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Massachusetts Program Administrators

Final Report – Commercial and Industrial Non-Energy Impacts Study

June 29, 2012

Massachusetts Program Administrators

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June 29, 2012

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Prepared for: Massachusetts Program Administrators

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		Kerosene			Water Usage		
NEI Reporting Category	n	Average NEI (gallons)	Gallons/ Therm	Stat Sig	Average NEI (Gallons)	Gallons/ Therm	Stat Sig
Building Envelope	46	0	0.0000	No	0	0.0000	No
HVAC	41	643	0.0526	No	0	0.0000	No
Water Heater	23	0	0.0000	No	287,594	65.3489	No
Other	2	0	0.0000	No	0	0.0000	No
Overall	**112**	**338**	**0.0431**	**No**	**48,670**	**6.2021**	**No**

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1. EXECUTIVE SUMMARY

This report presents the Massachusetts Cross-Cutting Evaluation Team's analysis of Non-Energy Impacts (NEI) attributable to 2010 commercial and industrial (C&I) retrofit programs administered by the Massachusetts Program Administrators (PA). Non-Energy Impacts include positive or negative effects attributable to energy efficiency programs apart from energy savings.

DNV KEMA embarked on this study to fulfill the directive set forth by the State's Department of Public Utilities to update and improve non-energy impact estimates for use in the PA's 2013 to 2015 energy efficiency three-year plan and future annual plans. In addition, the PAs will use this study to assist in program marketing, as NEIs increase the value proposition of Energy Efficiency programs for participants.

The goal of this study was to provide a comprehensive set of statistically reliable NEI estimates across the range of C&I retrofit programs offered by the Massachusetts electric and gas PAs.

DNV KEMA identified the following objectives for this study:

1. Quantify participant NEIs by gross NEIs per unit of energy savings separately for prescriptive and custom electric and gas measures;
2. Examine the attribution rates of individuals who did and did not realize NEIs to inform the appropriate free-ridership rate for computing net NEIs; and
3. Identify incidence of spillover, or energy savings resulting from program-influenced installation of energy efficiency measures that did not receive program incentives, by providing separate estimates for the incidence of "like"[1] and "unlike"[2] spillover.

1.1 OVERVIEW OF APPROACH

Drawing on the lessons learned from both the TecMarket Works and Optimal Energy research [3] [4], the evaluation team conducted a large scale in-depth interview (IDI) effort with sufficient sample to provide statistically significant NEI estimates across prescriptive and custom electric and gas measure groups.

The development of the study proceeded in the following steps:

[1] We define "like" spillover as energy savings resulting from program influenced installation of energy-efficient equipment of the same type (i.e. the same measure, capacity, and efficiency level).

[2] We define "unlike" spillover as energy savings resulting from program influenced installation of energy-efficient equipment of a different type (i.e. different measure, capacity, or efficiency level)

[3] TecMarket Works. "*Non-Electric Benefits from the Custom Projects Program: A look at the effects of custom projects in Massachusetts*" Prepared for: National Grid. Roth, Johna and Nick Hall. September 25, 2007.

[4] Optimal Energy, Inc. *Non-Electric Benefits Analysis Update. D.P.U. 09-119.* Attachment AG-1-22 (j). *. Mosenthal, Phil and Matt Socks. November 7, 2008.*

1. Selected sample for telephone interviews with 2010 Massachusetts C&I custom and prescriptive energy efficiency program participants.
   - For prescriptive measures, the evaluation team selected the sample from the 1,499 measures completed by the 2011 free-ridership and spillover (FR/SO) survey with 2010 program participants;
   - For custom measures, the evaluation team conducted surveys with the 258 respondents to the 2010 participant FR/SO survey with 2010 program participants, and supplemented this sample with 2010 custom program participants who did not complete the FR/SO surveys;
2. Designed the survey instruments and trained the interview staff;
3. Conducted the semi-structured interviews using experienced DNV KEMA energy analysts and oversaw quality control;
4. Collected data on NEI types and dollar values, and like and unlike spillover. Separate NEI data obtained for the following mutually exclusive categories:
   - Operations and maintenance costs;
   - Administrative or other labor not associated with operations or maintenance;
   - The cost of supplies, materials and materials handling;
   - Transportation or materials movement costs;
   - Other labor costs;
   - Water usage;
   - The amount of product spoilage or defects;
   - Waste disposal costs
   - Fees including insurance, inspections, permits and legal fees;
   - Other costs;
   - Sales;
   - Rent revenues;
   - Other revenues.
5. Calculated NEIs by predetermined measure categories;
6. Estimated like and unlike spillover; and
7. Combined NEI survey results with 2010 participant FR/SO survey results to examine the relationship between NEIs and program attribution.

1.2 KEY FINDINGS

Table 1-1 presents a summary of the number of measures reporting NEIs of different magnitudes across all measures and fuel types. The evaluation team captured NEI information for 789 prescriptive and custom electric and gas measures. Positive NEIs or non-

energy benefits were realized for 58% of measures, while 3% of measures resulted in negative NEIs. An additional 40% of measures reported no positive or negative NEIs.

Table 1-1 Number of measures reporting NEIs by Size of NEI

NEI Value	Number of measures	Percent of measures
Negative	22	3%
Zero	315	40%
Greater than Zero to $1,000	235	30%
Greater than $1,000 to $5,000	119	15%
Greater than $5,000 to $10,000	44	6%
Greater than $10,000 to $15,000	15	2%
Greater than $15,000 to $50,000	29	4%
Greater than $50,000 to $100,000	8	1%
Greater than $100,000	2	0%
Total	789	

1.2.1 Gross Non-Energy Impacts

Our analysis identified the presence of NEIs resulting from energy efficiency programs, providing statistically significant NEI estimates and also identified that there was a significant correlation between program savings and the level of NEIs reported. The evaluation team found a strong and statistically significant correlation between NEIs and savings for the following measures: prescriptive electric, custom electric and custom gas. We also found a statistically significant correlation between NEIs and savings for prescriptive gas, but this result was not as strong, largely resulting from the low sample size.

Table 1-2 summarizes the results of our analysis.[5]

[5] For the prescriptive electric study the "other" reporting category included the comprehensive and compressed air end uses. For the custom electric study the "other" reporting category included the building envelope, compressed air, process and other end uses. The "other" reporting category for custom gas included the process and other end uses

Table 1-2 Summary of Average Annual NEI Estimates

Electric measures	n	Average Annual NEI per Measure*	NEI/kWh	90% CI Low	90% CI High	Stat Sig
Precriptive						
HVAC	27	$ 7,687	$ 0.0966	$ 0.0544	$ 0.1389	Yes
Lighting	163	$ 1,636	$ 0.0274	$ 0.0176	$ 0.0372	Yes
Motors and Drives	50	$ 541	$ 0.0043	$ (0.0005)	$ 0.0091	No
Refrigeration	30	$ 5	$ 0.0013	$ (0.0002)	$ 0.0028	No
Other	32	$ 28	$ 0.0039	$ (0.0002)	$ 0.0079	No
Total	*302*	*$ 1,439*	*$ 0.0274*	*$ 0.0188*	*$ 0.0360*	*Yes*
Custom						
CHP/Cogen	6	$ (12,949)	$ (0.0147)	$ (0.0247)	$ (0.0047)	Yes
HVAC	20	$ 5,584	$ 0.0240	$ 0.0003	$ 0.0477	Yes
Lighting	89	$ 5,686	$ 0.0594	$ 0.0318	$ 0.0871	Yes
Motors and Drives	42	$ 1,433	$ 0.0152	$ (0.0005)	$ 0.0309	No
Refrigeration	90	$ 1,611	$ 0.0474	$ 0.0244	$ 0.0705	Yes
Other	29	$ 15,937	$ 0.0562	$ 0.0038	$ 0.1087	Yes
Total	*276*	*$ 4,454*	*$ 0.0368*	*$ 0.0231*	*$ 0.0506*	*Yes*

Gas measures	n	Average Annual NEI per Measure**	NEI/Therm	90% CI Low	90% CI High	Stat Sig
Prescriptive						
Building Envelope	2	$ 1,551	$ 3.6151	$ 2.6418	$ 4.5885	Yes
HVAC	50	$ 755	$ 1.3464	$ 0.5433	$ 2.1496	Yes
Water Heater	47	$ 129	$ 0.2604	$ (0.0012)	$ 0.5221	No
Total	*99*	*$ 439*	*$ 0.8344*	*$ 0.3634*	*$ 1.3053*	*Yes*
Custom						
Building Envelope	46	$ 922	$ 0.4774	$ 0.1258	$ 0.8290	Yes
HVAC	41	$ 2,798	$ 0.2291	$ 0.1522	$ 0.3060	Yes
Water Heater	23	$ 803	$ 0.1824	$ (0.4953)	$ 0.8601	No
Other	2	$ 1,905	$ 0.5253	$ (5.6577)	$ 6.7083	No
Total	*112*	*$ 1,940*	*$ 0.2473*	*$ 0.1490*	*$ 0.3455*	*Yes*

*Equals (NEI/kWh) x (Average annual kWh)
*Equals (NEI/therm) x (Average annual therms)

Prescriptive electric. HVAC measures showed the highest estimated NEI (NEI $0.097/kWh), while lighting showed the second highest NEI both in terms of NEI/kWh ($0.03/kWh) and average NEI ($1,636 per measure).

Prescriptive gas. Building envelope showed the highest estimated NEI/therm ($3.62/therm), which also resulted in the largest average NEI ($1,551 per measure). HVAC measures showed the second highest NEI both in terms of NEI/Therm (1.35/therm) and average NEI ($755 per measure).

Custom electric. Lighting showed the highest NEI in NEI/kWh ($0.06/kWh) and highest average NEI ($5,686 per measure). NEIs for cogeneration showed negative results because

the energy efficient equipment required increased preventative maintenance and increased administrative costs.

Custom gas. HVAC showed the highest estimated average NEI ($2,798 per measure). Building envelope had the second highest estimated average NEI ($922 per measure) and the highest NEI/therm ($0.47/therm).

1.2.2 Relationship between NEIs and Program Attribution

DNV KEMA used program attribution, NEI expectation information, and the realized non-energy impacts to examine differences in attribution rates between participants who realized NEIs and those who did not report NEIs. However, our analysis did not provide conclusive evidence that NEIs and attribution (as estimated using the FR/SO study method) were correlated. However, some of the data suggested that this finding may have been due to the consistently high attributions from the FR/SO study.

1.2.3 Like and Unlike Spillover

Only a few respondents provided sufficient measure descriptions to estimate spillover savings. Therefore, results of the spillover analysis were restricted, reporting the percent of respondents who claimed to have installed measures of the same type (like spillover) and of a different type (unlike spillover) at one of their facilities.

The results suggested that Massachusetts energy efficiency programs did result in substantial unlike spillover. Between 10% and 25% of measures resulted in some type of energy efficiency measure being installed without program support. The results demonstrated the importance of considering purchase decisions made across multiple locations of an organization when estimating spillover. Further, the relatively high incidence of unlike spillover suggested opportunities for cross selling programs not yet realized by the PAs.

1.3 RECOMMENDATIONS

DNV KEMA has the following recommendations based on this study's research, analysis and conclusions:

- National Grid and NStar should use the measure mappings provided in Appendix G to apply the appropriate NEIs to their existing programs. The remaining PAs should use the gross NEI per kWh and therm savings estimates presented in Table 1-2 to estimate NEIs, provided estimates were statistically significant. For measures corresponding to non-significant NEI estimates, the PAs should use $0.
- PAs should continue their current practice of applying the attribution rate used for estimating net energy savings to estimate net NEIs. We did not find sufficient evidence to justify altering this approach. We recommend further study of this relationship.
- DNV KEMA recommends further study of unlike spillover. Evidence provided by this report suggests high potential for unlike savings, particularly among multiple location companies. However, such a study will require more a focused engineering based approach to obtain the necessary engineering parameters needed to estimate savings.

The study should also account for spillover resulting from measures installed across multiple locations.

- The PAs should continue to promote NEIs in program marketing, as their current efforts appear to be effective in driving awareness of NEIs as a source of value. Data obtained for this NEI study may provide valuable insights into key touch points for account managers promoting the programs.
- The NEI study was able to provide some evidence for resource NEIs. Capturing these effects directly in program tracking data or through on-site interviews would be best.

1.4 LIMITATIONS TO THE APPROACH

- This study was primarily focused on estimating monetary NEIs associated with C&I programs. While the evaluation team did capture information pertaining to resource savings, we did not obtain sufficient data to obtain statistically reliable resource savings estimates.
- Spillover information obtained through this study was not sufficient to quantify like and unlike spillover savings associated with program measures. This is largely due to the level of complexity in the NEI interview itself, which required individuals with extensive knowledge of the business impacts associated with the installed measures. These individuals often did not have knowledge of the engineering specifications needed to estimate spillover.

  Our analysis indicated that it is important to consider technology purchases across all locations of a company when examining spillover, rather than looking at each location separately. Investment decisions in one location frequently influence subsequent decisions at other locations. Conducting spillover analysis at the facility level can result in ignoring spillover from additional locations.
- Our research approach focused primarily on identifying annual NEIs. Consequently, the results may under estimate NEIs associated with one-time costs or benefits.
- The NEI estimates provided by this study were largely influenced by O&M cost reductions. In a number of instances this change in O&M costs resulted from decreased repair costs associated with the new, high efficiency (high quality) equipment. Due to number of assumptions required to depreciate the installed equipment and amortize the cost differential, our estimates assumed that this cost differential occurs annually, over the life of the equipment. This may over estimate NEIs associated with older measures. Further research is required to examine the appropriate treatment of NEIs associated with maintenance over time.
- NEIs may be underestimated simply due to the nature of self report surveys. Survey respondents were frequently able to identify NEIs, but we found that, for the same measure type, some did and some did not see the same NEIs across multiple respondents. For example, labor costs associated with less frequent changing of light bulbs were an NEI we would expect to find at most sites. While this was cited frequently,

many sites either did not experience this impact, or it did not occur to them during the survey despite probing.

- There was an increased chance of self selection bias because much of the sample consisted of people who agreed to be interviewed twice. This was true for all of the prescriptive measures and many of the custom measures.
- The following factors may limit the applicability of NEI estimates in other jurisdictions:
  - Values were specific to Massachusetts customers. For example the general cost of labor in MA may be higher than that in a Midwestern state.
  - The mix of measures assumes C&I programs that are retrofits, which consisted of a mix of early replacement and replace on failure measures. Additional steps should be taken to address new construction.
- The following limitations apply to the applicability of this research to future years:
  - The confidence intervals reported do not correct for the 2010 population size.
  - Significant program changes in terms of mix of measures, or favoring early replacement over replace on failure could make the NEI values from this study less applicable.

2. INTRODUCTION

This report presents the Massachusetts Cross-Cutting Evaluation Team's analysis of Non-Energy Impacts (NEI) attributable to the 2010 commercial and industrial (C&I) retrofit programs administered by the Massachusetts Program Administrators (PA).

DNV KEMA conducted in-depth telephone interviews with 505 participants representing 789 measures. The self-reported responses to the in-depth interviews covered prescriptive and custom measures for both electric and gas measures. For electric measures, we report the average NEI per kWh savings, and average NEI per therm savings for gas measures. The evaluation team also examined the relationship between NEIs and program attribution, and estimated the incidence of spillover.

2.1 RESEARCH OBJECTIVES

The overall goal of this Non-Energy Impact study was to provide a comprehensive set of statistically reliable NEI estimates across the range of C&I retrofit programs offered by the Massachusetts electric and gas PAs.

DNV KEMA identified the following objectives for this study:

1. Quantify NEIs – We estimated NEIs for commercial and industrial retrofit projects completed in 2010. We estimated gross NEIs per unit of energy savings resulting from both prescriptive and custom electric and gas measures separately.
2. Examine the relationship between NEIs and program attribution – We examined the attribution rates of individuals who did and did not realize NEIs to inform the appropriate attribution rate for computing net NEIs. This analysis focused on examining differences in attribution rates for NEIs rather than re-estimating the free-ridership rates presented in the 2011 free-ridership and spillover (FR/SP) study.
3. Identify incidence of spillover – We distinguished two types of spillover: like and unlike. **Participant spillover** was defined as energy savings resulting from program-influenced installation of energy efficiency measures that did not receive program incentives. We defined **like spillover** as energy savings resulting from program-influenced installation of energy-efficient equipment of the same type (i.e. the same measure, capacity, and efficiency level). **Unlike spillover** reflected energy savings resulting from program-influenced installation of energy-efficient equipment of a different type (i.e., different measure, capacity, or efficiency level).

2.2 BACKGROUND

The evaluation team embarked on this study to fulfill the directive set forth by the State's Department of Public Utilities (DPU) to update and improve non-energy impact estimates for use in the PA's 2013 to 2015 energy efficiency three-year plan and future annual plans. In addition, the PAs will use this study to assist in program marketing, as NEIs increase the value proposition of energy efficiency programs for participants.

