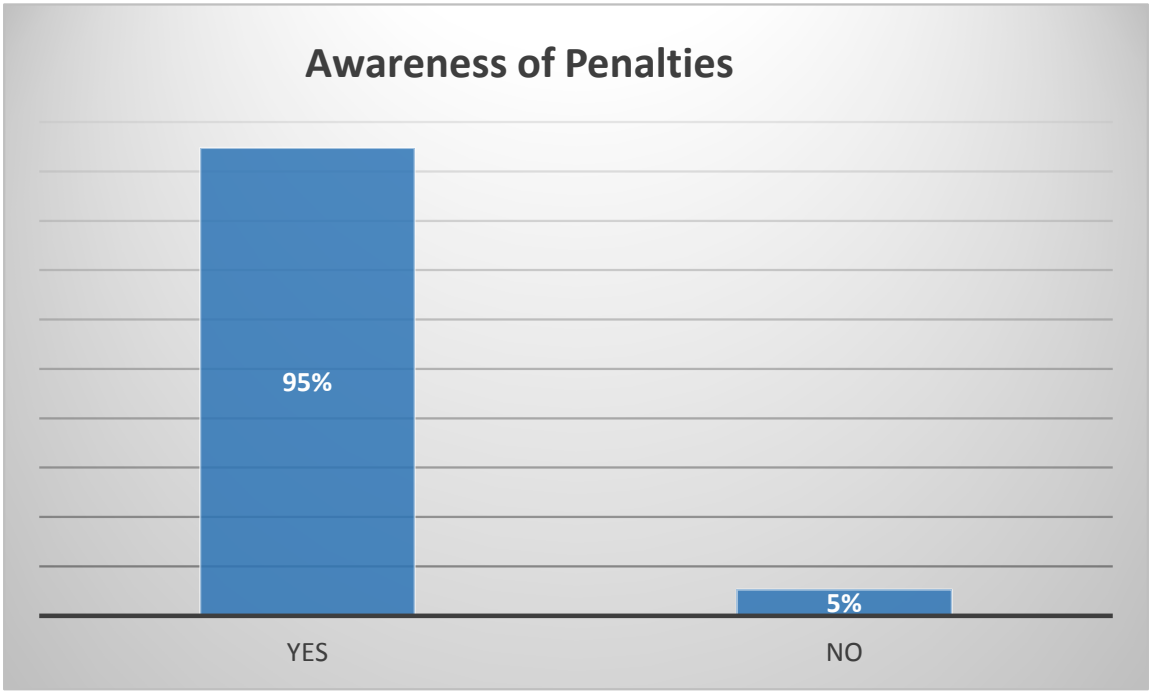
Building owners became aware of the conversion requirement via a number of different information sources[2].



[2] Though this finding resembles that found in a typical process evaluation, the Impact Evaluation Team included such questions in the telephone survey, as no process evaluation was conducted for the Program.

