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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CONTENTS

LIST OF TABLES

LIST OF FIGURES

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

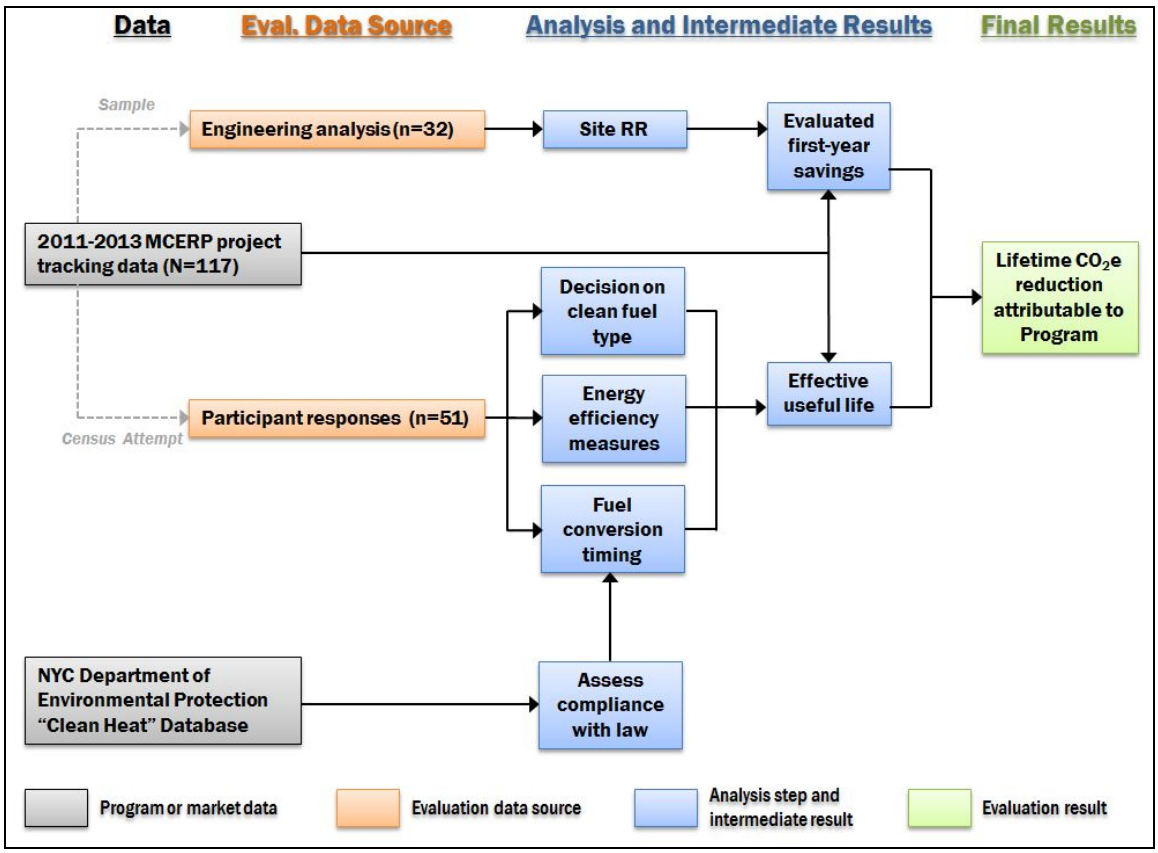
The Program has not been evaluated previously.