The results of the NEI analysis will be used to assess the cost effectiveness of the C&I programs in Massachusetts. In 2010, the DPU approved use of NEIs in the energy efficiency

three-year and annual plans, but directed the PAs to provide more current and comprehensive evidence of NEIs:

> *"We approve the evaluation, measurement, and verification plans proposed by the Program Administrators. However, we direct them to evaluate their assumptions regarding non-electric benefits, avoided transmission and distribution costs, and savings associated with oil heat efficiency measures in order to develop more up-to-date and well-documented estimates for future planning purposes…*
>
> *"The Attorney General urges the Department to require that the Program Administrator support non-gas non-resource benefits included in their cost-effectiveness analyses with actual claimed results, recent studies, actual field validations, and independent third-party audits (Attorney General Brief at 27). The Program Administrators indicated that they intend to evaluate non-gas benefits, including non-resource benefits, during the course of the Three-Year Plans (Exh. Common 2, at 257; Tr. 3, at 461-462). In Section V.C, above, the Department expressed concern regarding the reliability of non-gas non-resource benefits, noting that the Program Administrators themselves accept that at least some of the categories of non-resource benefits claimed in their Three-Year Plans are lacking in recent and thoroughly-reviewed support documentation"*[6]

Therefore, the primary motivation for this cross-cutting NEI research effort was to obtain the necessary information to incorporate NEIs into the PA's next 2013–2015 three-year plan. In addition, the PAs and EEAC consultants expressed interest in using this NEI research to assist in program marketing efforts.

In the following subsections, we define NEIs and discuss their application in the design, evaluation, marketing, and implementation of energy efficiency programs. We discuss the state of NEI research prior to this study, the advantages and shortcomings of that research in fulfilling the PAs current research needs, and identify how the current research was designed to fill those gaps.

2.2.1 Definition of NEIs

Non-Energy Impacts (NEIs) include positive or negative effects attributable to energy efficiency programs apart from energy savings. Non-energy benefits (NEB) frequently refer to positive NEIs, while negative NEIs—non-energy costs— reflect ways that energy efficiency measures result in adverse effects. NEIs (or NEBs) are further distinguished into participant and societal NEIs.

> *"Participant benefits (or NEIs)* are monetary and non-monetary benefits (positive or negative) that directly benefit a program partner, stakeholder, trade ally, participant, or the participant's household." Examples include lower operations and maintenance costs, or increased sales or revenue."[7]

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[6] The Commonwealth of Massachusetts. DEPARTMENT OF PUBLIC UTILITIES. January 28, 2010. D.P.U. 09-121 through D.P.U. 09-128. http://www.env.state.ma.us/dpu/docs/gas/09-121/12810dpuord.pdf

[7] Hall, Nick, Jeff Riggert, and Tom Talerico. TechMarket Works. *Focus on Energy Statewide Evaluation Non-Energy Benefits Cross-cutting Report: Year 1 Efforts*: *Focus on Energy*." State of Wisconsin Department of Administration Division of Energy. January 30, 2003.

Societal benefits (or NEIs) are "those that benefit society at large and can be provided via monetary savings to the energy provider that can be passed on to the society at large via energy price reductions or lower price increases, or benefits that directly benefit the society at large."[8] Examples include reduced carbon emissions and lower water treatment costs.

This report focuses on participant NEIs for C&I customers only. Residential NEI estimates were presented to the PAs in an August 2011 report.[9]

2.2.2 Applications of NEIs

Estimating NEIs provides utilities, regulators, and customers with valuable information when designing, promoting, implementing and evaluating energy efficiency programs. Hall et al (2003) reviewed the current and potential uses of NEIs by these groups. They identify several applications of NEIs, including the following:

- Program marketing /targeting – Positive NEIs represent opportunities for customers to decrease costs for maintenance, administration, and waste management. Similarly, NEIs identify sources of increased revenues from added sales or production increases, as well as increased amenities such as improved lighting conditions, reductions in noise pollution, or an intrinsic desire to "do the right thing." Program implementers and utilities can use information provided by NEI research to help promote energy efficiency programs and target customers who are most likely to realize such benefits.
- Benefit/cost analysis (BCA) for customers – Potential customers (particularly C&I customers) use BCA to evaluate capital investment decisions, such as the installation of new energy efficiency equipment. Whether customers conduct a formal BCA, or they intuit the result based on intricate knowledge of their business, positive NEIs offer additional information that implementation contractors and utilities can offer into this decision making process. Documented positive NEIs provide valuable information for BCA tests performed by customers, allowing them to off-set capital investment costs with benefits derived from reduced operations and maintenance, administrative, or waste handling costs, or added sales and revenue. Positive NEIs have the potential to reverse the results of a BCA for C&I customers in cases where the energy savings alone provide minimal to marginal net benefits.
- Program refinement – Understanding what NEIs may or may not result from a program can help inform the PAs in their design.
- Portfolio development – Centralized agencies are concerned with the overall economic impact on their society across a range of programs. While some programs may not represent substantial energy savings alone, they may provide greater societal benefits. NEIs offer important information regarding societal impacts, or externalities that may reflect a more accurate accounting of the overall impact of EE programs on the state than energy savings alone.

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[8] Hall, et al. 2003. (Senergy efficiency footnote 3.)

[9] NMR. *"Massachusetts Special and Cross-Sector Studies, Residential and Low-Income Non-Energy Impacts Evaluation." Prepared for the: Massachusetts Program Administrators. August 15, 2011.*

- Regulatory cost-effectiveness testing – A more recent application of NEIs is for Total Resource Cost models used in regulatory filings, such as annual and energy efficiency three-year plans filed by PAs with regulatory agencies.

2.2.3 Existing NEI research for Massachusetts energy efficiency programs[10]

While there is a wealth of literature surrounding NEIs, there is fairly limited current NEI research specific to Massachusetts-based C&I programs. The following two studies discussed in this section are the most current and directly applicable to the PA's C&I Energy efficiency programs.

TecMarket Works (2007)[11] – This study used a survey based approach to obtain self-reported non-electric benefits to custom measure programs. The study made a number of improvements over much of the existing survey based NEI research effort. First, it separated NEIs into mutually exclusive business impacts that may result from the installation of energy efficiency measures. The authors first used closed-ended questions to determine whether respondents experienced changes to any of the business areas. This allowed respondents to distinguish cost and revenue impacts derived from separate business areas such as operations and maintenance, material handling, administration, and waste management. The study then used open ended questions to obtain quantified NEI estimates. The study also focused considerable attention on handling extreme values for NEIs.

However, several of the current research needs were not addressed by this study. First, the TecMarket Works study focused on custom non-electric impacts only, while the current research objectives focused on NEIs associated with prescriptive and custom electric and gas measures. Second, the study resulted in many missing ("don't know") responses to the open ended self reported valuation questions. We speculated that this is due to the obscure nature of non-electric benefits. While respondents were aware that "things changed" when a measure was installed, absent detailed probing regarding the nature of those changes, respondents likely found it too difficult to quantify. A third limitation of this study was the relatively limited sample size, which contributed to a lack of statistically significant results. Finally, this study did not address questions pertaining to energy efficiency program attribution and NEIs.

Optimal Energy (2008)[12] – This study provided non-electric benefits associated with prescriptive C&I electric programs in Massachusetts. Using an engineering based approach, this study estimated cost changes resulting from newly installed lighting and energy management system (EMS) equipment. The benefit of this approach was that it clearly defined and documented the specific sources for cost savings resulting from the installed measures.

However, due to the complexity in modeling, the study used a more conservative approach to quantifying NEBs by assuming values of zero for all measures except those associated with

[10] While a full literature review is outside the scope of this study, we provide a brief review of existing NEI research employed by the PAs.

[11] TecMarket Works. "*Non-Electric Benefits from the Custom Projects Program: A look at the effects of custom projects in Massachusetts*" Prepared for: National Grid. Roth, Johna and Nick Hall. September 25, 2007.

[12] Optimal Energy, Inc. *C&I Prescriptive Non-Electric Benefits. Wyatt, Francis. August 22,2003.*

prescriptive lighting and EMS measures. Further, custom measures were not addressed. This study also did not attempt to address questions pertaining to program attribution and NEIs.

The present study incorporated elements from each of these studies in order to further the evolution of NEI research. Our approach uses self reported responses to a series questions to derive estimates of the same mutually exclusive NEI categories developed by Roth and Hall (2007). We then expanded the sample size to nearly 800 measures across prescriptive and custom EE programs. We then designed used trained energy industry analysts to conduct in-depth interviews rather than a standardized survey. This allowed interviewers to probe deeply into potential sources of NEIs, in order to extract information used to estimate NEIs, similar to the engineering based approach used in the Optimal Energy study. These probes allowed respondents to express the NEIs in terms with which they are failure (i.e. number of hours saved to change light bulbs and wages) rather than requiring them to approximate a value to an abstract concept such as the impact of EE lighting on operations and maintenance costs. The combination of these factors lead to the development of robust set of NEI estimates presented in this report.

2.3 ORGANIZATION OF REPORT

This report is presented in the following sections:

Section 3 – Discusses the methodology used in this study;

Section 4 – Presents the study results;

Section 5 – Provides conclusions, recommendations, and limitations of the study;

Appendix A Prescriptive measure sampling plan;

Appendix B Custom measure sampling plan;

Appendix C Detailed weighting approach;

Appendix D Prescriptive Measure Interview guide; and

Appendix E Custom Measure Interview guide.

3. METHODOLOGY

The NEI Study was based on survey data collected from a sample of 2010 C&I program participants for prescriptive and custom as well as electric and gas measures. The primary source for the sample frame was the pool of respondents to the 2011 Massachusetts free-ridership and spillover study, which allowed the evaluation team to examine the relationship between program attribution and NEIs.[13] [14] Drawing on the lessons learned from both the TecMarket Works and Optimal Energy Research, we conducted a large scale in-depth interview (IDI) effort to provide statistically significant NEI estimates across program type (prescriptive and custom) and fuel types (electric and gas) by measure category.

The evaluation team based NEI estimates on survey responses from the same group of participants used in the 2010 participant FR/SO study. This allowed us to examine the appropriate level of attribution to apply to NEIs relative to the attribution rates on energy savings. While providing revised free ridership rates for NEIs was not within the scope of this study, our analysis did provide valuable insight into the appropriate level of attribution when applied to NEIs, an issue clearly identified in the NEI literature.[15]

The research instrument separated NEIs into mutually exclusive groups and used a series of open ended questions to determine NEI values. Experienced energy industry analysts collected information about the costs and benefits incurred by the customer at their facility's business operations. This technique allowed respondents to provide specific valuations of each NEI category across all electric and gas prescriptive and custom measures, reduced the number of "don't know" responses, and documented the sources of value to the respondent by identifying the specific cost and revenue changes that occurred as well as obtaining metrics to measure the magnitude of those changes.

3.1 OVERVIEW OF APPROACH

The key components of the methodology were as follows:

- Selected sample for telephone interviews with 2010 Massachusetts C&I custom and prescriptive energy efficiency program participants;
  - For prescriptive measures, selected the sample from the 1,499 measures completed by the 2010 participant FR/SO2010 participant FR/SO survey;
  - For custom measures, conducted surveys with the 258 measures from the 2010 participant FR/SO2010 participant FR/SO survey, and supplemented this sample with 2010 custom program participants who did not complete FR/SO surveys;
- Designed the research instruments, trained the interview staff, and oversaw quality control;
- Experienced DNV KEMA energy analysts conducted the semi-structured interviews;

[13] 2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study: Final Report. Prepared for the Massachusetts PAs. Prepared by TETRA TECH. July 26, 2011.

[14] 2010 Commercial and Industrial Gas Programs Free-ridership and Spillover Study: Final Report. Prepared for the Massachusetts PAs. Prepared by TETRA TECH. September 20, 2011.

[15] Skumatz, Lisa A. Ph.D., M. November 2009. See Footnote 7

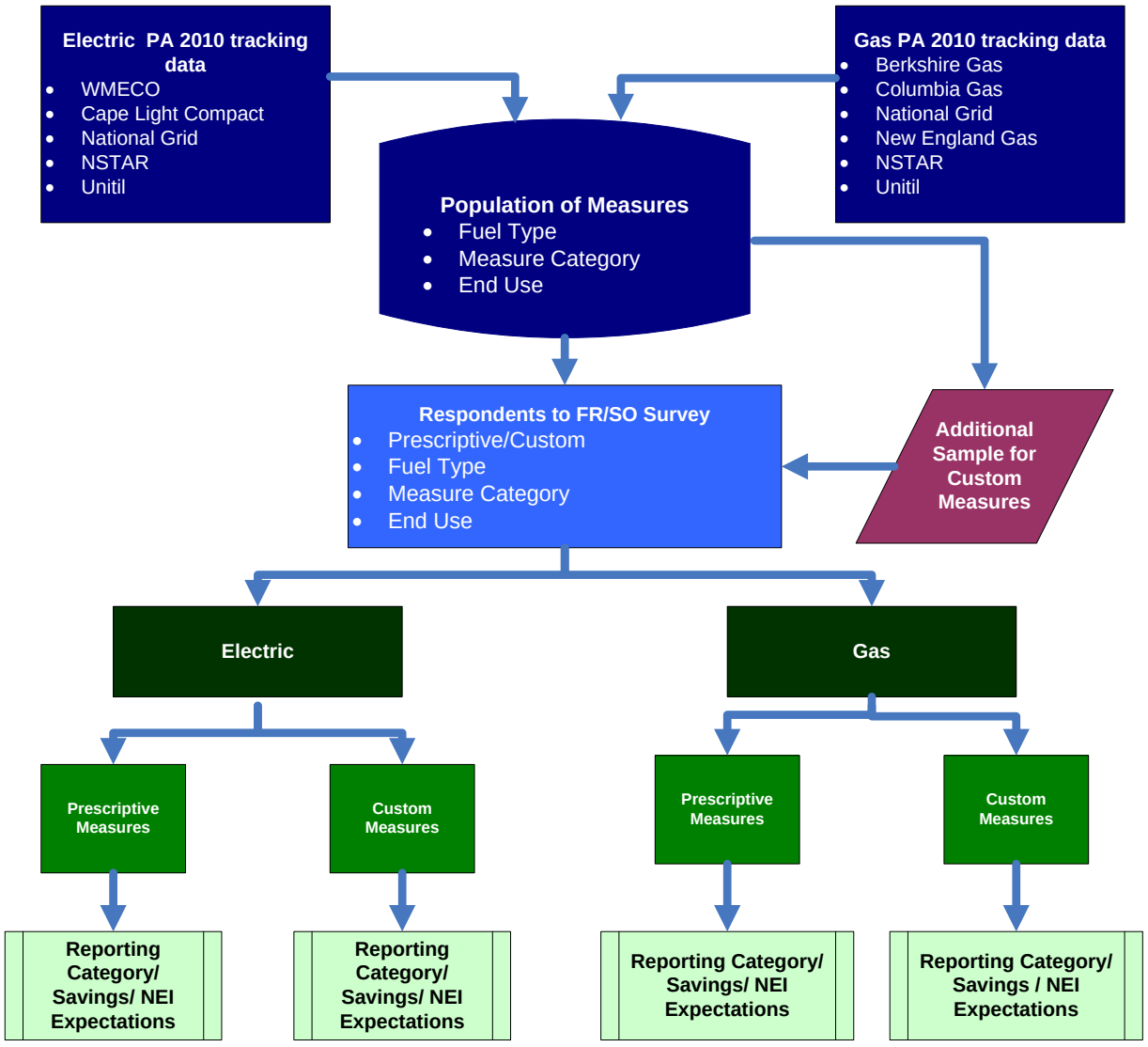
- Collected data on NEI types and dollar values, and like and unlike spillover.
- Calculated NEIs by reporting measure categories;
- Estimated like and unlike spillover; and
- Combined NEI survey results with 2010 participant FR/SO2010 participant FR/SO survey results to examine the relationship between NEIs and program attribution.

3.2 SAMPLE DESIGN

This section presents a summary of the prescriptive and custom measure sampling plans. Detailed plans for the prescriptive and custom measure sample designs are provided in Appendix B and Appendix C, respectively.

Figure 3-1 depicts our sampling approach for this NEI study.

Figure 3-1 Sample Frame Overview: Prescriptive and Custom Measures



3.2.1 Prescriptive Measure Sample Design

For the prescriptive measure NEI sample, the population frame was the projects included in the 2010 participant FR/SO study. Following the same group of respondents allowed the evaluation team to examine linkages between expected[16] and realized NEIs, and the relative influence of program marketing on expected NEIs. Moreover, we were able to assess potential differences in the free-ridership rates of those who expected and realized (experienced) NEIs from those who did not expect and/or realize NEIs. A sample of 450 sampled prescriptive measures (297 electric and 153 gas measures) were selected from the population of 1,499 prescriptive measures.

Electric sample

The number of completed interviews targeted for each of the NEI Study reporting groups[17] is presented in Table 3-1. The overall level of precision was expected to range between 9% (assuming an error ratio of 1.0) and 15% (assuming an error ratio of 1.6).

Table 3-1 Expected Precisions – Prescriptive Electric Scenario 3: Recommended Approach

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
Lighting	769	128	77%	11%	18%
Motors and Drives	124	67	13%	7%	21%
HVAC	62	38	5%	16%	34%
Other	336	64	5%	31%	51%
Overall	**1,291**	**297**	**100%**	**9%**	**15%**

* Optimistic precisions assumed an error ratio of 1.0 and used an expected response rate of 2/3 in the reporting groups where we took a census, while the conservative precisions assumed an error ratio of 1.6 and a response rate of 1/2 in the reporting groups where we took a census.