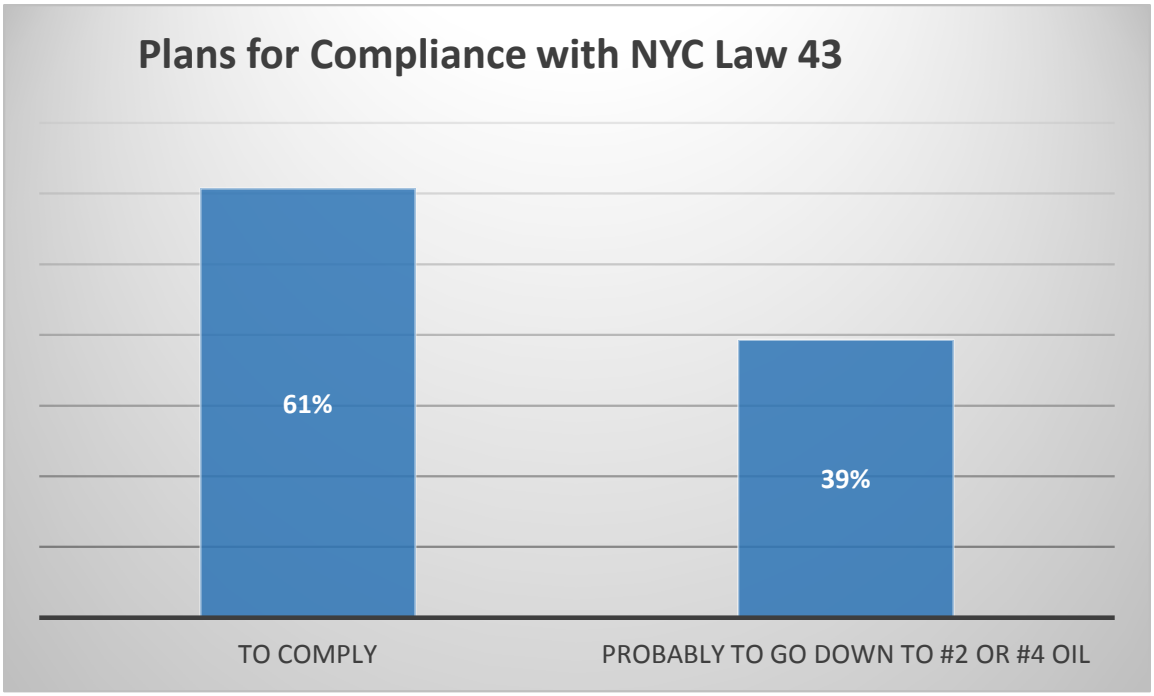
Penalties Associated with Local Law 43

Nearly all participants were aware of the penalties associated with failure to comply with the law.