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

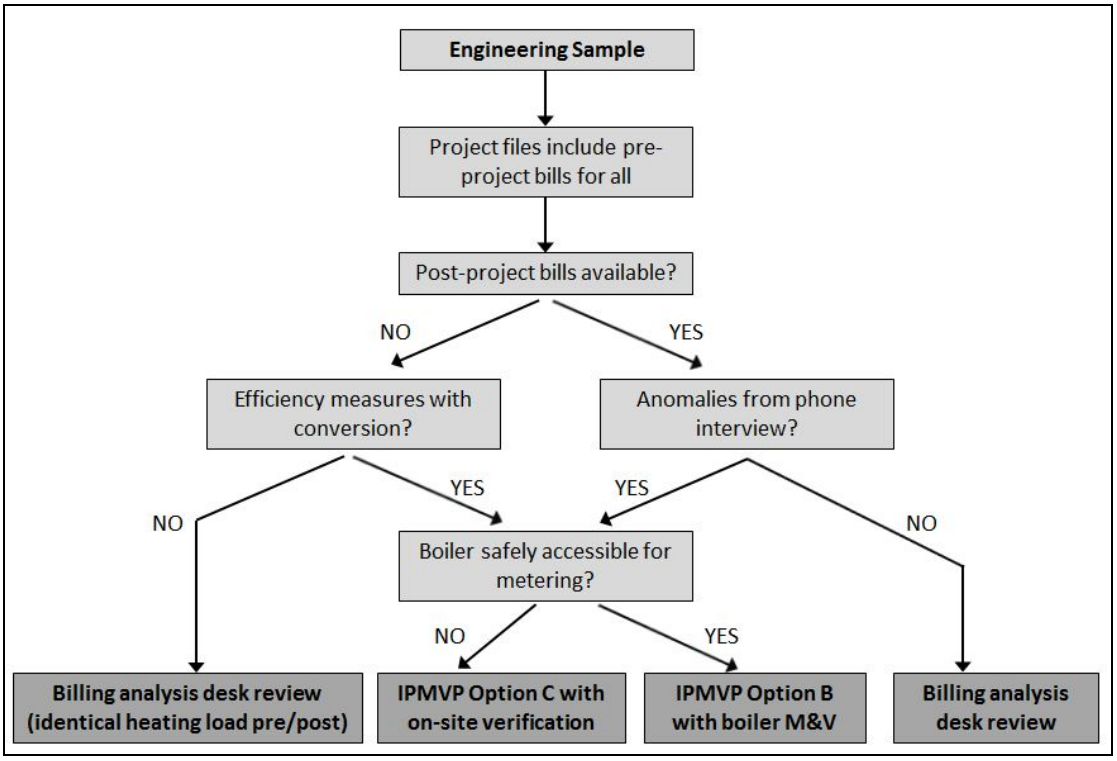


Table 3-1 further describes each level of rigor employed in the evaluation.