Gas sample

We recommended taking a census of gas prescriptive measures in order to maximize the statistical precision of NEI estimates. We estimated that a census of measures would provide between 9% and 15% overall relative precision depending on the expected number of completed surveys achieved and the observed variance in responses. Table 3-2 presents the target number of completed interviews and the estimated relative precisions based on taking a census of all gas measures completed in the 2010 participant FR/SO study.

[16] Data to estimate expected NEIs were gathered at the same time as part of the FR/SO study.
[17] We use the term reporting group to refer to collapsed electric end use categories and gas measure categories.

Table 3-2 Expected Precisions – Prescriptive Gas Scenario 2: Recommended Approach

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
HVAC	116	77	51%	11%	18%
Water Heater	109	73	46%	15%	24%
Other	4	3	3%	103%	167%
Overall	**208**	**153**	**100%**	**9%**	**15%**

* Optimistic precisions assumed an error ratio of 1.0 and used an expected response rate of 2/3 in the measure groups where we took a census, while the conservative precisions assumed an error ratio of 1.6 and a response rate of 1/2 in the measure groups where we took a census.

3.2.2 Custom Measure Sample Design

DNV KEMA sampled a census of the participants who installed custom measures that were also included in the 2010 participant FR/SO study. We supplemented this sample with additional measures from the population of custom measures from the PAs 2010 tracking data in order to obtain better precision in our estimates.

Electric sample

Table 3-3 illustrates the target number of completes and the expected precision levels for the custom electric sample for each 2010 participant FR/SO Reporting Groups. The sample size and distribution targeted a relative precision of 80% confidence +/-10% precision levels for each reporting category based upon an assumed error ratio of 1.2. For some measure categories, including the building envelope, CHP/Cogeneration, Compressed Air, Process and Comprehensive categories, the samples sizes were too small to attain the 80% confidence +/-10% precision levels.

Table 3-3 Expected Precisions – Custom Electric Sample by 2010 participant FR/SO Reporting Group

2010 participant FR/SO Reporting Group	Pop Measures**	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop kWh	Optimistic Precision at 80% Confidence	Conservative Precision at 80% Confidence
Building Envelope	5	1	3	0%	57%	76%
CHP/Cogen	15	5	11	11%	15%	41%
Compressed Air	15	6	10	5%	11%	33%
HVAC	110	36	48	28%	10%	13%
Lighting	320	79	91	25%	10%	13%
Motors and Drives	84	26	39	10%	10%	15%
Process	21	11	15	6%	16%	34%
Refrigeration	284	73	80	8%	10%	14%
Other	27	8	13	7%	26%	36%
Overall	**881**	**245**	**310**	**100%**	**5%**	**8%**

* Optimistic precisions assumed an error ratio of 1.2 and used an expected response rate of 2/3 in the measure groups where we took a census, while the conservative precisions assumed an error ratio of 1.6.

** For custom measures we also show the population of measures to illustrate the additional sample frame available for selecting the subsequent custom measure sample.

Gas Sample

Table 3-4 presents the target number of completed interviews and expected precisions at the 80% confidence level for the custom gas sample for each 2010 participant FR/SO Reporting Group.

Table 3-4 Expected Precisions – Custom Gas Sample by 2010 participant FR/SO Reporting Group

2010 participant FR/SO Study Reporting Group	Pop Measures **	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Therms	Expected Precision at 80% Confidence	Conservative Precision at 80% Confidence
Building Envelope	82	7	52	6%	13%	17%
HVAC	170	39	66	74%	10%	13%
Water Heater	55	23	22	8%	48%	64%
Process	9	37	6	8%	28%	37%
Other	8	0	5	5%	30%	41%
Overall	**324**	**106**	**151**	**100%**	**8%**	**11%**

* Optimistic precisions assumed an error ratio of 1.2 and used an expected response rate of 2/3 in the measure groups where we took a census, while the conservative precisions assumed an error ratio of 1.6.

** For custom measures we also show the population of measures to illustrate the additional sample frame available for selecting the subsequent custom measure sample.

3.3 INTERVIEW GUIDE AND ADMINISTRATION

The evaluation team's approach to instrument design and administration were critical factors in developing robust NEI estimates from self-reported interview responses. In-depth interviews provided interviewers with the flexibility to probe for differing business impacts resulting from the installed measures. We structured our research instrument to provide interviewers with the needed flexibility, while maintaining consistency in the data collected. Using energy industry experts to conduct interviews allowed us to probe more deeply to identify the specific relevant business impacts. Interviewers were familiar with how the installed measures may impact a facility. Because of the interdependency between instrument design and data collection, we describe both activities in this section.

3.3.1 Instrument Design

DNV KEMA developed two separate interview guides for the prescriptive and the custom measures. The guides included the following sections:

1. Introduction and Screening. This section verified we had the proper respondent on the phone and introduced the survey.
2. Equipment Verification. This section verified that the rebated equipment was still installed. If not, it attempted to learn what happened and if the rebated equipment was replaced by other equipment.
3. Free-ridership (Custom measures not surveyed previously as part of the FR/SO study only). This section asked the respondent if the program incentives or assistance affected the timing, efficiency, or quantity of the equipment they installed. These respondents did not have a corresponding attribution rate to apply to spillover estimates obtained through this study, while customer included in the FR/SO study did have attribution rates available.
4. Non-Energy Impacts. This section asked respondents whether their company had experienced any non-energy impacts from the rebated equipment. The NEIs were divided into costs and revenues, which were then each divided into several categories and sub-categories. The purpose of this division was to help guide respondents through the process of estimating NEIs. The categories and questions were based on categories used in the 2007 TecMarket Works non-electric benefits questionnaire. DNV KEMA reworded and reordered the questions to improve flow and to reduce the likelihood of double-counting.
5. Spillover. These questions assessed whether the respondent's company installed any non-rebated energy efficiency measures since participating in the program in 2010.

In the early stages of implementing the custom survey, DNV KEMA determined that many respondents had both prescriptive and custom measures. For these participants, interviewers relied on a unified interview guide with skip instructions to guide the respondents to the relevant sections. Copies of the final in-depth interview guides used for both prescriptive and custom measures are included in Appendix D and Appendix E.

NEI Questions

The NEI question battery focused on 13 categories, as presented below. The questions were structured to prevent possible double counting across categories by presenting related categories sequentially (e.g. three and four) for easier respondent recall. In addition, the interviewer protocols were designed to confirm that costs or savings included in one category were not included in any other categories.

1. Operations and maintenance costs, including associated labor and parts for both contractors and in-house staff.
2. Administrative labor refers to the company's time costs from the back office people, such as accounting.
3. The cost of supplies, materials and materials handling. The survey defined this NEI category as: "Time and costs for people in the loading docks and warehouses."
4. Transportation or materials movement costs including time, fuel costs, vehicle costs, wages.
5. Other labor costs - other labor at the company not covered in O&M, Administration, Materials Handling, or Materials Movement categories.
6. Water usage, including the amount of fresh water or processing water used and waste or discharge water. Water savings was an NEI of specific interest to the Massachusetts PAs. In addition, many of the gas-saving measures, such as pre-rinse sprayer valves, save energy by simultaneously saving water.
7. The amount of product spoilage or defects.
8. Waste disposal costs.
9. Fees including insurance, inspections, permits and legal fees.
10. Other costs. This category was to ensure that we recorded all of the cost changes that resulted from installation of the new measure.
11. Sales. This was intended to capture basic revenue changes resulting from the new measures. These could occur as indirect results of the new measures. For example, new lighting might improve visibility in a company's showroom and increase sales. Or, being more energy efficient could be reflected in the company's advertising and increase business from people trying to be environmentally sensitive.
12. Rent revenues.
13. Other revenues.

When NEI sources were determined, the evaluation team used additional closed ended questions to assess whether the respondent experienced an increase or decrease in each affected NEI (e.g., an increase or decrease in operations and maintenance costs). Next, we used open ended questions to ask respondents to provide the overall dollar impact associated with each NEI category.[18] Because many respondents were unable to provide

[18] For resource savings (fuel and water) we obtained estimates of the quantity of resource saved. Where respondents were only able to provide the monetized value of resource savings, we used this information, along

overall NEI estimates outright, the interviewers guided respondents through a series of structured probes to determine whether respondents experienced any changes to various cost or revenue centers associated with each NEI category. For example, internal labor and external labor are separate cost centers associated with Operation and Maintenance (O&M) costs. Once the interviewer identified the impacted cost and revenue centers, deeper probes were used to determine the nature of those changes and specific metrics for quantifying the impact. O&M costs consist of internal and external labor costs, as well as parts and supplies, and training. If a respondent indicated a measure affected their O&M costs, the interviewer asked another series of questions to obtain the necessary information for imputing a value. In this case, if the respondent indicated that the installed measure decreased labor costs, we asked them to estimate the number of hours that labor was reduced and the loaded or un-loaded cost of that labor. In some cases, respondents were not capable of providing values at this level of detail (hours of labor or wages). In these cases, the interviewers used additional probes that allowed the evaluation team to impute values. This approach improved upon previous NEI survey efforts by having the interviewers work with respondents to help them monetize the NEIs and ensure that the respondent thought about the various sub-categories that could apply to an NEI. This provides a more robust estimate than respondents' initial top-of-the-head estimate or a "don't know."

Table 3-5 presents the general probes for each NEI section. The goal of these probes was to quantify the NEIs of each measure into the monetary and resource impacts of the installed measures.

Table 3-5 Non-Energy Impact Categories

NEI Category	Probes						
	Labor[1]	Parts / Materials	Training	Fuel[2]	Water	Fees / Permits	Other
Operations & maintenance	✓	✓	✓	✓			✓
Administration	✓		✓				✓
Materials handling	✓						✓
Materials movement	✓	✓		✓			✓
Other labor	✓		✓				✓
Spoilage/Defects	✓	✓					✓
Water usage					✓		
Waste disposal	✓	✓				✓	✓
Fees						✓	✓
Other costs							✓
Sales							✓
Rent revenues							✓
Other revenues							✓

[1] Labor included internal and external labor and included probes for assessing fully loaded costs.
[2] Fuel included: natural gas, no. 2 distillate, no. 4 fuel oil, propane, wood, and kerosene.

with average resources prices, to estimate the resource savings, and excluded the value of that savings from monetized NEI estimates.

Specific probes for each NEI category include:

Operations and maintenance costs

The interview guide included probes for internal labor, external labor, parts, training, fuel saved, and other O&M costs.

For the labor and training subcategories, the interviewers attempted to get annual hours of increase or decrease and an hourly rate. If the respondent could provide fully loaded hourly rates (including overhead, benefits, and insurance), interviewers gathered it. If the respondent could not give us exact fully loaded costs, interviewers asked for the base hourly rate and their best estimate of a multiplier to apply to that rate to impute fully loaded rates.

For parts, interviewers attempted to quantify the number and type of parts that increased or decreased, and the unit cost of each.

For training, interviewers attempted to quantify increases or decreases in training costs and whether these were one-time costs or recurring costs.

For fuel, interviewers attempted to quantify specific changes (increase or decrease) in fuel usage.

For other, interviewers asked the respondent if there were any other O&M related costs that increased or decreased that we had not yet covered.

Administrative or other labor

This section included probes for internal labor, external labor, training, and other. The use of these specific probes was similar to their descriptions in the O&M section, except they were applied to administrative rather than O&M costs.

Cost of supplies, materials and materials handling

This section included probes for internal labor, external labor, and other. The use of these probes was similar to their descriptions in the O&M section, except they were applied to materials handling rather than O&M costs.

Transportation or materials movement costs

This section included probes for internal labor, external labor, fleet service and parts, fuel, and other. Except for being applied to transportation and materials movement's costs, these probes were used in a similar way as in the O&M section.

Other labor costs

This section included probes for internal labor, external labor, training, and other costs. The probes were used in the same way as for the O&M section.

Water usage

This section included probes for water usage costs, gallons of water, and wastewater.

For water usage costs, the probes attempted to identify if water usage costs increased or decreased and associate a dollar value with that change.

For gallons of water, the probes attempted to identify if water use increased or decreased and quantify it in gallons.

For wastewater, the probes attempted to quantify gallons of wastewater increased or decreased.

Product spoilage or defects

There were no specific probes for this section.

Waste disposal costs

The section included probes for waste materials, waste handling, permits, and other.

For waste materials, the probes attempted to identify the type of material (e.g. carbon dioxide, sulfur dioxide, etc.) and quantify in units the increase or decrease in emission.

For waste handling, the probes attempted to identify number of hours of labor, and the fully-loaded hourly costs for that labor, just like the internal or external labor costs in the O&M section. In the event that the respondent could not supply fully loaded hourly costs, interviewers attempted to gather enough information to allow us to impute it.

For permits, interviewers attempted to quantify in dollars the increase or decrease in pollution permitting fees incurred.

Other Fees

This section included specific probes for insurance, inspections, licenses, legal fees, and other fees. In each case, the probes attempted to quantify the increase or decrease in dollars and whether it was a one-time or ongoing change.

Other costs

There were no specific probes in this section.

Sales

This section did not include any specific probes.

Rent revenues

This section included specific probes for dollars per unit, number of units, and occupancy rates.

For dollars per unit, this probe attempted to quantify the dollar increase or decrease in rent per unit rented. It included a probe to establish the unit of measure (square feet, apartments, etc.).

Number of units attempted to quantify whether the number of units (square feet, apartments, etc.) available for the owner to rent out increased or decreased.

Occupancy rates attempted to quantify the increase or decrease in the duration of unit occupancy or vacancy.

Other revenues

There were no specific probes for this section.

Spillover Questions

In addition to NEI questions, each guide contained a series of questions to obtain data necessary for estimating like and unlike spillover. The guides contained the like spillover series from the 2011 FR/SO study. DNV KEMA added questions to address unlike spillover to estimate savings associated with these measures.

Rather than asking respondents to determine whether the additional measures were like or unlike spillover, the survey simply asked if the respondent had installed any other energy-using equipment since participating in the program. Once interviewers established the respondent installed subsequent measures, the interviewer also asked them to provide the following:

- Type of measure(s) installed;
- Efficiency level of the equipment;
- Quantity installed; and
- Whether their experiences with the rebate program, rebated measures, or contractors who did the rebated work had any effect on their decision to install the additional equipment.

DNV KEMA used this information to determine if there was like or unlike spillover for the respective end use or measure category.

Free-ridership Questions

The custom measure guide included questions used to collect program attribution information. These data were required for the portion of the custom sample that was not drawn from the 2010 participant FR/SO study's respondent pool. Because these participants were not included in the previous study, they lacked estimated program attribution scores. These scores were required to determine whether spillover estimates, also asked in this survey, were attributable to the programs.

The first version of the custom measure interview guide incorporated the same battery of free-ridership questions that was used in the 2010 participant FR/SO study. This was an attempt to keep the methodology consistent with estimates derived of that study. However, after completing a few interviews using this battery, it proved to be too lengthy to include in the NEI survey. Given the relatively limited use of the attribution questions (i.e. for spillover estimates of a small proportion of the custom measure sample), the evaluation team revised the free ridership battery to include a standard set of four questions that identified overall

program attribution, plus changes to the timing, efficiency, and quantity of the installed measures. DNV KEMA has used these questions for over ten years on numerous studies, most notably for the evaluation of Wisconsin's Focus on Energy programs.

3.3.2 Survey Administration

DNV KEMA initiated the interviews on January 17, 2012 and extended data collection through May 11, 2012. The following describes procedures used for administering the survey.

Training

Senior staff provided in-person, project-specific training to all interviewers prior to data collection. The trainers reviewed the guides thoroughly with interview staff, and walked through the in-depth guide. Interviewers practiced conducting the survey with each other, and returned to the trainers to discuss any questions or problems that arose. Any interviewers added to the project at a later date received a similar training session. Interviewers were monitored closely throughout the interview process to ensure consistent questioning and reporting of results, and reported results to the survey manager daily.

The interview team consisted of recruiters and interviewers. Recruiters were responsible for identifying the appropriate contacts within each company and scheduling interviews with our trained energy analysts. Interviewers included trained experts with between three to 15 years of energy industry interviewing experience

Sample selection

The sampling unit for this study was a measure at a location. DNV KEMA's sampling approach selected a sample of measures for each of the strata identified in the sample plan presented in Section 3.2. However, customers frequently installed multiple measures, spanning various electric and gas prescriptive and custom projects. Further, there were many customers in the population that installed measures across multiple addresses, all of which tied to the same contact, company, or phone number. For these customers, we first selected the sampled measures. We then went back into the database and selected the remaining measures that linked to the sampled measure by contact name, phone number, company name, or address. We released samples to recruiters in bins selected to achieve the target number of completes across strata.

Recruiting

Recruiters sent respondents a notification letter prior to launching the study to inform them that they might be contacted within the next few months. To maximize response rates, recruiters called the sampled measures up to six times before coding all measures that linked to that respondent as a non-response. Additional bins were released once existing bins were exhausted.

A primary challenge of the survey recruitment process was identifying all of the relevant measures for each respondent. The sample data structure spanned prescriptive and custom measures for both electric and gas. To minimize the number of times customers were contacted and maximize response rates, recruiters selected all measures that linked to a single contact by either contact name, phone number, company name, or address. Recruiters then attempted to schedule a single interview across all measures the respondent

could address. In some cases, recruiters were required to schedule multiple interviews with a single company to gather data for each of their installed measures.