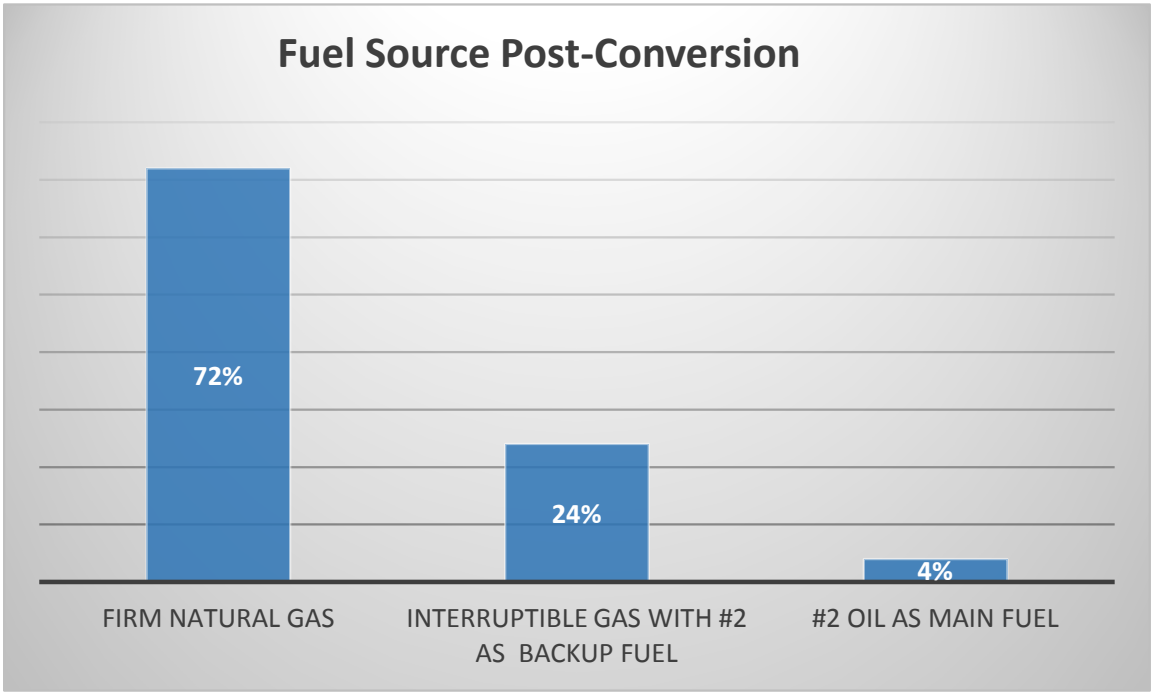
Compliance Plans without Program

When asked how they would have complied with the law if the Program did not exist, participants' plans varied. Of those surveyed, 61% said they planned to comply with the law, but offered no specifics. The remaining 39% said they would have complied by going to #2 fuel oil or to #4 fuel oil at the very least.



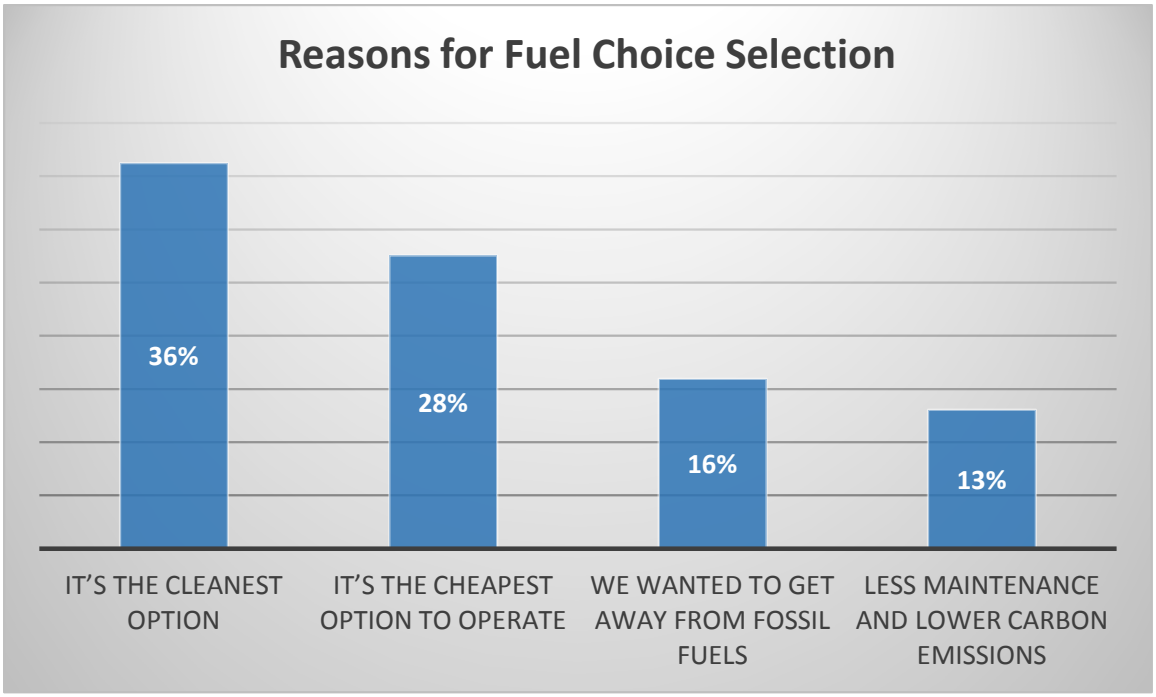
Post-Project Fuel Type

The telephone survey confirmed that nearly all participants are now using natural gas as a primary fuel, either through firm or interruptible connections.