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

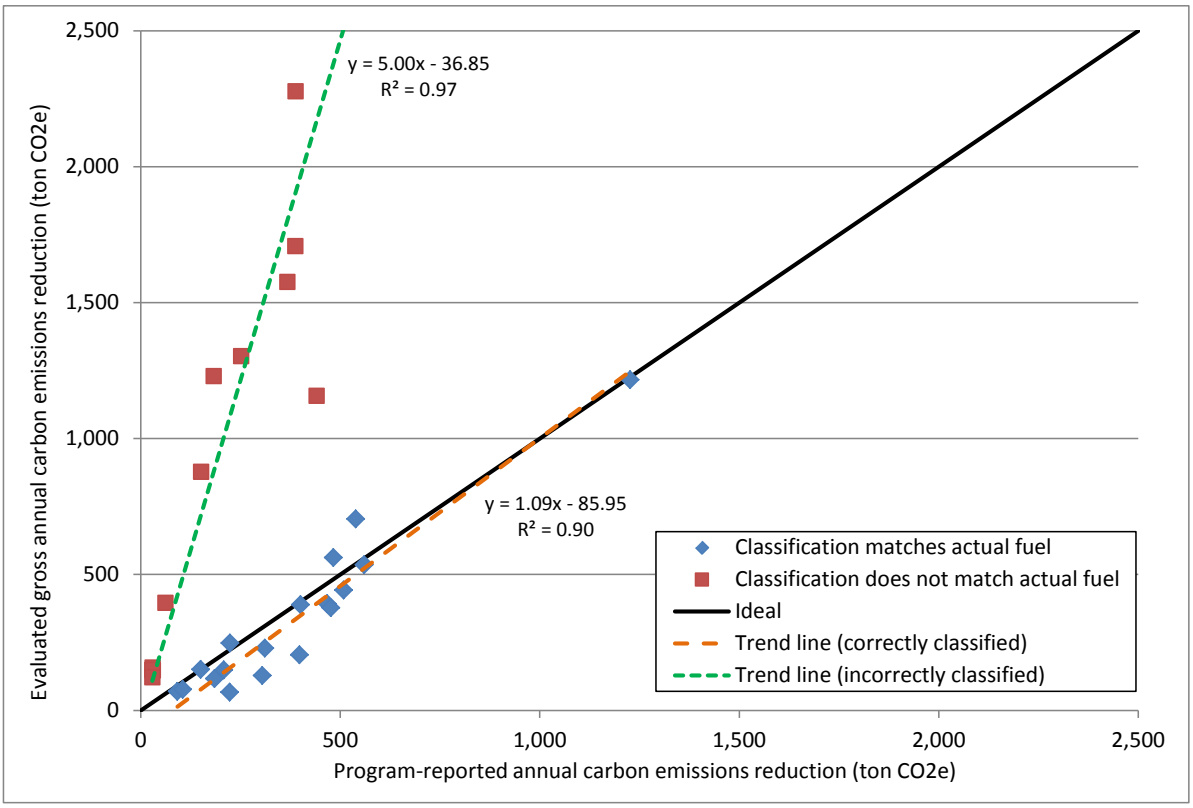


Figure 4-1 above categorizes site results by whether the Program's post-project fuel classification correctly matched the actual post-project fuel type. Mismatches were likely anticipated by the Program, as the natural gas infrastructure became available at several participating facilities between the 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

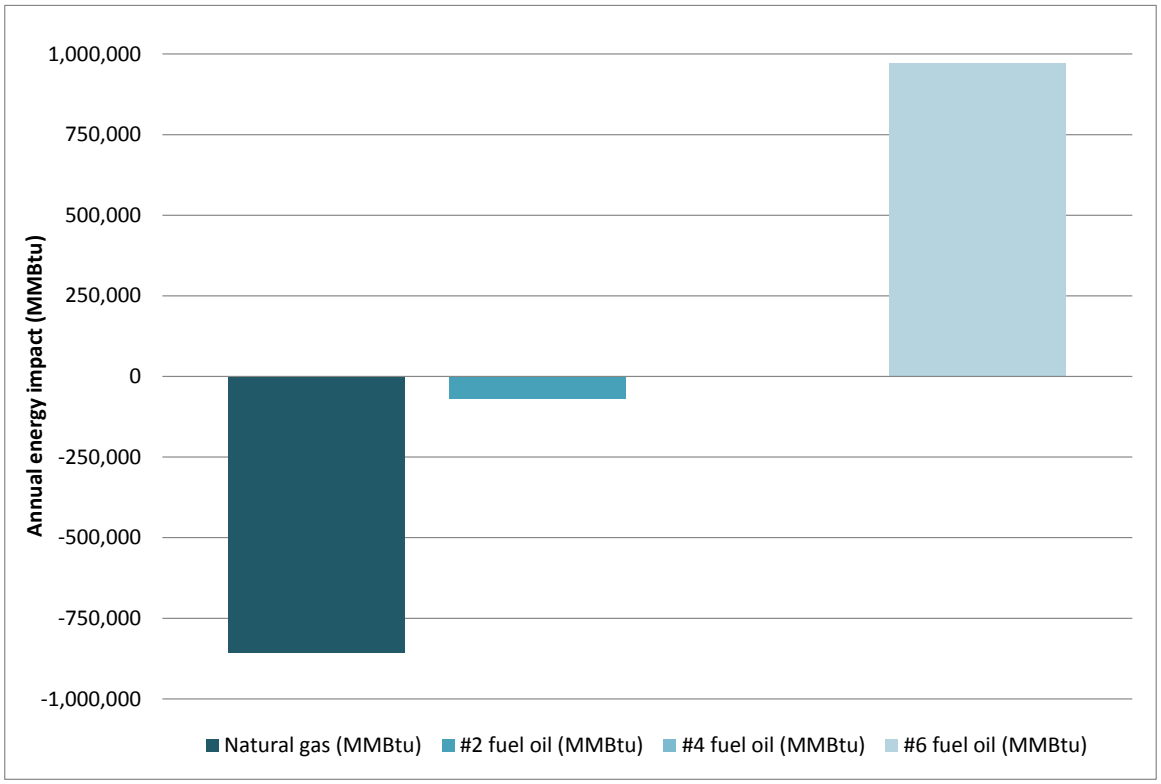


Figure 4-2 above illustrates that MCERP projects led to a 46,443 MMBtu/year reduction in total heating fuel consumption for the 32 projects included in the M&V sample[18].

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.