Interview preparation

Interviewers reviewed all relevant measures for each customer prior to the interview. They then populated the in-depth interview guide with the following information to aid in the interview:

Customer identifying information – Interview contact, company/organization name, all addresses associated with that contact, telephone number, name of PA, program name, and participation date(s).

Project information –Respondents with multiple addresses could have up to two prescriptive and two custom measures sampled for each address. Interviewers reviewed the measure information for multiple site respondents to determine whether the same measures were installed across multiple facilities, or if the measures differed by location. For example, review of the tracking data helped reveal whether the upcoming interview was with a facility manager responsible for a chain of stores that all installed the exact same measures. This information was used to help reduce the interview length, as NEIs associated with duplicate measures across identical buildings could respond for the typical or average impacts across facilities.

Free-ridership – Interviewers identified whether any of the customer's measures for an upcoming interview were not selected from the pool of respondents to the 2010 participant FR/SO study. For these measures, interviewers needed to ask the free ridership sequence since attribution rates were not available through the previous study.

Spillover – Interviewers recorded all known measures for a respondent at each location. They referenced this information during the spillover section of the survey to help determine whether a measure the respondent reported as spillover actually received an incentive.

Conducting the interview

Interviewers informed respondents of the purpose of the study and identified the measure information recorded for each address associated with the contact. Next, interviewers asked the equipment verification section for the measures sampled under the reporting category. For measures that were no longer installed, the interviewer asked the respondent to provide the reason for removal. If the measure was removed due to a potentially negative non-energy impact (i.e. it made costs go up), the measure was retained for the interview. If all measures under the sampled NEI reporting category were removed, but the reason for removal was not a negative NEI, the interviewer moved onto the next NEI reporting category.

For those custom measures not included in the 2010 participant FR/SO study, interviewers then asked respondents to answer the abbreviated free-ridership battery discussed above.

Next, the interviewer cycled through the NEI sections of the interview guide for each sampled NEI reporting category at a facility. Respondents with similar measures installed across multiple locations were asked to identify facilities and measures where the NEIs were the same or similar because the structure, operations, and measures installed were the same. This helped reduce the number of times the respondent was required to cycle through the

interview guide as they were able to provide a single response that represented multiple installed measures. Some respondents with multiple locations reported one set of NEIs were relevant to certain measures and facilities, while another set of NEIs were relevant to a different set of measures and facilities, even within the same NEI reporting category.

Next, the interviewer asked respondents to indicate the relevant NEI sources to explore further in the interview (e.g. operations and maintenance, or rent revenue). Once the sources of NEIs were determined, as well as the direction of those impacts (i.e. increase or decrease), interviewers guided respondents through the series of structured probes to identify the cost and revenue centers impacted, the nature of those impacts, and to obtain estimates of specific metrics needed to quantify the NEIs (e.g. frequency, time/quantity, and salary/cost) associated with each NEI category. The objective was to estimate monetary costs or benefits, so for some of these categories, our interviewers probed to convert time into money. In practice, interviewers modified probes and interview survey order based on respondent feedback, using the layered probes as guidelines only. For example, if a respondent gave full details about a measure impact at any point during the interview, the interviewer switched to more targeted, ad-hoc questions.

Data collected to estimate NEIs clustered around five major categories:

1. Respondent provided. Respondents were asked directly about any changes by NEI category, and we recorded dollars and how the estimate was derived (i.e. for example, what parts of the Operations & Maintenance costs were reduced/increased). As noted above, few respondents were able to provide reliable estimates without additional interview probes and adjustments.

2. Respondent identified NEIs and monetization. A respondent who was able to monetize the NEIs appeared straightforward, in terms of data collection. However, interviewers discovered inconsistencies, errors, and unsubstantiated results when asking how the respondent estimated the amount. For example, for the respondent who stated “I think we saved $1,000 per year on O&M,” the interviewer then asked about specific changes that may have occurred, how these changes impacted the respondent’s business, and how the cost estimate was derived. Very few respondents were able to monetize NEIs without energy analysts’ probing.

3. Respondent identified NEIs for one or more categories, but could not monetize them. Interviewers asked a series of layered probes. For example, interviewers asked if the NEI category increased or decreased (if not already answered) and then asked about cost and revenue items impacted (i.e. internal labor, external labor, parts or supplies, training, or fuel) to understand which metrics the interviewers should inquire further about.

4. Respondent did not know if there were NEIs If a respondent did not know if there were NEIs, interviewers used an interview strategy similar to the one described above. But, interviewers provided more detail and prompts, as needed, based on typical category activities. For example, lighting measure installations may have resulted in changes to the frequency of light bulb changes.

5. Respondent reported no NEIs. While the respondent who reported no NEIs also appeared straightforward, interviewers discovered that additional probes sometimes uncovered NEI impacts the respondent may not initially have considered or did not consider significant (as compared to electricity savings). For the latter, interviewers assured respondents that we wanted to capture all non-electric impacts and proceeded with the probes.

Interviewers collected spillover information at the customer level. As stated above, capturing NEI information for all relevant measures often required a single interview to span multiple measure categories across numerous addresses. A respondent's experience with a measure in one location may have influenced their decisions to install the same or different measures at separate locations. Simplifying the interview process required limiting the spillover section to the respondent level.

Recording the interview

Each interviewer entered responses into a database immediately following the interview. Responses were recorded verbatim. Where possible, they indicated the value of each NEI source, and also the values for any metrics identified through the interview. They also provided a rough formula depicting the cost or revenue impact calculation they envisioned based on the information provided. For example, the cost associated with changing light bulbs would entail the fully loaded wage times hours per year that was needed to change the bulbs.

3.4 DATA ANALYSIS

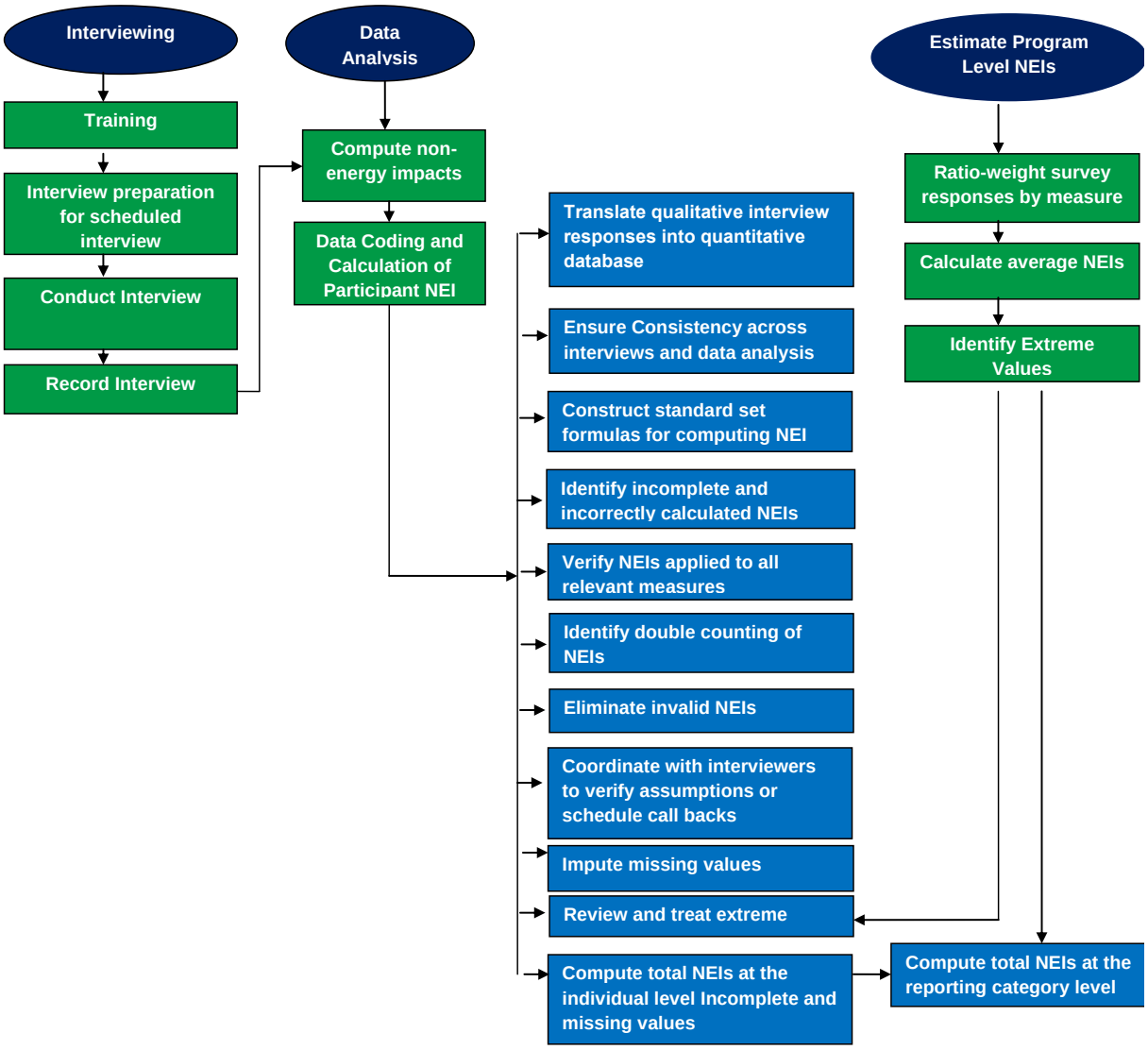
This section describes the analytical approach for computing NEIs, attribution of NEIs to energy efficiency programs, spillover, and attribution for custom measures that were not included in the 2010 participant FR/SO study.

3.4.1 Computing non-energy impacts

DNV KEMA used a multi-step process to compute NEIs associated with each measure. Figure 3-2 shows the process for computing NEIs, which began with the in-depth interview, and flowed into the data analysis process. The data analysis process and final estimation process were interrelated, as estimating average NEIs across all measures identified extreme values.

Each of the processes presented in the figure are discussed in the sections that follow.

Figure 3-2 Process for computing NEIs



Conduct Participant Interviews

During the interview process, analysts used their knowledge of the intersection of energy efficiency measures and business functions to identify an appropriate "formula" for estimating cost and benefit impacts resulting from the installed measures in relation to each specific facility. This was the first step in estimating NEIs for each measure. In order to complete this step, the interviewer was required to capture the following information during the interview itself:

- Discern the relevant cost and revenue items impacted;

- Identify the nature of those impacts; and
- Capture estimates for each parameter necessary to monetize NEIs.

Interviewers used the following basic formula to help capture the necessary information for computing most NEIs:

NEI cost change = (old equipment) – (new equipment)

Where

Cost change = increase or decrease in NEI category/activity

Old equipment = NEI activity prior to measure installation in 2010

New equipment = NEI activity after measure installation in 2010

Interviewers probed to ensure that the pre and post measure installation time periods were typical, and adjusted if necessary. For example, if a respondent said they repaired the boiler four times per year, interviewers asked further questions to verify the frequency of the equipment maintenance. On occasion the additional questions revealed that the repairs happened four times in 2009, but occurred only two times per year in previous years. This information was used to revise the initial response. This formula compared the typical year prior to and after the measure installation, typically 2009 to 2011. Table 3-6 presents the range of probes interviewers used, from general (e.g., NEI categories) to more specific (e.g., Cost/Revenue Items Impacted, Nature of Impact, and Impact Metrics). The most frequently used Impact Metrics that interviewers used to compute the NEIs were:

- Frequency – number of times activity occurred, per year, and whether it was annual-recurring or one-time;
- Time spent – internal or external labor in units of time (e.g. minutes, hours, days);
- Quantity – number of relevant staff/purchased items (e.g. employees, contractors, parts);
- Salary – labor wage, as loaded value including employee benefits; and
- Cost – total cost (or $ cost/each).

For example, if a respondent indicated that a new lighting measure required fewer bulb changes, they would then probe for the number of hours saved per bulb, times per year, number bulbs replaced, and the loaded wage. These variables were used to estimate the corresponding NEI as described in the section *Data Coding and Calculation of Participant NEIs.*

Table 3-6 Probes by NEI Category

NEI Category	Cost/Revenue Center Impacted	Nature of Impact	Impact Metrics				
			Occurs (# times / year)	Time (min / hrs)	Quan-tity	Salary ($/hr)[1]	Cost ($/ea.)
Operations and Maintenance	**Internal labor**	• Parts replacement • Routine maintenance • Equipment diagnostics & repair • External labor coordination • Customer calls/complaints	✓	✓	✓	✓	
	External labor	• Contractor visits	✓	✓	✓	✓	✓
	Parts / supplies	• Parts replacement • New equipment parts • Avoided parts	✓		✓		✓
	Training	• External/internal classes • Instructor labor • Training materials	✓	✓	✓	✓	✓
	Fuel Saved	• Natural Gas • Propane • No.2 Distillate • Wood • No.4 Fuel Oil • Kerosene	✓		✓		✓
Administration	**Internal labor**	• Bill handling & remittance • Administrative tasks	✓	✓	✓	✓	
	External labor	• Contracted accounting • Contracted administration	✓	✓	✓	✓	✓
Materials Handling	**Internal labor**	• Loading dock labor • Other materials handling labor	✓	✓	✓	✓	
	External labor	• Contracted load dock staff	✓	✓	✓	✓	✓
	Other	• Rental or purchased equipment • Other non-labor changes	✓		✓		✓
Materials Movement	**Fleet service/parts**	• Fleet repair/maintenance • Fleet vehicle parts	✓		✓		✓
	Fuel	• Gasoline • Electricity (plug in vehicles) • Natural gas	✓		✓		✓
	Internal labor	• Driver • Mechanic	✓	✓	✓	✓	
	External labor/services	• Contractor • Mechanic	✓	✓	✓	✓	✓
	Other	• Parking fees • Highway tolls	✓		✓		✓

[1] Includes benefits (loaded value)

(Table 3-6. Continued)

NEI Category	Cost/Revenue Center Impacted	Nature of Impact	Impact Metrics				
			Occurs (# times / year)	Time (min / hrs)	Quan-tity	Salary ($/hr)[1]	Cost ($/ea.)
Other Labor	**Internal labor**	• Any other labor	✓	✓	✓	✓	
	External labor	• Other contractor visits • Other external labor	✓	✓	✓	✓	✓
	Training	• External classes • Instructors • Training materials	✓	✓	✓	✓	✓
Water Usage	**Water Usage**	• Water usage	✓		✓		✓
	Wastewater	• Wastewater usage	✓		✓		✓
Product Spoilage	**Product Spoilage**	• Product/service damaged or spoiled	✓		✓		✓
Waste Disposal	**Waste Materials**	• Solid waste • Gaseous waste	✓		✓		✓
	Waste Handling	• Labor	✓	✓	✓	✓	
	Permits	• Permits/fees	✓		✓		✓
	Other	• Other costs	✓	✓	✓	✓	✓
Fees	**Insurance**	• Insurance premium change	✓				✓
	Inspections	• Equipment/facility inspections	✓		✓		✓
	Permits	• Permits (non-waste disposal)	✓		✓		✓
	Legal Fees	• Legal services • Legal filing fees	✓	✓	✓	✓	✓
Other Costs	**Labor**	• Any other labor	✓	✓	✓	✓	✓
	Non-Labor	• Non-labor costs	✓		✓		✓
Sales	**Sales**	• Change in sales revenue			✓		✓
Rent revenues	**Rent Revenues**	• Rent revenues			✓		✓
Other Revenue	**Other Revenue**	• Any other revenue changes			✓		✓

[1] Includes benefits (loaded value)

Data Coding and Calculation of Participant NEIs

The calculation of participant NEIs was based upon a thorough and rigorous review of the respondent data. DNV KEMA implemented a quality control process to ensure consistency for each participant's responses and to eliminate double counting NEIs across categories.

1. Translate the qualitative interview responses into a quantitative database

Data analysts received qualitative interview responses from the interviewers in a semi-structured text format; however, NEI computation required quantitative information. The recorded responses were entered into a database. Data analysts entered responses to the questions for each NEI category, costs and revenue items impacted, and the various metrics that were used to compute NEIs. For example, analysts entered separate fields (variables) for the total NEI dollars under each NEI category, as well as variables for the potential cost and revenue items impacted. They then recoded the specific metrics captured by the interviewer to estimate the NEI associated with that cost or revenue item.

Analysts also recorded interview notes (i.e. the text version of the interview responses) in separate fields next to the translated data fields. These text fields provided valuable information during the quality control process.

2. Ensure consistency across interviewers and data analysts

Responses to open ended in-depth interviews often varied across respondents and had the benefit of eliciting information that may not be uncovered through traditional pre-determined close-ended responses. Therefore, a primary function of the quality control process was to ensure that the data collected, and the interpretation of that data, was consistent across interviewers and data analysts. The evaluation team ensured consistency by having a second analyst responsible for reviewing all data entered, as well as verifying and standardizing data coding.

3. Construct standard set of formulas for computing NEIs

Data analysts were responsible for the quality control of the data entered by the interviewers. The data analysts identified a set of standard formulas and metrics for each cost and revenue center (i.e., the cost or revenue items) impacted under each NEI category. Standardizing the formulas across multiple measures allowed analysts to evaluate each in terms of the necessary metrics (i.e. salary, hours, price), and the range of responses to those metrics ($/hour). Table 3-7 presents the standard formulas for Operations and Maintenance, Administration, Material Handling, and other labor. For all other NEI categories, the NEIs recorded did not require a formula because respondents stated NEI values outright. The table also shows the number of measures for which each formula was used.