Key Drivers for Fuel Selection

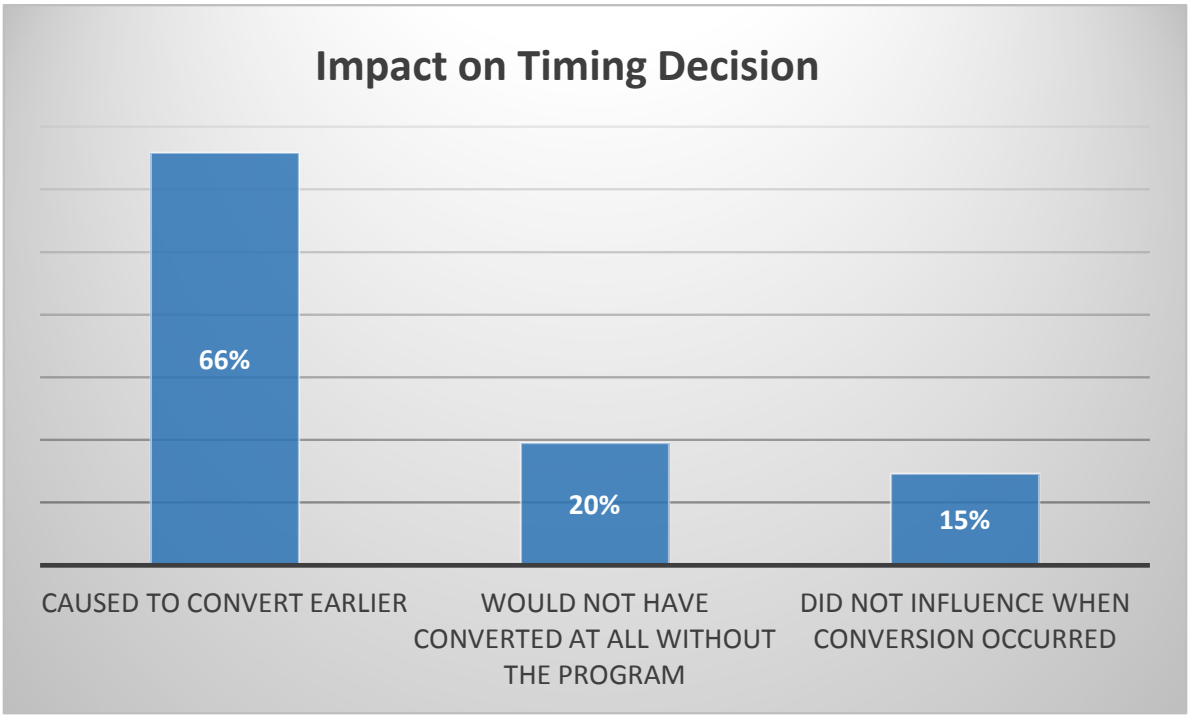
The most common reasons for converting to natural gas were that it was the cleanest fuel source and the most economical.