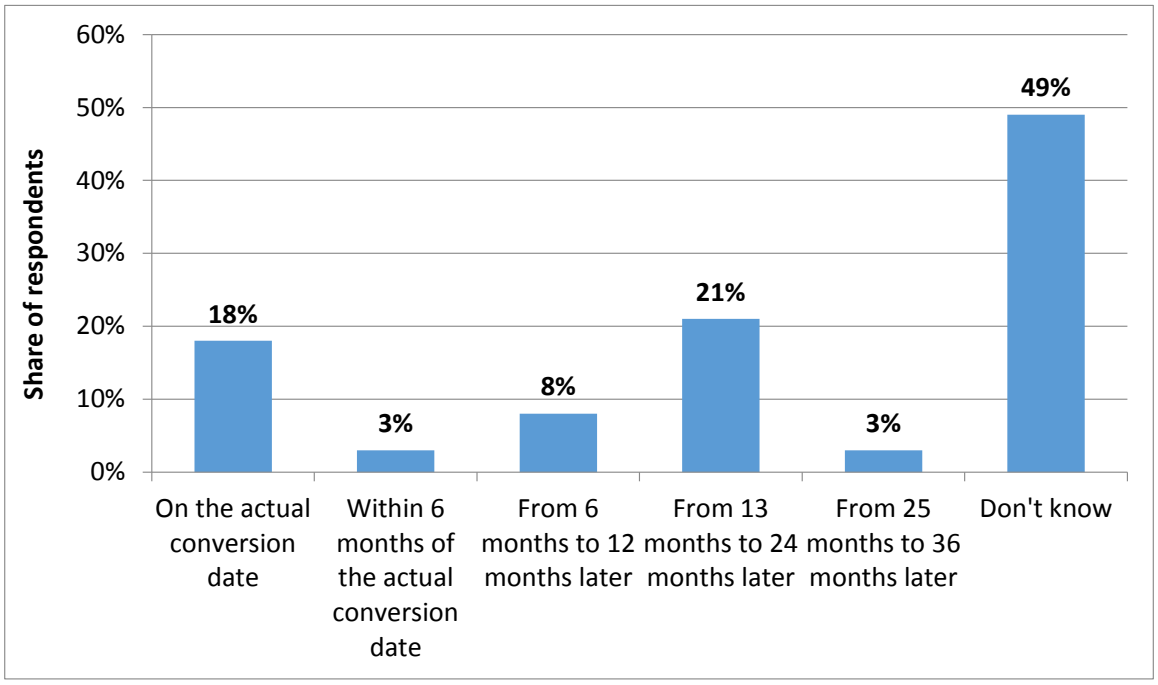
Table 4-3. Summary of Compliance- and Timing-Related Survey Responses

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.

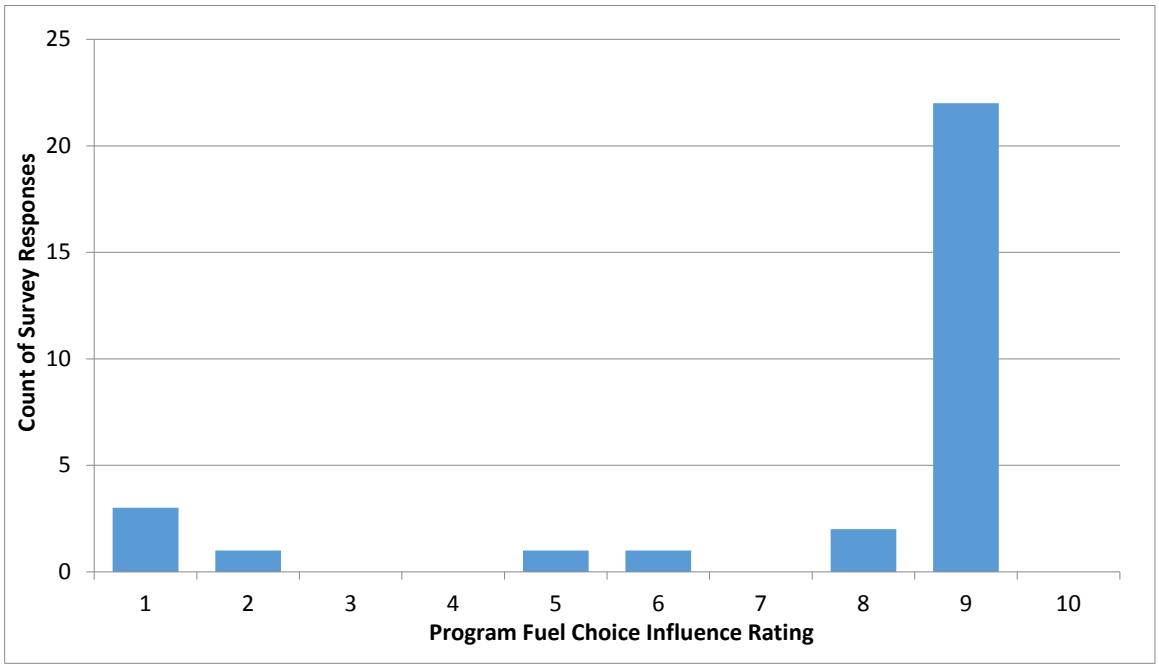
Table 4-4. Summary of Survey Responses Related to Fuel Choice