Table 3-7 shows that Operation and Maintenance costs are clearly the most widely referenced NEI category, while Table 3-8 displays all of the other formulas used to calculate the NEIs by category. Below are key highlights:

- Internal labor makes up the majority of calculations. Below is a brief description of the most common internal labor formulas:

  *(Hours per year due to Old Equipment - Hours per year due to New Equipment)*Loaded wage per hour.*

  The hours spent per year due to the old equipment minus the hours spent per new equipment yields the hours saved due to the new energy efficient equipment. Thus, this

formula calculates the hours saved multiplied by the loaded wage to yield the NEI for internal labor.

Hours per year due to Old Equipment Loaded wage per hour*

There were many cases when installing the new equipment meant that the customer was now spending zero hours on internal labor due to the new equipment. Therefore the cost was simply estimated based on the elimination of the hours spent on the old equipment.

- External labor frequently involved an outside contractor who would provide a particular service a number of times over year. With the new equipment, it was common that there were fewer external costs throughout the year. Similar to internal labor, there were many cases when installing the new equipment meant that the customer was now spending zero hours on external labor due to the new equipment. Therefore the cost was simply estimated based on the elimination of the hours spent on the old equipment.
- Parts and Supplies NEIs frequently referred to changes in the number of parts purchased resulting from the new equipment.
- There were fewer instances in which training occurred due to the new equipment. When a customer did incur a cost due to training, the cost reflected the cost associated with time spent away from their job as well as the cost of the training itself.

Table 3-7 Formulas Used to Calculate Overall NEIs for Operations and Maintenance NEIs

NEI Category	Cost/Revenue Center	Formula	Measures using formula	Percent
Operation and Maintenance	Internal Labor	(Hours per year due to Old Equipment - Hours per year due to New Equipment)*Unloaded wage per hour*Loaded factor	21	6%
		(Hours per year due to Old Equipment - Hours per year due to New Equipment)*Loaded wage per hour	153	44%
		(Hours per year due to Old Equipment - Hours per year due to New Equipment)* Times per year*Loaded wage per hour	11	3%
		(Hours per year due to Old Equipment - Hours per year due to New Equipment)* Times per year*Unloaded wage per hour*Loaded factor	1	0%
		Hours per year due to New Equipment*Loaded wage per hour	13	4%
		Hours per year due to New Equipment* Unloaded wage per hour*Loaded Factor	2	1%
		Hours per year due to Old Equipment*Loaded wage per hour	50	14%
		Hours per year due to Old Equipment * Times per year * Loaded wage per hour	7	2%
		Hours per year due to Old Equipment * Times per year * Unloaded wage per hour*Loaded Factor	6	2%
		Hours per year due to Old Equipment * Unloaded wage per hour*Loaded Factor	3	1%
		Don't Know	1	0%
		No Calculation Required- Value stated upfront	79	23%
		Operation and Maintenance Internal Labor Total	**347**	**100%**
	External Labor	(Hours per year due to Old Equipment - Hours per year due to New Equipment)* Cost per hour	24	4%
		Cost per hour * Hours per year	26	4%
		Cost per hour * Times per year	11	2%
		Hours per year * Labor Costs	1	0%
		Hours per year*Cost per hour * Times per year	17	3%
		Labor costs * Times per year	38	6%
		Times per year * Cost per hour * Labor costs	1	0%
		No Calculation Required- Value stated upfront	550	82%
		Operation and Maintenance External Labor Total	**668**	**100%**
	Parts and Supplies	Number of parts * Cost of Parts	89	81%
		Cost of parts * Number of parts * Times per year	1	1%
		Hours * Costs of Parts	1	1%
		Times per year * Cost of parts	19	17%
		Operation and Maintenance Parts and Supplies Total	**110**	**100%**
	Training	Hours * Labor Costs	20	91%
		hours * Times per year	1	5%
		No Calculation Required- Value stated upfront	1	5%
		Operation and Maintenance Training Total	**22**	**100%**
	Other	No Calculation Required- Value stated upfront	6	100%
		Operation and Maintenance Other Total	**6**	**100%**

Table 3-8 Formulas Used to Calculate Overall NEIs for All other NEIs

NEI Category	Cost/Revenue Center	Formula	Measures using formula	Percent
Administration	Internal Labor	(Hours per year due to Old Equipment - Hours per year due to New Equipment)*Loaded wage per hour	49	44%
		(Hours per year due to Old Equipment - Hours per year due to New Equipment)*Unloaded wage per hour*Loaded factor	10	9%
		No Calculation Required- Value stated upfront	53	47%
		Administration Internal Labor Total	112	100%
	External Labor	Hours*Labor Costs	2	100%
		Administration External Labor Total	**2**	**100%**
Material Handling	Internal Labor	Number of hours* Loaded wage per hour	4	9%
		Number of hours*Unloaded wage per hour* Loaded factor	1	2%
		No Calculation Required- Value stated upfront	38	88%
		Material Handling Internal Labor Total	**43**	**100%**
	External Labor	No Calculation Required- Value stated upfront	4	100%
		Material Handling External Labor Total	**4**	**100%**
Other Labor	Internal Labor	(Hours per year Old Equipment- Hours per year New Equipment)*Loaded wage per hour	7	70%
		(Hours per year due to Old Equipment - Hours per year due to New Equipment)*Unloaded wage per hour*Loaded factor	1	10%
		Times per year*Unloaded wage per hour* Loaded factor	1	10%
		No Calculation Required- Value stated upfront	1	10%
		Other Labor Internal Labor Total	**10**	**100%**

In addition, the evaluation team used information provided by respondents to estimate quantities of fuel and water saved. For fuel savings, respondents often did not know the quantities saved, but provided the cost associated with the fuel savings. Analysts used the average price of the respective fuel resources published by the EIA in order to estimate the quantity of fuel saved.

Table 3-9 Formulas Used to Calculate NEIs by Fuel Type

Fuel Type	Unit	Price
Natural Gas	Therm	$.86/therm[1]
No.2 Distillate	Gallon	$2.695/gallon[2]
No 4 Fuel Oil	Gallon	$2.57/gallon[3]
Propane	Gallon	$2.480/gallon[4]
Wood	Cord	$200.00/cord[5]
Kerosene	Gallon	$3.671/gallon[6]

[1] EIA.GOV, http://205.254.135.7/dnav/ng/ng_pri_sum_dcu_nus_a.htm
[2] EIA.GOV, http://www.eia.gov/dnav/pet/pet_sum_mkt_a_EPD2_PTA_dpgal_a.htm
[3] Environmental Defense Fund, http://www.edf.org/sites/default/files/10071_EDF_BottomBarrel_Ch3.pdf
[4] EIA.GOV, http://www.eia.gov/dnav/pet/pet_sum_mkt_a_EPLLPA_PTA_dpgal_a.htm
[5] EIA.GOV, www.eia.gov/neic/experts/heatcalc.xls
[6] EIA.GOV, http://www.eia.gov/dnav/pet/pet_sum_mkt_a_EPPK_PTG_dpgal_a.htm

For water savings, respondents frequently indicated savings, but could not estimate the amount of water saved. While some respondents did provide a specific monetary cost associated with the water savings, many did not know the cost of water saved. For respondents who knew they saved water, but could not provide additional information, the evaluation team based water savings estimates on the Massachusetts TRM using values of gallons per measure as used in the TRM to estimate energy savings.[19]

4. Identify incomplete and incorrectly calculated NEIs

Assigning interview responses to the standard formulas enabled data analysts to identify incomplete, incorrect, and illogical responses. Analysts first identified responses for which the respondent did not provide all the necessary information for computing NEIs. These responses were coded as incomplete and handled according to the procedures described in the section on “impute missing values” below.

Interviewers frequently constructed preliminary NEI formulas and computed rough NEI estimates based on information provided during the interviews. Upon reviewing these data, the data analysts occasionally needed to recalculate NEIs. Some respondents included revenue increases resulting from additional production and sales, but failed to estimate the increase in costs associated with the additional sales, such as raw material costs for industrial participants or re-stocking costs for retailers.

[19] http://www.ma-eeac.org/docs/MA%20TRM_2011%20PLAN%20VERSION.PDF

During the QC process, the Evaluation Team realized that a number of NEIs resulted from measures that were either replaced on failure of the existing measure or replacing a functioning measure that was scheduled to be replaced immediately. The Team determined that the portion of the NEI associated with these measure's "newness" was not applicable to the program because the participant would have incurred that benefit or cost without the program. Reviewing the formula used to compute attribution in the 2010 FR/SO study revealed that the attribution rate alone did not account for this distinction. Therefore, the following adjustment to the NEI estimates was required.

- DNV KEMA identified measures with 100% scores to the timing component free ridership. These measures were determined to be set for immediate replacement either through equipment failure, or some other reason.

- Then, we identified the percent of the NEI that respondents reported was due to the measure being energy efficient in the NEI survey.

- We multiplied the estimated NEI for each measure by the percent due to it being energy efficient to estimate the amount of the NEI that did not result from the measure's newness.

5. Verify NEIs applied to all relevant measures

Interviewers frequently conducted interviews spanning multiple measures and addresses. In these interviews, respondents were asked to provide NEI estimates for the typical or average impact across all relevant locations. They were also asked to identify the measures and locations to which each set of NEI values applied. Some respondents could not provide average responses and instead indicated the NEI applied to all locations. In these cases, the data analyst divided NEI responses by the number of relevant measures. In other cases, respondents could not provide a full accounting of all locations where measures were installed, so interviewers collected information about a typical site and applied that value for all of the respondent's relevant sites.

6. Identify double counting of NEIs

Data analysts examined NEIs reported for each cost and revenue center within each NEI category. By reviewing the sources of each reported NEI, their descriptions, and metrics, analysts ensured that a single NEI was not reported for multiple NEI categories. For example, analysts verified that reductions to internal labor reported under O&M was not also recorded under internal labor for Other Labor or Administration.

7. Eliminate invalid NEIs

Occasionally, respondents reported NEIs that should not be included in the analysis. In some instances, we flagged responses as invalid because they were impacts accounted for in the PA benefit-cost models as other energy or resource related impacts. For example, one respondent reported high "other revenue" resulting from clean energy credits which was separately accounted for in the PAs benefit-cost models.

8. Coordinate with interviewers to verify assumptions or schedule callbacks

When necessary, a few respondents were called back to either collect missing data or to verify the applicability of NEI estimates to additional locations. Data analysts first coordinated with the interviewers to determine whether the interviewer knew the necessary information, or needed to make a follow up phone call to capture the data.

9. Impute missing values

Approximately 40 respondents provided incomplete information for one or more of the NEIs for a measure. Imputing values for partial responses provided for reduced standard errors without biasing the results. DNV KEMA used published data to impute values for the missing variables, which included the ratio of loaded to unloaded wages, waste disposal costs, and costs of production. For less than 10 missing values, analysts used the mean value by end use from the interview responses to impute the missing values, each of these are discussed below. For a number of the missing values there were no published data. For example, there were no data reporting the reduction in the average number of parts replaced due to the new EE measure. Further for some missing values, identifying the correct published values would require many assumptions that were themselves difficult determine. For those missing values, we imputed the average from survey responses. Appendix G presents sensitivity analysis of the NEI results with and without imputed values to ensure that magnitude of NEI estimates was dependent upon values imputed from the overall set of survey responses.

Loaded to unloaded wage factors – The most common metric missing from the interview response was a measure of employee benefits, or the loaded wage. As seen in Table 3-7 and Table 3-8, many respondents provided the "unloaded wage" for NEI computations, but were not able to provide the fully loaded wage. In cases where only the unloaded wage was provided, analysts estimated the fully loaded wage based on information provided by the Bureau of Labor Statistics, which describes employer costs per hour worked for employee compensation and costs as a percent of total compensation. Employee wages without benefits make up 69.4% of total compensation on average. The average is based on all workers in the non-farm and non-federal sectors.

Waste disposal costs – One respondent reported decreased disposal costs for lighting measures, but did not provide a unit cost of disposal.[20] DNV KEMA assumed an average waste disposal cost of $0.60/lb. Based on information published by the US EPA regarding lighting waste, disposal costs vary between $1.50/lb and $0.60/lb. Therefore, our assumed value of $0.60/lb provides for a conservative estimate of NEI resulting from decreased waste disposal. (Note: if the PAs offer waste disposal as a service of the programs they should not apply this NEI.)

Production cost changes – Five respondent provided NEI estimates for increased revenue resulting from production increases, but provided no information concerning the corresponding increase in costs. For each of these cases, DNV KEMA assumed an average profit margin for the corresponding industry based on published sources to impute the costs.[21] [22] [23] [24] [25]

[20] http://www.dep.state.fl.us/waste/quick_topics/publications/shw/mercury/wastedi.pdf
[21] http://biz.yahoo.com/ic/322.htmlhttp://biz.yahoo.com/p/sum_qpmd.html
[22] ttp://biz.yahoo.com/ic/322.html
[23] http://biz.yahoo.com/ic/712.html, http://biz.yahoo.com/ic/715.html
[24] http://biz.yahoo.com/ic/627.html
[25] http://biz.yahoo.com/ic/322.html

Remaining intermediate missing values – For each of the missing intermediate values shown in Table 3-10, DNV KEMA used the average value by reporting category from the completed interviews, For HCAC and building envelope, the average values do cross electric and gas, but this impacted less than 10 cases. The n's shown represent the number of measures included in the average.

Missing cost details of information – There were 11 measures for which the respondents reported a definite reduction in costs in a category, but provided no other information. Five of these were for "O&M costs," two were "Administrative costs," one was "material handling," and two were "other costs." In each of these cases, analysts first estimated the average NEI per savings ratio for the corresponding reporting category in the study across all completed measures that also had a decrease in costs. Analysts then multiplied this ratio by the reported savings for the measure to impute a NEI estimate for the measure

- Operations and Maintenance had the most missing values for the NEI calculations.

  Internal Labor, hours per year: In some cases, the customer could not estimate the change in the number of hours for an employee due to the new energy efficient equipment. To complete the NEI calculation, DNV KEMA used an average change in hours and multiplied that value by the loaded wage for that employee.

  Internal Labor, loaded wage per hour: The loaded wage per hour was the most common missing value for Operations and Maintenance. In some cases, the customer provided the change in hours due to the new equipment, but could not provide the hourly wage. DNV KEMA used an average value for hourly wage to calculate the NEI.

  Parts and Supplies: For parts and supplies, DNV KEMA generated an average for Costs of parts, Number of parts, Labor Costs, and Cost per hour. For this cost/revenue center, customer could provide the cost of parts, but could not estimate the change in the number of parts purchased since the installation of the new equipment. Other customers could provide the number of parts, but could estimate the cost of those parts. Additionally, some customers knew that there was a change in the purchasing of parts and supplies but could not estimate the yearly costs (titled as Labor Costs) due to that change in purchasing of parts and supplies. Therefore, DNV KEMA created the average value across the complete survey responses for each input in order to generate the NEI.

- Admin, Internal Labor: Like Operation and Maintenance, it was necessary to generate averages for the change in hours due to the new energy efficient equipment. The change in hours was multiplied by the internal labor employee loaded wage per hour. For admin, DNV KEMA generated an average for only internal labor. There was no need to create an average for any other cost/revenue center.

- For Other Labor, Product Spoilage, and Waste Disposal, the data was incomplete but respondents often would indicate there was a change in each category, but could not estimate the dollar value of the NEI. DNV KEMA imputed the average for the dollar value of the NEI by reporting category across respondents who provided a response.

Table 3-10 Average Value of Variables for NEI Calculation

Business Function	Formula	Variable	Building Envelope n=52	Comprehensive n=26	Compressed Air n=12	HVAC n=138	Lighting n=252	Motors and Drives n=92	Other n=10	Process n=11	Refrigeration n=120	Water Heater n=70
Operation and Maintenance	Internal Labor	Hours per year spent due to New Equipment	0	0	100	44	34	127	0	2,400	28	4
		Hours per year spent due to Old Equipment	147	10	28	136	175	145	157	939	32	16
		Loaded wage per hour	$25	$22	$46	$37	$32	$36	$25	$34	$34	$38
		Days per year	0	300	5	202	200	185	0	0	0	0
		Dollar value of NEI	$3,734	$4	$7,831	$4,017	$4,886	$2,967	$3,890	$8,690	$2,762	$1,018
	External Labor	Labor Costs	$2,357	$0	$3,500	$4,261	$13,608	$2,747	$1,000	$100	$400	$2,665
		Cost per hour	$0	$0	$0	$190	$79	$96	$0	$0	$86	$306
	Parts and Supplies	Cost of parts	$559	0	8,000	1,512	1,165	1,277	0	0	1,331	188
		Number of parts	86	0	2	6	223	30	0	0	13	1
		Dollar value of NEI	$5,454	$0	$12,964	$1,749	$25,484	$1,704	$2,100	$327,807	$16,300	$423
Administration	Internal Labor	Hours per year spent due to New Equipment	0	0	0	1	1	0	0	0	0	0
		Hours per year spent due to Old Equipment	54	0	3	31	38	8	0	0	1	2
		Loaded wage per year	$45	$0	$30	$2,257	$30	$21	$0	$0	$10	$31
Other Labor	N/A	Dollar value of NEI	$0	$0	$19,800	$16,440	$1,851	$50	$27,300	$24,000	$0	$456
Product Spoilage	N/A	Dollar value of NEI	$161	$0	$3,100	$1,918	$0	$20,000	$0	$20,000	$109,500	$0

10. Review and treat extreme values

To identify potential outliers, DNV KEMA conducted an additional QC review of NEIs that met any of the following criteria:

- Measures with negative overall NEI values;
- Measures with an NEI greater than $15,000. In addition, measures with greater than $50,000 in overall NEIs also passed through a final verification by a team of senior KEMA analysts.
- Measures with NEIs that exceeded five times the non-zero mean NEI within the same reporting group and savings type (kWh or therm).
- Measures that had NEI with a standard deviation two times the standard deviation of the measures with non-zero NEIs of the same end use.