Program Impact on Conversion Timing

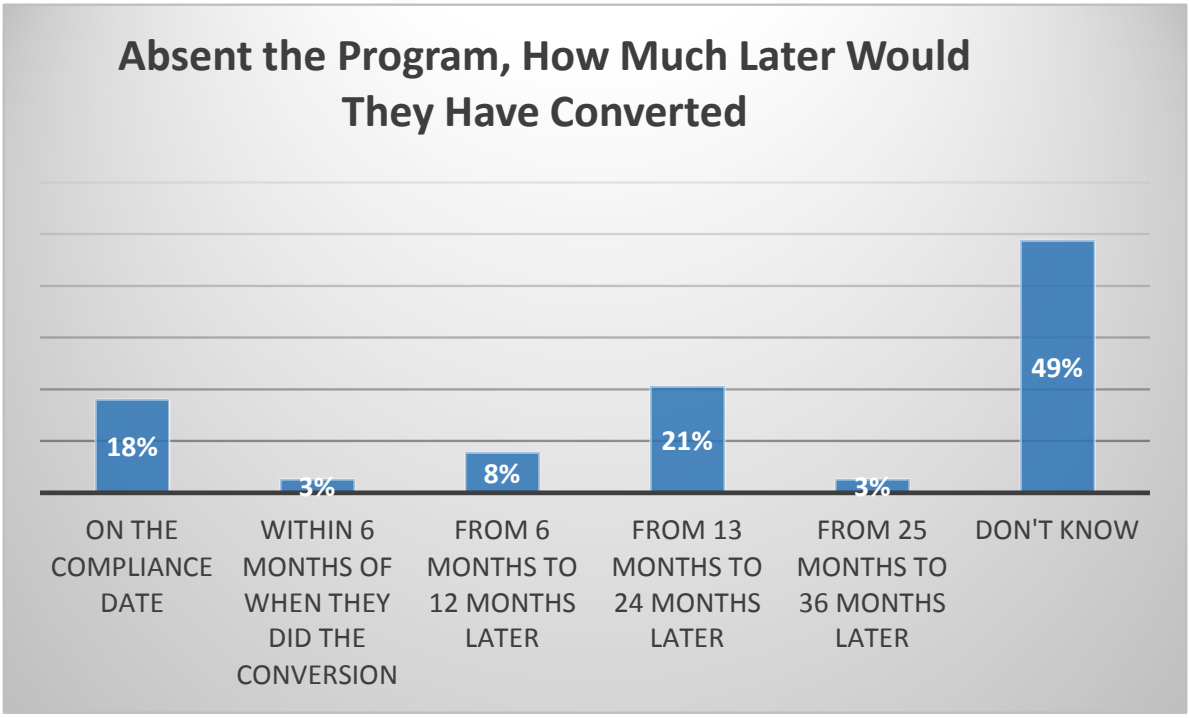
A key influence of the Program was that it caused participants to convert to a cleaner fuel earlier than they had planned[3].

[3] Please note that the 20% stating that they would not have converted without the Program is an unrealistic hypothetical provided by a single decision-maker who represented eight projects.



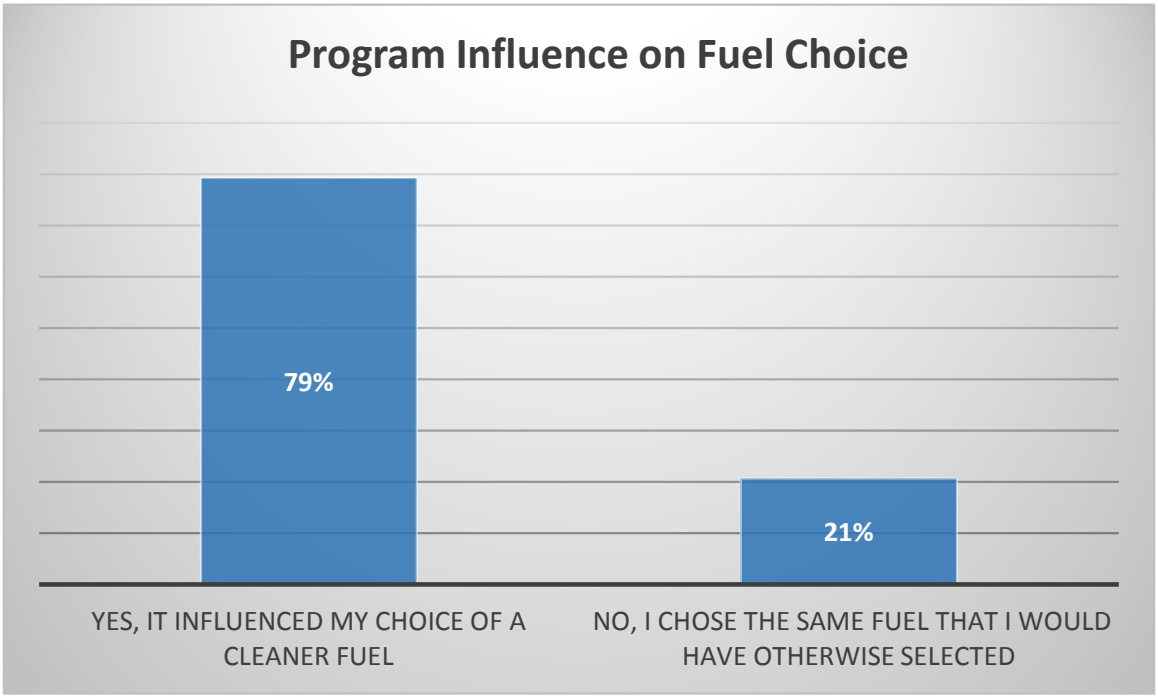
Hypothetical Conversion Date without Program