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

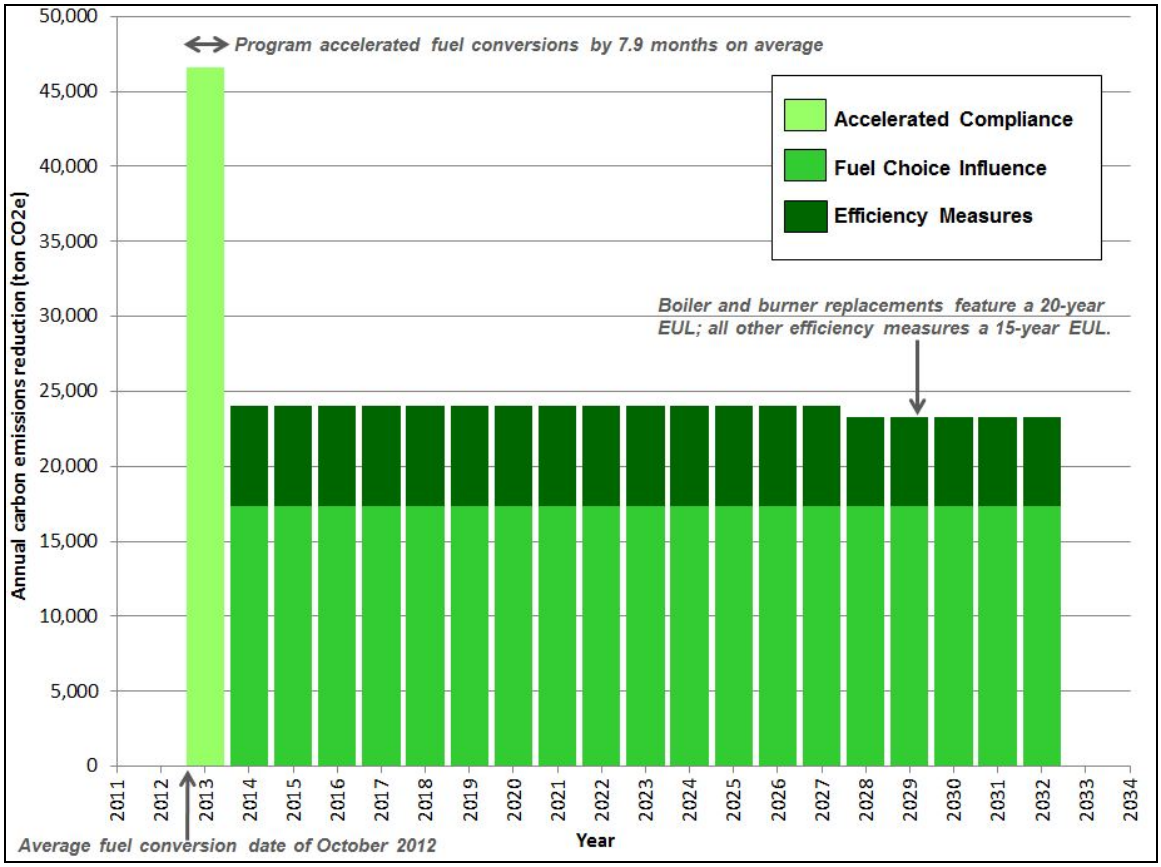


Table 4-7 summarizes the results of the impact evaluation study, including M&V and attribution research findings.

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}