The initial QC of the interview data revealed roughly 50 extreme values. However, most of the values initially thought to be outliers were reduced or set to zero upon further review of the survey responses. Because the interviewer's primary function was to probe for and record NEI information, they did not attempt to evaluate whether all of the data provided would pass the rigorous QC process. Within the QC process, we identified extreme values and re-assessed the assumptions used to estimate them. In a number of cases the values were deemed to be either double counted or reporting values the team decided should not be reflected in NEIs.

Ultimately, DNV KEMA found only two measures that were considered outliers. One had a substantial increase in production due to the new measure. The other had a cost savings in insurance payments due to a safety improvement from the installed measure. Each had NEI dollar values greater than $100,000 and reasons for the NEIs that were not seen in other surveyed sites. In order to keep these measures from biasing the results, but at the same time respect the fact that the unusual does happen, we made sure that each measure represented only itself in the study by assigning it a weight of one. Information provided by the interview allowed us to conclude that, while valid responses, these cases should not receive the sample weight associated with the stratum. By unit weighting extreme value, we are assuming that the case is not representative of other cases within the pre-defined stratum and represents itself. We are including it in the average, but not saying it is representative of other cases.

11. Compute total NEIs

The last step in the data coding and quality control phase was to calculate total NEIs for the measure by summing across the different NEI categories at the individual measure level.

Extrapolation of results and gross NEI/kWh and NEI/therm

DNV KEMA used the statistical procedure of ratio estimation to develop estimates of NEI per kWh or per therm, for electric and gas measures, respectively. Once the individual measure level NEIs were calculated, the final step was to expand the sample results to the population of measures. This was accomplished by calculating the ratio of NEI (in dollars) to reported savings for the sample. The ratios are also referred to in this analysis as adjustment factors.

The evaluation team used ratio estimates to extrapolate measure level NEIs to the population of measures. The calculation of the NEI adjustment factor used appropriate weights corresponding to the sampling rate. The adjustment factor was calculated as a ratio estimator over the sample of interest (Cochran, 1977, p.165). The formulas for these factors are given below.

The NEI rate R_I was calculated using:

$$R_I = \frac{\sum_{j \varepsilon A} G_{Ij} w_{Aj}}{\sum_{j \varepsilon A} G_{Tj} w_{Aj}}.$$

Where:

G_{Tj} = tracking estimate of gross savings for measure *j*

G_{Ij} = evaluation estimate of gross non energy impacts for measure *j*

w_{Aj} = weighting factor for measure j used to expand the sample to the full population[26]

The ratio estimator was calculated using a SAS® macro for ratio estimation by domains. The procedure also returned the standard error of the estimate. The standard error was calculated using two methods.

The first method recognized the sample as drawn from a finite population: the measures completed within the analysis period with associated energy impacts in the program-tracking database. This calculation used the Finite Population Correction (FPC) factor.

> *Finite Population Correction* – This factor is a reduction to the calculated variance that accounts for the fact that a relatively large fraction of the population of interest has been observed directly and is not subject to uncertainty. It is appropriate to apply precision statistics, such as confidence intervals, based on the standard error calculated in this manner when quantifying the results of the program during the study period only.

The second calculation treated the population of interest as essentially infinite. Thus, the population of measures completed to date and the sample were assumed to have a virtually infinite number of combinations of measures that could have been completed under the program. In this case, the FPC was not included. It is appropriate to apply standard errors calculated in this manner when applying the verification factors developed from this study to tracked savings from other years to estimate NEIs in those years. Confidence intervals reported in this document do not include the FPC.

[26] Because the sample for the prescriptive studies were pulled from the measures completed in the 2011 FR/SO studies, the weighting factor for the prescriptive studies consists of two parts multiplied together: the selection probability for the measure in the 2011 FR/SO study and the selection probability from this study.

3.4.2 Analysis of Attribution – Net Non-energy Impacts

Because the analysis followed the same group of respondents through from the 2010 participant FR/SO study to this NEI study, the evaluation team was able to track the attribution rates of people who did and did not report NEIs. This enabled us to examine potential differences in attribution rates for participants who realize NEIs and those who do not. Specifically, we explore whether it is appropriate to apply the same attribution rate used to estimate net savings, when estimating net NEIs.

Currently, the PAs compute NEIs attributable to program activities by multiplying an estimate of NEI per unit of gross savings (e.g. per kWh) by gross savings for a measure or measure group. They multiply the resulting measure NEIs by the measure's attribution rate to calculate net NEI for the measure. This approach assumes that participants who experience NEIs have the same free ridership rate as those who do not. If free ridership rates are higher among participants who experience non-energy benefits, then the overall free ridership rate is not the appropriate value to use for non-energy impacts.

DNV KEMA's analysis applied the attribution rate from the 2010 participant FR/SO study for each respondent to the gross NEIs estimated in the present study. This provided a revised estimate of net NEIs specific to each respondent. We then calculated the average net NEI by reporting category, and compared it to the net NEIs using the traditional approach, and compared the two approaches. The evaluation team further explored differences in attribution rates and net NEIs for individuals who did and did not expect to receive NEIs prior to participation. Finally, we examined the impact of program marketing on NEI expectations and program attribution.

3.4.3 Spillover

The interview response data were used to identify the incidence of like and unlike spillover at the respondent level. "Like" spillover is identified as an energy efficient measure that was installed without an incentive that was exactly the same type of measure for which the customer received program support. "Unlike" spillover is an energy efficient measure that was installed by the customer that was neither incentivized nor the same as past program supported measures. In addition to the characterization of spillover, the analysis provides the percent of respondents who stated the program influenced their decision to install the like and unlike spillover measures. DNV KEMA's approach for estimating the incidence of like and unlike spillover was as follows:

1. We compiled the responses to all spillover questions from each respondent. Because respondents frequently reported on measures across multiple locations, we grouped spillover information by respondent, and considered reported spillover data across locations.
2. We identified whether the respondents reported having received an incentive for the noted spillover measure. Measures that were noted to have received an incentive were eliminated because they do not qualify as spillover.
3. We identified all measures for each respondent across all addresses reported by the PAs program tracking records. Interviews frequently spanned multiple measures and locations.
4. We compared the spillover measure descriptions and the program supported measures corresponding to the various locations to determine if the reported measure was "like" or "unlike" the measures listed in the tracking records for each respondent.

Many of the respondents reported having received incentives for the measures reported as spillover; therefore, these measures were eliminated from the analysis. The analysis also revealed that many measures reported as spillover by multi-building facilities, chains, or franchises participants installed the measures at locations other than the locations noted in the PA tracking records. Should a quantification of the kWh or therm savings be associated with these spillover measures, DNV KEMA suggests that the savings be divided between the number of buildings for which the owner received program support.

Further, it was also found that for many measures, there was not sufficient information to estimate savings or even classify the savings as high or low impacts. There were several reasons for this finding. First, the primary focus of this study was the more detailed NEI information and the individual being interviewed was asked to focus on all measures installed across their organization, rather than at a specific location. Secondly, the target respondents were those who were most knowledgeable of the specific business impacts of installed energy efficiency measures. While capable of providing the impacts on business operations, this person often did not know the specific engineering or purchasing details of the measures installed. Lastly, it is believed that respondent fatigue became a factor and limited the accuracy and amount of detail the respondents provided when answering the spillover questions. After answering the complex set of NEI questions, respondents provided brief, non-descript answers or referred the question to another department or person in their organization.

4. RESULTS

In this section, we present the results of NEI estimates, analysis of the attribution of NEIs (net NEI), and spillover. First, we present the gross NEI estimates for prescriptive and custom projects. Next, we present results that follow the model development process as we identify the survey and other data collection results used as model inputs.

4.1 NON-ENERGY IMPACTS

DNV KEMA captured NEI information for 789 prescriptive and custom electric and gas measures. Positive NEIs or non-energy impact benefits were realized for 58% of measures, while 3% of measures resulted in negative NEIs, non-energy impact costs. An additional 40% of measures reported no positive or negative NEIs. Table 4-1 presents a summary of the number of measures reporting NEIs of different values across all measure and fuel types.

Table 4-1
Number of measures reporting NEIs:
by Size of NEI

NEI Value	Number of measures	Percent of measures
Negative	22	3%
Zero	315	40%
Greater than Zero to $1,000	235	30%
Greater than $1,000 to $5,000	119	15%
Greater than $5,000 to $10,000	44	6%
Greater than $10,000 to $15,000	15	2%
Greater than $15,000 to $50,000	29	4%
Greater than $50,000 to $100,000	8	1%
Greater than $100,000	2	0%
Total	789	

Table 4-2 and Table 4-3 present some of the key anecdotal findings. Table 4-2 and 4-3 present information pertaining to the electric measures, while the data presented in Table 4-4 pertains to gas measure NEI interviews. This information may be useful for future marketing activities.

Table 4-2 Sources of Non-Energy Impact – Electric Measures

NEI Category	NEI Description	Impact Description	Prescriptive	Custom
Annual operations and maintenance costs	1. Avoided light bulb and ballast changes	LED lighting decreases bulb changes and staff time to identify burnt out bulbs.	✓	✓
		Occupancy sensors eliminates twice daily building checks to turn lights on and off.	✓	✓
	2. Avoided routine maintenance and repairs	New compressor requires less frequent oil changes.	✓	
		VFDs decreases frequency of system inspections needed.	✓	
	3. Avoided electrician/service visits	Decreases external service contract by 30% annually due to fewer bulb and ballast changes.	✓	✓
		Saves 20 hours/year contractor labor (at $90/hour) on decreased bulb and ballast changes.	✓	✓
		Saves 9 annual contractor visits; customer able to diagnose problems using Web-based system.	✓	✓
	4. Avoided system monitoring/equipment checks (automatic sensor monitoring)	Lighting occupancy sensors eliminates staff twice daily building tours to turn lights on and off.	✓	✓
	5. Avoided parts (e.g. bulbs, filters, etc.)	Less frequent lamp changes decreases purchase of light bulbs, ballast and gloves (due to heat of lamps)	✓	✓
Administration costs	1. Avoided electrician/service invoice processing	Saved 2 hours/month processing external contractor invoices.	✓	✓
	2. Avoided service or parts/supplies procurement	Fewer bulb changes saves 4 hours/year ordering light bulbs, ballasts and gloves.	✓	✓
	3. Avoided external contractor coordination	Saves one hour administrative staff time coordination for each avoided contractor visit.	✓	✓
	4. Avoided tenant/customer equipment complaints	Building control system automates temperature setting and saves 6 tenant calls per week	✓	✓
Materials handling	1. Avoided parts handling in warehouse	Eliminates one stockroom FTE at $18,000/year due to decreased light bulb changes.	✓	✓
		Saves 25 hours/year staff time on receiving and stocking equipment.	✓	✓

Table 4-3 Description of Electric Measure Non-Energy Impacts (continued)

NEI Category	NEI Description	Impact Description	Prescriptive	Custom
Materials movement	1. Fewer parts deliveries	Decreases central supply deliveries to maintenance dept staff.	✓	✓
	2. Avoided gasoline to pick up parts/supplies	Fewer trips to pick up lighting supplies saves 10 gallons of gas/year.	✓	✓
	3. Avoided vehicle maintenance (fewer parts/supplies pickups)	Saves $200/year on wear and tear of company vehicles to pick up lighting supplies.	✓	✓
Other labor	1. Avoided staff down time	New compressor breaks down less often and eliminates 20 – 30 hrs /year staff down time.	✓	
		Avoides two chiller failures/year and saves 8 hours/year staff downtime.	✓	
Water usage and wastewater	1. Avoided water pumped	VFDs installed on water pumps saves 10.5 million gallons/year per motor.	✓	
	2. Avoided water usage	Customer's water usage decreases by 250,000 gallons/yr after installing new HVAC system.	✓	✓
Product spoilage	1. Avoided product loss - manufacturing	Avoides $5,000 annual product lost due to old compressor failing mid-manufacturing process.	✓	
	2. Avoided product loss - non-manufacturing	Improved refrigeration equipment saves customer $73,000 in avoided food spoilage annually across 10 stores.	✓	✓
Waste disposal	1. Avoided waste disposal	Customer disposes of six fewer bulbs/month and saves $3.50 per lamp or $252/annually.	✓	✓
		Customer saves $200 annually due to decreased waste oil.	✓	✓
	2. Avoided waste disposal contract	Saves $340 per year on external lighting contract due to lower bulb & ballast waste disposal costs.	✓	✓
Fees	--	--		
Other costs	1. Avoided manufacturing downtime	Avoides 20 – 30 hrs /year staff time lost when compressor failed.	✓	
	2. Avoided accidents	Outdoor LED lighting improves visibility and decreased accidents; saves $80,000 per incident in lost productivity, medical bills, and insurance premium increases.	✓	✓
Sales	1. Improved product lighting	Quality of LED lighting allows better viewing of products and increases sales.	✓	✓
Rent revenues	1. Decrease/avoid building vacancy	Avoids rent increases and decreases risk of vacancy due to lower utility costs (from HVAC/lighting upgrades).	✓	
		Customer plans to decrease rental rates (50 cents/sq ft) to fill vacancies due to decreased electricity usage costs.	✓	
Other revenue	1. Increased property value	Installed EMS system increases property value by $500,000, based on $50,000/year in energy savings).	✓	✓
	2. Increased productivity	Better lighting improves employee productivity, and requires fewer man hours to do the same job.	✓	✓

Table 4-4 Sources of Non-Energy Impact – Gas Measures

NEI Category	NEI Description	Impact Description
Annual operations and maintenance costs	1. Avoided maintenance/repair	Improved insulation saved customer $1,500 annually on roof maintenance. New boiler saved customer 120 hours annual staff time in avoided repairs.
	2. Avoided plumber/HVAC service visits	Customer saved $4,000 per year in avoided HVAC contractor visits because new boiler requires fewer repairs.
	3. Avoided parts (e.g. thermostats, lubricating oil, filters, etc.)	Customer saved $1,400 annually in plexi glass pane window replacement parts due to building envelope measure installation. EMS system saved $500/month in pneumatic thermostats and other supplies.
	4. Avoided HVAC system monitoring/checks (sensors/monitor remotely)	Installed EMS system saves 26 hours annual staff time to monitor and adjust thermostats Customer's new EMS system saved $1,040 annually in avoided contractor labor to set and check thermostats.
Administration costs	1. Avoided invoice processing	Customer saved 24 hours/year in avoided bill payment and processing (contractor and parts/supplies)
	2. Avoided labor handling maintenance/repair	Customer saved 20 hours/year in avoided phone calls and paperwork handling maintenance and repair issues.
Materials handling	1. Avoided stockroom labor	Customer decreased stockroom labor to receive and store parts (new boiler requires fewer repairs and parts).
Materials movement	1. Avoided gasoline	New HVAC system saved customer $400/year in automobile gasoline costs due to decreased HVAC repairs and travel among multiple facilities.
Other labor	1. Avoided labor downtime	Customer saved ~$400 in avoided staff time waiting because new hot water is instantaneous.
Water usage and wastewater	1. Avoided water loss	Customer avoided wasted water from small, constant water leaks from old boilers.
Product spoilage	--	--
Waste disposal	1. Avoided waste disposal	Customer avoided disposal costs of wastewater (oil/water) drum due to new HVAC system installation. Customer saved ~$100/year in avoided mercury disposal due to new EMS system.
Fees	1. Avoided inspection fee	Custsomer avoided EPA inspection for tank water heater because installed tankless
Other costs	1. Avoided energy usage	Customer eliminated heating costs at one building (saved 1 million BTUs/hour) due to new manufacturing compressor which is water cooled and heats facility.
Sales	--	--
Rent revenues	--	--
Other revenue	1. Increased property value	Customer estimated property value rose $200,000-$500,000 due to new boiler system.

The estimates for gross NEIs per unit of energy savings are presented below. Electric results are reported by end use, while gas results are by measure category. The measures are aggregated or disaggregated to the level of reporting appropriate for the PAs. The NEI estimates were aggregated to major reporting categories that provide for the greatest degree of statistical precision.[27]

In addition to monetized NEIs, we present estimates of resource impacts, which quantify water and non-electric energy savings resulting from the installed measures.

4.1.1 Prescriptive measure results

DNV KEMA captured NEI information for 302 prescriptive electric and 98 prescriptive gas measures. For prescriptive electric measures, we exceeded the target number of completes for lighting measures. Completing a census of the remaining reporting categories provided an additional 139 measures. For prescriptive gas measures, we exhausted a census of all measures in the sample frame.