When asked to specify how much later their conversion would have taken place, close to half of those surveyed did not know. For those providing an estimate in months, their responses were aggregated to determine the Program's weighted acceleration effect of 7.9 months.



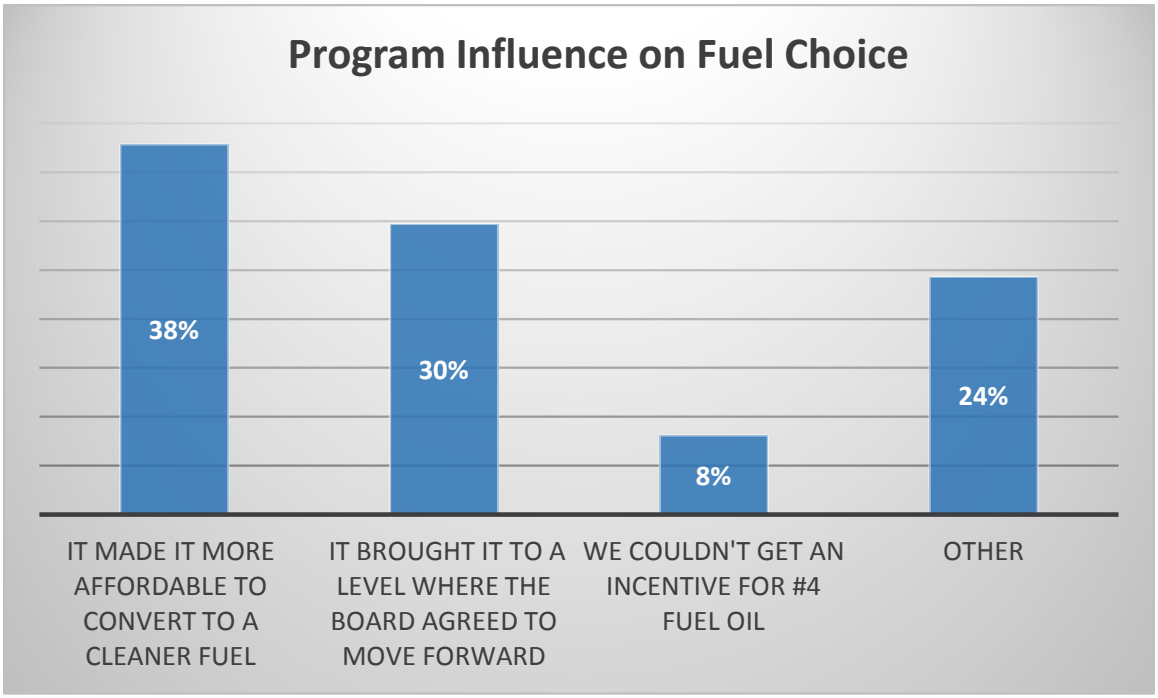
Program Influence on Fuel Choice

The majority of respondents credited NYSERDA's incentive and technical support with influencing their choice of clean fuels. More than 75% of the 30 respondents rated NYSERDA's influence on their fuel choice highly, providing scores of 8, 9, or 10 on a 0-to-10 scale.



Reasons for Program Fuel Choice Influence

The most common way that the MCERP influenced a participant's fuel choice was by making it more affordable to convert to a clean fuel through program incentives.