Electric Measures

Table 4-5 presents the NEI estimates for prescriptive electric measures. DNV KEMA collapsed electric end uses into four "NEI Reporting categories" to provide separate NEI estimates for lighting, motors and drives, HVAC, and all other prescriptive electric measures. This provided for statistically reliable NEI estimates across each of the reporting categories. The table shows the estimated NEI per kWh for each reporting category, as well as the 90% confidence interval for the estimate. We also show the percent of the kWh savings represented by each measure category, and the average estimated NEI using the ratio of NEI/kWh and the average savings for each reporting category.

HVAC measures, which included measures such as air conditioning, air handling units, and chillers, showed the highest estimated NEI ($0.097kWh), as well as the largest average NEI ($7,687 per measure). Lighting showed the second highest NEI, both in terms of NEI / kWh ($0.027/kWh) and average NEI ($1,636 per measure). Estimating NEIs associated with lighting measures are simpler than for other types of measures, because NEIs largely consisted of reduced time replacing bulbs and decreased disposal costs. DNV KEMA recommends using $0 for prescriptive electric measures that were not statistically significant (Motors and Drives, Refrigeration, and Other) because the data do not provide sufficient evidence to support a non-zero estimate.

Table 4-5 Gross Annual NEI per kWh – Prescriptive Electric

NEI Reporting Category	n	Average NEI	NEI/kWh	90% CI Low	90% CI High	% of Population kWh	Stat Sig
HVAC	27	$ 7,687	$ 0.0966	$ 0.0544	$ 0.1389	8%	Yes
Lighting	163	$ 1,636	$ 0.0274	$ 0.0176	$ 0.0372	69%	Yes
Motors and Drives	50	$ 541	$ 0.0043	$ (0.0005)	$ 0.0091	18%	No
Refrigeration	30	$ 5	$ 0.0013	$ (0.0002)	$ 0.0028	0%	No
Other	32	$ 28	$ 0.0039	$ (0.0002)	$ 0.0079	3%	No
Overall	**302**	**$ 1,439**	**$ 0.0274**	**$ 0.0188**	**$ 0.0360**	**100%**	**Yes**

[27] Because some measures are not represented in the sample of NEI respondents, estimates are directly applicable to all measures.

Table 4-6 shows the correlation between prescriptive measure NEIs and their corresponding savings. We calculated the correlation for all prescriptive electric measures, including those respondents that reported no NEIs, and then for respondents excluding the zero NEIs. The results show a strong, statistically significant correlation whether or not the zero NEIs were included. This supports using NEI / kWh savings as a means of estimating total NEIs across prescriptive electric programs.

Table 4-6 Correlation NEI/kWh Savings
Prescriptive Electric

Variable	Correlation: NEI:Gross kWh	P-Value
All NEIs	0.3301	0.0000
NEI not equal to zero only	0.3428	0.0000

Table 4-7 presents the average contribution of each NEI category to the overall average NEIs. Some NEI categories resulted in an average positive NEI (e.g. a decrease in costs, or increase in sales). For these NEI categories, the percent contribution to the overall average NEI was positive. Other NEI categories resulted in an average negative NEI (e.g., an increase in costs, or decrease in sales). For these NEI categories, the percent contribution to the overall average NEI was a negative impact.

Table 4-7 Distribution of Annual NEIs by NEI Category – Prescriptive Electric

NEI Reporting Category	Admin	Fees	Material Handling	Material Movement	Other Costs	Other Labor	O&M	Other Revenue	Product Spoilage	Rent Revenue	Sales Revenue	Waste Disposal	Total Impacts
HVAC	8.2%*	0.00%	0.00%	0.00%	3.40%	-0.30%	69.8%*	0.00%	0.00%	18.90%	0.00%	0.00%	100.0%*
Lighting	5.0%*	0.00%	2.9%*	0.40%	0.00%	7.30%	73.7%*	0.00%	0.00%	0.00%	8.30%	2.3%*	100.0%*
Motors and Drives	0.6%*	0.00%	0.0%*	0.0%*	4.90%	0.20%	94.80%	0.00%	0.00%	0.00%	-0.50%	0.0%*	100.00%
Refrigeration	0.0%*	0.00%	0.0%*	0.0%*	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.0%*	100.00%
Other	1.00%	0.00%	0.0%*	0.0%*	0.00%	0.00%	99.00%	0.00%	0.00%	0.00%	0.00%	0.0%*	100.00%
NEI Reporting Category	**5.4%***	**0.00%**	**2.4%***	**0.40%**	**0.60%**	**6.10%**	**73.5%***	**0.00%**	**0.00%**	**2.80%**	**6.90%**	**2.0%***	**100.0%***
Significance:*													

Table 4-7 identifies the following sources for positive and negative NEIs from each of the NEI reporting categories:

- *Lighting*

  Operations and Maintenance (73.7%): Respondents most commonly reported decreased time spent changing bulbs. They also reported decreased time spent overseeing contractors who replaced less efficient lighting more frequently. Additionally, respondents stated that the energy efficient light bulbs last longer, resulting in decreased cost of purchasing new bulbs

  Sales Revenue (8.3%): Respondents stated the new lighting enhances their retail display showroom, thereby making products more visible and attractive to buyers resulting in increased sales. Other respondents stated that better lighting in refrigerated cases allow respondents to see the products better, which increases sales.

Other Labor (7.3%): Multiple respondents stated that improved lighting has increased worker productivity by providing better working conditions.

Material handling (2.9%): Respondents reported a positive NEI for Material Handling for several reasons, all related to new lighting. Some stated that they saved time receiving and handling new lighting parts and supplies. Others stated that staff no longer had to wait 10 minutes every day for the lights to turn on. Another customer reported that staff no longer needed to move pallets of used T8 bulbs from the facility to the disposal site.

Waste Disposal (2.3%): All respondents reported that they are no longer spending as much money or time disposing of used bulbs.

- *Motors and drives*

  Operation and Maintenance (94.8%): O&M accounts for 94.8% of the total motor and drives prescriptive electric impacts. Respondents stated that there is a decrease in labor time spent conducting repairs, cleaning existing parts, or purchasing new parts. Others have found that installing energy efficient motor controls has reduced labor time needed to monitor the system.

  Other Costs (4.9%): Other Costs accounts for 3.3% of the total NEI. Respondents stated that the new motor and drives equipment has improved employee satisfaction and reduced the number of maintenance calls due to malfunctioning equipment. This in turn has reduced costs for the customer.

  Sales Revenue (-0.5%): The decrease in Sales Revenue was caused by a VSD malfunction, causing the equipment to shut down for two hours.

- *HVAC*

  Operation and Maintenance (69.8%): Respondents stated that there was a decrease in annual maintenance of the HVAC systems. They saved labor hours in overseeing contractor visits, repairs, and purchasing new parts or supplies.

  Rent Revenue (18.9%): Respondents that owned rental properties found that the new energy HVAC equipment lowered monthly utility costs. The decrease in the utility costs allowed these respondents to drop monthly rental rates which were more competitively priced to retain or attract tenants. Another property owner stated that, due to the new HVAC equipment, the air temperature of the building remained at a more comfortable level, which has decreased renter turnover.

  Other Labor (-0.3%): Respondents stated that, due to the energy efficient equipment, there are less equipment failures, which means there are fewer disruptions in the work day. Conversely, some respondents have stated that there is an increase in other labor due to preventative maintenance and increased time to ensure that all equipment is operating correctly.

- *Other*

  Operation and Maintenance (99.0%): Overall, respondents stated that there was a decrease in time spent monitoring, repairing or overseeing contractor visits.

Table 4-8 presents average NEIs and NEI/kWh by industry sector.

- The data clearly show that the manufacturing sector experienced the highest average NEIs ($4,163 per measure; n=17). Manufacturers were most likely to experience NEIs resulting from multiple NEI categories, such as O&M, material handling, and material movement cost reductions as well as increased productivity and sales.
- The Public Order and Safety sector experienced the second highest average impacts ($3,908 per measure; n=8). This sector consists of fire departments, courthouses, police stations and other public facilities related to the preservation of order and safety. These facilities were most likely to see NEIs resulting from a decrease in operations and maintenance and across end uses such as lighting, HVAC, and refrigeration.
- Public Assembly also experienced high impacts; however, these are not significant.
- Conversely, food sales, mercantile, and food service experienced the lowest average impacts. For these industries, the NEIs were most likely found within O&M, and across end-uses such as lighting and refrigeration.

Table 4-8 NEI Estimates per Measure by Industry – Prescriptive Electric

Building Use	n	Average Annual NEI	NEI/kWh	90% CI Low	90% CI High	Stat Sig
Education	40	$ 2,634	$ 0.0631	$ 0.0106	$ 0.1156	Yes
Food Sales	60	$ 330	$ 0.0074	$ 0.0004	$ 0.0143	Yes
Food Service	4	$ 80	$ 0.0089	$ (0.0060)	$ 0.0238	No
Health Care	14	$ 2,966	$ 0.0106	$ 0.0021	$ 0.0192	Yes
Lodging	26	$ 1,001	$ 0.0178	$ 0.0022	$ 0.0333	Yes
Manufacturing	17	$ 4,163	$ 0.0269	$ 0.0023	$ 0.0515	Yes
Mercantile	24	$ 332	$ 0.0205	$ 0.0087	$ 0.0324	Yes
Office	43	$ 2,656	$ 0.0423	$ 0.0247	$ 0.0600	Yes
Public Assembly	10	$ 2,761	$ 0.1142	$ (0.0276)	$ 0.2561	No
Public Order and Safety	8	$ 3,908	$ 0.2241	$ 0.1721	$ 0.2760	Yes
Religious Worship	1	$ 105	$ 0.0053	$ 0.0053	$ 0.0053	No
Service	15	$ (3)	$ (0.0001)	$ (0.0009)	$ 0.0006	No
Warehouse and Storage	2	$ 2,030	$ 0.0154	$ (0.0322)	$ 0.0630	No
Other	17	$ 1,487	$ 0.0087	$ 0.0063	$ 0.0110	Yes
Unknown	21	$ 285	$ 0.0130	$ 0.0013	$ 0.0247	Yes
Building Use Overall	**302**	**$ 1,439**	**$ 0.0274**	**$ 0.0188**	**$ 0.0360**	**Yes**

Table 4-9 presents resource savings for prescriptive electric measures. These savings are measured in quantity of resources saved rather than dollars. The table shows that resource savings that were reported for natural gas and water savings. Because most respondents were not able to quantify resource savings, and the results were not statistically significant, DNV KEMA recommends using the average fuel and water savings provided by the TRM.

Table 4-9 Annual Resource Savings – Prescriptive Electric Measures (Natural Gas and Water Resource Savings)

		Natural Gas			Water Usage		
NEI Reporting Category	n	Average NEI (Therms)	Therms/kWh	Stat Sig	Average NEI (Gallons)	Gallons/kWh	Stat Sig
HVAC	27	964	0.0121	Yes	0	0.0000	No
Lighting	163	95	0.0016	No	0	0.0000	No
Motors and Drives	50	0	0.0000	No	167,751	1.3304	No
Refrigeration	30	0	0.0000	No	0	0.0000	No
Other	32	0	0.0000	No	0	0.0000	No
Overall	**302**	**96**	**0.0018**	**No**	**6,896**	**0.1313**	**No**

Gas Measures

Table 4-10 shows the NEI estimates for prescriptive gas measures. We collapsed prescriptive gas measure categories to provide separate NEI estimates for building envelope, HVAC, and water heater, which provides for statistically reliable NEI estimates across each of the reporting categories. The table shows the estimated NEI per therm for each reporting category, as well as the 90% confidence interval for the estimate. We also show the percent of the therm savings represented by each measure category, and show the average NEI estimated using the ratio of NEI/therm and the average savings for each reporting category.

Building envelope measures resulted in the highest NEI both in terms of NEI/therm ($3.62/therm) and average NEI ($1,551 per measure). This category included measures such as insulation and energy efficient windows and doors. Many of the NEIs for building envelope measures resulted from savings in operations and maintenance due to reduced labor in repairs and equipment replacement. HVAC measures, which include measures such as gas boilers, furnaces, and chillers, resulted in the second largest average NEI ($755 per measure) and second highest estimated NEI per therm ($1.346/therm). Most HVAC NEIs were reported as operation and maintenance savings. Through the use of energy efficient HVAC equipment, respondents stated that there was a decrease in time spent on labor and cost incurred for parts and supplies. There were fewer NEIs reported for water heater savings. Respondents noted that after the water heater was installed, there was virtually no maintenance required.

DNV KEMA recommends using $0 for prescriptive gas measures that were not statistically significant (Motors Water Heat) because the data do not provide sufficient evidence to support a non-zero estimate.

Table 4-10 Gross Annual NEI per Therm – Prescriptive Gas

NEI Reporting Category	n	Average NEI	NEI/Therm	90% CI Low	90% CI High	% of Population Therms	Stat Sig
Building Envelope	2	$ 1,551	$ 3.6151	$ 2.6418	$ 4.5885	1%	Yes
HVAC	50	$ 755	$ 1.3464	$ 0.5433	$ 2.1496	58%	Yes
Water Heater	47	$ 129	$ 0.2604	$ (0.0012)	$ 0.5221	40%	No
Overall	**99**	**$ 439**	**$ 0.8344**	**$ 0.3634**	**$ 1.3053**	**100%**	**Yes**

Table 4-11 shows the correlation between prescriptive gas measure NEIs and savings. The results show a statistically significant correlation between NEIs and savings when zero NEIs were included, but not when they were excluded. This suggests using NEI per therm savings should provide a proxy for estimating NEIs across prescriptive gas programs, but the limited sample of prescriptive gas measures (98 measures) limited our ability to capture this relationship across all measure type.

Table 4-11 Correlation NEI/therm Savings — Prescriptive Gas

Variable	Correlation: NEI:Gross Therms	P-Value
All NEIs	0.1755	0.0823
NEI not equal to zero only	0.0361	0.2860

Table 4-12 presents the average percentage contribution of each NEI category to the overall average NEIs across prescriptive gas reporting categories. Key findings include:

- *Building Envelope*

  Operations and Maintenance (100%): All respondents who installed building envelope measures stated that the equipment decreased their annual operations and maintenance costs. In general, respondents saved labor hours due to the decrease in window, roof, door, or other miscellaneous repairs.

- *HVAC*

  Operations and Maintenance (85.1%): Most respondents stated a costs savings as a result of less maintenance due to the new energy efficient equipment. Respondents also stated that labor time is reduced due to the automated thermostats.

  Rent Revenue (4.1%): Respondents that owned rental properties found that the new energy HVAC equipment lowered monthly utility costs. The decrease in the utility costs allowed these respondents to drop monthly rental rates and to become more competitive in the market. Another property owner stated that, due to the new HVAC equipment, the air temperature of the building remained at a more comfortable level, which in turn, has decreased renter turnover.

Table 4-12 Distribution of Annual NEI by NEI Category – Prescriptive Gas

NEI Reporting Category	Admin	Fees	Material Handling	Material Movement	Other Costs	Other Labor	O&M	Other Revenue	Product Spoilage	Rent Revenue	Sales Revenue	Waste Disposal	Total Impacts
Building Envelope	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%*	0.00%	0.00%	0.00%	0.00%	0.00%	100.0%*
HVAC	9.2%*	1.00%	0.00%	0.40%	0.00%	0.00%	85.1%*	0.00%	0.10%	4.10%	0.00%	0.00%	100.0%*
Water Heater	6.3%*	0.00%	0.00%	0.00%	0.00%	3.40%	90.20%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
NEI Reporting Category	**8.6%***	**0.80%**	**0.00%**	**0.30%**	**0.00%**	**0.50%**	**86.1%***	**0.00%**	**0.10%**	**3.40%**	**0.00%**	**0.00%**	**100.0%***
Significance=*													

Table 4-13 presents average NEIs and NEI/therm by industry sector.

- The Religious Worship sector experiences the highest significant average impacts ($1,273 per measure) and the highest significant NEI/Therm ($1.80/therm). The Religious Worship sector was most likely to experience NEIs from reduced labor costs needed to perform maintenance.
- The lodging sector experienced the second highest significant average impacts ($76 per measure) and the second highest significant NEI/Therm ($0.36/therm). Lodging was most likely to experience NEIs resulting from Operation and Maintenance as well as across all end uses.