Program Influence on Fuel Choice
38%
30%
8%
24%
IT MADE IT MORE AFFORDABLE TO CONVERT TO A CLEANER FUEL
IT BROUGHT IT TO A LEVEL WHERE THE BOARD AGREED TO MOVE FORWARD
WE COULDN'T GET AN INCENTIVE FOR #4 FUEL OIL
OTHER

APPENDIX G: CALCULATION OF ATTRIBUTABLE LIFETIME CO_2E SAVINGS

The Impact Evaluation Team defines lifetime net savings as the sum of contributions from the three avenues of program influence.

$$Program\ net\ savings = Acceleration\ savings + Fuel\ choice\ savings + Efficiency\ savings$$

where,

$Program\ net\ savings$	= Carbon emissions reduction attributable to the Program
$Acceleration\ savings$	= Carbon emissions reduction attributable to the Program through accelerated compliance
$Fuel\ choice\ savings$	= Lifetime carbon emissions reduction attributable to the Program through influence on new fuel choice
$Efficiency\ savings$	= Lifetime carbon emissions reduction attributable to the Program from supplementary efficiency measures not reflected in project incentives

The detailed calculation of each savings component is presented in this appendix.

Acceleration Savings

The Impact Evaluation Team found that the Program influenced participants to convert to a cleaner fuel 7.9 months[1] earlier than they otherwise would have. During this time period, 5.1% of the program-reported measure life, or 7.9 months out of the 156-month program-reported lifetime of the fuel conversion, the full evaluated gross savings are attributable to the Program. Therefore, the lifetime effect of acceleration savings can be defined as follows:

$$Acceleration\ savings = \left(\frac{Months\ acceleration}{Months\ of\ conversion\ EUL}\right) \times Reported\ savings\ \times RR\ \times EUL$$

where,

$Months\ acceleration$	= Program's acceleration effect in months (7.9 months)
$Months\ of\ conversion\ EUL$	= Evaluator-recommended effective useful life of the conversion measure in months (240 months)

[1] Numbers in this appendix have been rounded to one decimal place, in order to correspond with the body of the report. As such, some calculations presented below do not result in the exact carbon emissions reduction outputs listed when rounded numbers are used. Therefore, the Impact Evaluation Team has indicated which parameters have been rounded in each of the three equations below.

$Reported\ savings$	= Program-reported annual CO_2e emissions reduction (18,719.3 tons/year)
RR	= Realization rate determined through this impact evaluation (248.9% after rounding)
EUL	= Effective useful life of the conversion measure in years (20 years)

The above formula leads to **30,673 tons of attributable CO_2e emissions reduction from the Program accelerating participants to convert early**.

Fuel Choice Savings

As noted, many of the customers converted from #6 oil to a less emissive source than the minimally compliant #2 oil. The program influenced some of the upgrades from #2 oil to a less emissive fuel source. The program should be credited with impact for the upgrades they influenced. This influence effectively starts at the end of the 7.9-month acceleration period (to avoid double counting impact) and continues reducing emissions until the end of the effective useful life of the new burner or boiler.

The Impact Evaluation Team determined that the Program, through its incentives and technical support, was responsible for 49% of the additional carbon emissions savings from firm gas conversions and 31% of the additional carbon emissions savings from interruptible gas conversions. Overall, the Program was responsible for 37.3% (after rounding) of the additional carbon emissions savings from conversions to natural gas. These calculations assume a baseline of #2 fuel oil, as all participants would have had to convert to that fuel at the very least to be eligible for the Program.

Additionally, the calculation of the 37.3% influence factor considers all possible outcomes for projects in the evaluation population, not just those that resulted in conversions to firm or interruptible natural gas. As this factor accounts for projects that result in zero incremental carbon savings due to cleaner fuel (i.e., conversions to #2 fuel oil), the factor is applied to the whole evaluated gross savings over the life of the fuel conversion, as follows:

$$Fuel\ choice\ savings = \left(\frac{Months\ of\ conversion\ EUL - Months\ acceleration}{12}\right) \times FCI\ factor \times Reported\ savings \times RR$$

where,

$Months\ of\ conversion\ EUL$	= Effective useful life of the conversion measure in months (240 months)
$Months\ acceleration$	= Program's acceleration effect in months (7.9 months)

$FCI\ factor$	= Fuel choice influence factor reflecting cleaner fuel savings attributable to Program (37.3% after rounding). This factor discounts the carbon savings from efficiency measures (calculated below) to avoid double-counting.
$Reported\ savings$	= Program-reported annual CO_2e emissions reduction (18,719.3 tons/year)
RR	= Realization rate determined through this impact evaluation (248.9% after rounding)

The above formula leads to **335,757 tons of attributable lifetime CO_2e emissions reduction from the Program encouraging participants to convert to a fuel cleaner than the minimally eligible #2 fuel oil**. These savings perpetuate for the 20-year lifetime of the fuel conversion measure. To avoid double-counting of CO_2e savings during the acceleration period, fuel choice savings are only possible after the acceleration period expires. The FCI factor also discounts the lifetime carbon savings from efficiency improvements, which are already reflected in the realization rate, to avoid double-counting.

Efficiency Savings

The Impact Evaluation Team analyzed the additional carbon emissions reduction resulting from several efficiency improvements implemented at the time of the fuel conversion projects. Per Table 4-2, these additional savings led to a 36% increase in realization rate. Table G-1 outlines the various efficiency measures, their respective EULs, and the carbon emissions savings for each measure category that contributes to the overall efficiency savings.

Table G-1. Carbon Savings for Supplemental Efficiency Measures

Measure Category	Number of Instances (32 Sampled Projects)	EUL (years)	Evaluated Annual Gross Carbon Savings (ton CO_2e/year)	Impact on RR (% of Program-Reported Annual Savings[1])
Replace boiler	4	20[a]	5,946	32%
Install high-efficiency burner	9	20[a]		
Install boiler controls	5	15[b]	763	4%
Insulate steam piping	3	15[b]		
Building envelope improvements	3	15[b]		
Total annual carbon savings due to efficiency improvements			**6,709**	**36%**
Total annual evaluated gross carbon savings[2]			**46,592**	**249%**

[a] "The Bottom of the Barrel: How the Dirtiest Heating Oil Pollutes Our Air and Harms Our Health," M.J. Bradley and Associates, Chapter 4, page 2. http://www.edf.org/sites/default/files/10072_EDF_BottomBarrel_Ch4.pdf

[b] "Appendix M: Guidelines for Early Replacement Conditions," New York Department of Public Service, page 11. http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/06f2fee55575bd8a852576e4006f9af7/$FILE/Appendix%20M%20final%205-05-2011.pdf

[1] Annual program-reported savings are 18,719.3 ton CO_2e per year. Percentages are calculated with this value in the denominator.

[2] As calculated from the program-reported annual carbon emissions reduction (18,719.3 ton CO_2e per year) multiplied with the realization rate determined from this evaluation (248.9%).

The additional carbon savings from non-incented efficiency measures at the time of the fuel conversion can be calculated as follows:

$$Efficiency\ savings = \sum_{year=1+}^{20} Boiler/burner\ replacement\ savings + \sum_{year=1+}^{15} Other\ measure\ savings$$

where,

$Boiler/burner\ replacement\ savings$ = Efficiency savings from boiler or burner replacements, which feature a 20-year EUL

$Other\ measure\ savings$ = Efficiency savings from all other measures affecting the boiler system or building heating load, such as installing automatic boiler controls. These measures feature a 15-year EUL.

The above calculation leads to **125,946 tons of lifetime CO_2e emissions reduction from the Program supporting participants to adopt supplemental efficiency improvements at the time of the fuel conversions**. These savings account for the varying EULs by measure type, as outlined in Table G-1. To avoid double-counting of CO_2e savings during the acceleration period, efficiency savings are only possible after the acceleration period expires. The first 7.9 months after project implementation are not eligible for efficiency measure savings, as the full savings are already claimed during the acceleration period..