Table 4-13 NEI Estimates by Industry – Prescriptive Gas

Building Use	n	Average Annual NEI	NEI/Therm	90% CI Low	90% CI High	Stat Sig
Education	10	$ 824	$ 3.2411	$ (1.1039)	$ 7.5860	No
Food Service	12	$ 236	$ 0.5450	$ (0.1451)	$ 1.2351	No
Health Care	1	$ -	$ 0.0000	$ 0.0000	$ 0.0000	No
Lodging	32	$ 76	$ 0.3622	$ 0.2315	$ 0.4930	Yes
Manufacturing	3	$ 396	$ 0.3530	$ (0.9599)	$ 1.6659	No
Mercantile	6	$ 496	$ 3.1565	$ (2.1894)	$ 8.5023	No
Office	5	$ 654	$ 2.8253	$ (2.8418)	$ 8.4924	No
Public Assembly	7	$ 415	$ 0.2212	$ (0.1128)	$ 0.5553	No
Public Order and Safety	2	$ 60	$ 0.4638	$ (0.4508)	$ 1.3784	No
Religious Worship	7	$ 1,273	$ 1.7961	$ 1.0524	$ 2.5399	Yes
Service	6	$ 308	$ 1.3836	$ (0.6969)	$ 3.4640	No
Other	5	$ 517	$ 0.5818	$ (0.6148)	$ 1.7784	No
Unknown	3	$ -	$ 0.0000	$ (0.0000)	$ 0.0000	No
Building Use Overall	**99**	**$ 439**	**$ 0.8344**	**$ 0.3634**	**$ 1.3053**	**Yes**

Prescriptive gas resource savings

Table 4-14 shows the resource savings for prescriptive gas measures, which were limited to water resource savings. Only savings from the water heat measure category provided statistically significant savings estimates. This reporting category contains spray valve and faucet aerator measures that are responsible for the savings.

Table 4-14 Annual Resource Savings – Prescriptive Gas Measures

(Water Resource Savings)

NEI Reporting Category	n	Water Usage		
		Average NEI (Gallons)	Gallons per Therm	Stat Sig
Building Envelope	2	0	0.0000	No
HVAC	50	25,381	45.2668	No
Water Heater	47	62,942	127.1226	Yes
Prescriptive Gas Total	**99**	**44,420**	**84.3465**	**Yes**

4.1.2 Custom measure results

Electric Measures

From Table 4-15, CHP/Cogeneration measures showed the highest negative estimated NEIs (-$12,949 per measure). NEIs for cogeneration showed negative results because the energy efficient equipment required increased preventative maintenance and increase administrative costs. The Other category showed the highest average NEI ($15,937 per measure). Lighting showed the highest NEI in term of NEI/kWh ($0.056/kWh) and the second highest in average NEI ($5,686 per measure).

DNV KEMA recommends using $0 for custom electric measures that were not statistically significant (Motors and Drives) because the data do not provide sufficient evidence to support a non-zero estimate.

Table 4-15 Gross Annual NEI per kWh – Custom Electric

NEI Reporting Category	n	Average NEI	NEI/kWh	90% CI Low	90% CI High	% of Population kWh	Stat Sig
CHP/Cogen	6	$ (12,949)	$ (0.0147)	$ (0.0247)	$ (0.0047)	11%	Yes
HVAC	20	$ 5,584	$ 0.0240	$ 0.0003	$ 0.0477	28%	Yes
Lighting	89	$ 5,686	$ 0.0594	$ 0.0318	$ 0.0871	25%	Yes
Motors and Drives	42	$ 1,433	$ 0.0152	$ (0.0005)	$ 0.0309	10%	No
Refrigeration	90	$ 1,611	$ 0.0474	$ 0.0244	$ 0.0705	8%	Yes
Other	29	$ 15,937	$ 0.0562	$ 0.0038	$ 0.1087	18%	Yes
Overall	**276**	**$ 4,454**	**$ 0.0368**	**$ 0.0231**	**$ 0.0506**	**100%**	**Yes**

Table 4-16 presents the correlation between custom electric measure NEIs and their corresponding savings. The evaluation team found a statistically significant correlation between savings and NEIs. When we only considered non-zero NEIs, the correlation was greater than 50%.

Table 4-16 Correlation NEI/kWh Savings--Custom Electric

Variable	Correlation: NEI:Gross kWh	P-Value
All NEIs	0.2693	0.0000
NEI not equal to zero only	0.5659	0.0000

Table 4-17 presents the average contribution of each NEI category to the overall custom electric NEIs. Key findings from this data include:

- *CHP/Cogeneration*
- Operations and Maintenance (79.7%): Respondents reported an increase in preventative maintenance and repairs. Recall the Co-generation NEI was negative, so the positive percentage reflects a cost increase. This was largely because co-generation requires an entirely new piece of equipment.
- Administrative accounted for 20% of the overall average NEI as the new equipment requires additional back office labor to support it such as accounting and human resources.
- HVAC
- Operations and Maintenance (70.8%): The new high quality equipment required less maintenance than less efficient, and often lower quality equipment. This lead to a reduction in the O&M costs associated with new furnaces, boilers and chillers.
- Increase rent revenue for nearly 4% of the overall average as facilities are more comfortable and attractive to tenants.
- Product spoilage: Food stores and food service industries constituted a noticeable share of the sampled customers. Consequently, food spoilage was an important concern for respondents. Improved cooling systems provided for more effective ambient temperature controls, thereby reducing product spoilage.
    - HVAC – Reduced product spoilage accounted for 2.0% of average annual NEIs.
    - Motors and Drives – Reduced product spoilage accounted for nearly 30% of average annual NEIs
    - Refrigeration – Reduced product spoilage accounted for nearly 42% of average annual NEIs

Table 4-17 Distribution of Annual NEI by NEI Category – Custom Electric

NEI Reporting Category	Admin	Fees	Material Handling	Material Movement	Other Costs	Other Labor	O&M	Other Revenue	Product Spoilage	Rent Revenue	Sales Revenue	Waste Disposal	Total Impacts
CHP/Cogen	20.3%*	0.00%	0.00%	0.00%	0.00%	0.00%	79.7%*	0.00%	-0.0%*	0.00%	0.00%	-0.0%*	100.0%*
HVAC	6.10%	0.00%	0.00%	0.00%	9.60%	7.70%	70.80%	0.00%	2.00%	3.80%	0.00%	0.0%*	100.0%*
Lighting	5.2%*	0.00%	0.20%	0.40%	13.20%	0.0%*	79.7%*	0.00%	0.0%*	0.00%	0.1%*	1.2%*	100.0%*
Motors and Drives	1.40%	0.00%	0.00%	0.00%	0.00%	0.0%*	68.7%*	0.00%	29.90%	0.00%	0.00%	0.0%*	100.00%
Refrigeration	0.00%	0.00%	2.60%	0.00%	0.00%	0.0%*	55.8%*	0.00%	41.6%*	0.00%	0.00%	0.0%*	100.0%*
Other	0.00%	0.00%	0.00%	0.00%	0.00%	14.80%	-41.60%	0.00%	6.10%	0.00%	120.60%	0.10%	100.0%*
Overall	**2.40%**	**0.00%**	**0.40%**	**0.20%**	**7.60%**	**5.4%***	**40.80%**	**0.00%**	**7.8%***	**0.60%**	**34.30%**	**0.6%***	**100.0%***
Significance=*													

Table 4-18 shows that manufacturing and offices had the highest statistically significant average NEIs for custom electric measures at roughly $14,600 and $14,700, respectively. Education and Food Sales industries also showed substantial average NEIs, but at a more modest level.

Table 4-18 NEI Estimates by Industry – Custom Electric

Building Use	n	Average Annual NEI	NEI/kWh	90% CI Low	90% CI High	Stat Sig
Education	36	3,145	$ 0.0244	$ 0.0108	$ 0.0380	Yes
Food Sales	134	2,355	$ 0.0469	$ 0.0246	$ 0.0693	Yes
Food Service	1	17,331	$ 0.0933	$ 0.0933	$ 0.0933	No
Health Care	2	5,462	$ 0.0551	$ (0.0176)	$ 0.1277	No
Lodging	7	4,185	$ 0.0128	$ (0.0125)	$ 0.0380	No
Manufacturing	14	14,594	$ 0.0311	$ 0.0017	$ 0.0604	Yes
Mercantile	4	1,435	$ 0.0718	$ (0.0137)	$ 0.1572	No
Office	27	14,738	$ 0.0596	$ 0.0173	$ 0.1019	Yes
Public Assembly	2	0	$ 0.0000	$ (0.0000)	$ 0.0000	No
Public Order and Safety	4	8,805	$ 0.0663	$ 0.0005	$ 0.1321	Yes
Service	10	878	$ 0.0197	$ (0.0019)	$ 0.0413	No
Warehouse and Storage	19	524	$ 0.0257	$ 0.0079	$ 0.0434	Yes
Other	13	975	$ 0.0052	$ (0.0041)	$ 0.0145	No
Unknown	3	122	$ 0.0005	$ (0.0012)	$ 0.0021	No
Building Use Overall	**276**	**4,454**	**$ 0.0368**	**$ 0.0231**	**$ 0.0506**	**Yes**

Table 4-19 presents the savings for custom electric measures, for which survey respondents indicated resource based NEIs for propane, natural gas, and water. There were no statistically significant resource savings. However, respondents did report positive savings resulting from HVAC custom electric measures for all three resources. They also reported water savings for the "other" category.

DNV KEMA recommends using No4 heating oil NEIs for CHP/Cogeneration, lighting, and refrigeration measures only. While we did see evidence that there were resource NEIs for propane, natural gas, and water, none of these estimates were statistically significant. For these resource types, we recommend using the average resource per kWh as specified in the Massachusetts TRM.

Table 4-19 Annual Resource Savings – Custom Electric

NEI Reporting Category	n	Propane			Natural Gas			Water Usage			No4		
		Average NEI (Gallons)	Gallons /kWh	Stat Sig	Average NEI (Therms)	Therms/ kWh	Stat Sig	Average NEI (Gallons)	Gallons/kWh	Stat Sig	Average NEI (Gallons	Gallons/ kWh	Stat Sig
CHP/Cogen	6	0	0.0000	No	0	0.0000	No	0	0.0000	No	(10,324)	(0.0117)	Yes
HVAC	20	545	0.0023	No	2,848	0.0123	No	1,003,582	4.3194	No	3,954	0.0170	No
Lighting	89	0	0.0000	No	0	0.0000	No	0	0.0000	No	4,532	0.0474	Yes
Motors and Drives	42	0	0.0000	No	0	0.0000	No	5,007,857	53.2712	No	985	0.0105	Yes
Refrigeration	90	0	0.0000	No	0	0.0000	No	0	0.0000	No	899	0.0265	Yes
Other	29	0	0.0000	No	0	0.0000	No	3,707	0.0131	No	(6,630)	(0.0234)	No
Overall	**276**	**68**	**0.0006**	**No**	**355**	**0.0029**	**No**	**601,714**	**4.9769**	**No**	**1,817**	**0.0150**	**No**

Gas Measures

From Table 4-20, we see that HVAC, which includes measures such as boilers, furnaces, and gas chillers, showed the highest estimated average annual NEI ($2,798 per measure). Building Envelope, which included measure such as insulation, windows, and doors, had the second highest estimated average NEI ($922 per measure) and the highest NEI/Therm ($0.4774/Therm).

DNV KEMA recommends using $0 for custom gas measures that were not statistically significant (Water Heat and Other) because the data do not provide sufficient evidence to support a non-zero estimate.

Table 4-20 Gross Annual NEI per Therm – Custom Gas

NEI Reporting Category	n	Average NEI	NEI/Therm	90% CI Low	90% CI High	% of Population Therms	Stat Sig
Building Envelope	46	$ 922	$ 0.4774	$ 0.1258	$ 0.8290	6%	Yes
HVAC	41	$ 2,798	$ 0.2291	$ 0.1522	$ 0.3060	74%	Yes
Water Heater	23	$ 803	$ 0.1824	$ (0.4953)	$ 0.8601	8%	No
Other	2	$ 1,905	$ 0.5253	$ (5.6577)	$ 6.7083	13%	No
Overall	**112**	**$ 1,940**	**$ 0.2473**	**$ 0.1490**	**$ 0.3455**	**100%**	**Yes**

Table 4-21 shows a statistically significant correlation between savings custom gas savings and NEIs.

Table 4-21 Correlation NEI / Therm Savings -- Custom Gas

Variable	Correlation: NEI:Gross Therms	P-Value
All NEIs	0.4981	0.0000
NEI not equal to zero only	0.5601	0.0000

Table 4-22 presents the average contribution of each NEI category to the overall custom gas NEIs. Key findings from this data include:

- *Building Envelope*

Operations and Maintenance (79.1%): Respondents who installed building envelope measures stated that the equipment reduced the time spent on windows, roofs, and other repairs.

Material Movement (8.3%): One customer stated a decrease in costs on the wear and tear of company vehicles transporting goods.

- *HVAC*

Operations and Maintenance (95.8%): Most Respondents stated a staff cost savings as a result of less maintenance due to the new energy efficient equipment. Respondents also stated that labor time is reduced due to the automated thermostats.

Other Labor 0.8%): Respondents stated an increase in other labor spent on recalibrating thermostats and verifying that all equipment is functioning properly.

Table 4-22 Distribution of Annual NEI by NEI Category – Custom Gas

NEI Reporting Category	Admin	Fees	Material Handling	Material Movement	Other Costs	Other Labor	O&M	Other Revenue	Product Spoilage	Rent Revenue	Sales Revenue	Waste Disposal	Total Impacts
Building Envelope	12.10%	0.00%	0.00%	8.30%	0.00%	0.00%	79.1%*	0.00%	0.50%	0.00%	0.00%	0.00%	100.0%*
HVAC	3.0%*	0.00%	0.00%	0.00%	0.10%	0.80%	95.8%*	0.00%	0.00%	0.00%	0.00%	0.30%	100.0%*
Water Heater	57.90%	0.00%	0.00%	0.00%	0.00%	0.00%	42.10%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Other	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Overall	**7.8%***	**0.00%**	**0.00%**	**1.00%**	**0.10%**	**0.60%**	**90.2%***	**0.00%**	**0.10%**	**0.00%**	**0.00%**	**0.20%**	**100.0%***
Significance=*													

Table 4-23 presents average NEIs and NEI/therm by industry sector. The data clearly show that the Manufacturing sector experiences the highest statistically significant average impacts. Manufacturing was most likely to have NEIs resulting from categories such as O&M, material handling, and movement cost reductions as well as increased productivity and sales. These impacts were found across end uses such as building envelope, HVAC, lighting and water heating process equipment. Industry sector Public Assembly also experienced a high average impact but is not statistically significant.

Table 4-23 NEI Estimates by Industry – Custom Gas

Building Use	n	Average Annual NEI	NEI/Therm	90% CI Low	90% CI High	Stat Sig
Education	15	$ 3,125	$ 0.4786	$ 0.1141	$ 0.8431	Yes
Food Sales	1	$ -	$ 0.0000	$ 0.0000	$ 0.0000	No
Food Service	1	$ -	$ 0.0000	$ 0.0000	$ 0.0000	No
Lodging	62	$ 664	$ 0.1065	$ (0.0004)	$ 0.2133	No
Manufacturing	6	$ 4,951	$ 0.1450	$ 0.0456	$ 0.2444	Yes
Mercantile	1	$ -	$ 0.0000	$ 0.0000	$ 0.0000	No
Office	11	$ 3,920	$ 0.8545	$ 0.5173	$ 1.1917	Yes
Public Assembly	4	$ 6,280	$ 1.0628	$ (2.3208)	$ 4.4465	No
Public Order and Safety	4	$ -	$ 0.0000	$ (0.0000)	$ 0.0000	No
Religious Worship	1	$ 26	$ 0.0473	$ 0.0473	$ 0.0473	No
Warehouse and Storage	3	$ 5,437	$ 0.6125	$ (0.4969)	$ 1.7219	No
Other	3	$ -	$ 0.0000	$ (0.0000)	$ 0.0000	No
Building Use Overall	**112**	**$ 1,940**	**$ 0.2473**	**$ 0.1490**	**$ 0.3455**	**Yes**

Table 4-24 shows that respondents only reported kerosene and water resource savings for custom gas projects. However, the savings were not statistically significant. Therefore, DNV KEMA recommends using zero for custom gas resource savings. For these resource types, we recommend using the average resource per therm as specified in the Massachusetts TRM.

Table 4-24 Annual Resource Savings – Custom Gas

NEI Reporting Category	n	Kerosene			Water Usage		
		Average NEI (gallons)	Gallons/ Therm	Stat Sig	Average NEI (Gallons)	Gallons/ Therm	Stat Sig
Building Envelope	46	0	0.0000	No	0	0.0000	No
HVAC	41	643	0.0526	No	0	0.0000	No
Water Heater	23	0	0.0000	No	287,594	65.3489	No
Other	2	0	0.0000	No	0	0.0000	No
Overall	**112**	**338**	**0.0431**	**No**	**48,670**	**6.2021**	**No**

4.2 ANALYSIS OF ATTRIBUTION – NET NEIS

Currently, the PAs use a three step process to compute net NEIs for a program:

> Step 1: Multiply the estimated NEI per unit of gross savings (e.g. per kWh) by gross savings for a measure or measure group to obtain gross NEIs.[28]
>
> Step 2: Multiply the gross NEI savings estimate by the measure group specific program attribution rate to calculate net NEIs for the measure or measure group.
>
> Step 3: Sum the measure or measure group net NEIs to calculate the net NEIs for the program.

This approach assumes that firms who experience NEIs have the same free ridership rate as those who do not (i.e. NEI values and free ridership are independent).

However, if free ridership rates are higher among participants who experience non-energy impacts, then the overall attribution rate is not the appropriate value to use for non-energy impacts. In this case, the attribution rate for NEIs would be lower than that of energy savings, reflecting the higher incidence of free ridership for NEIs. A negative correlation between program attribution and the level of NEIs experienced by participants would indicate higher free ridership rates for NEIs than for energy savings.

If free ridership rates are lower among participants who experience non-energy impacts, then the overall attribution rate is also not the appropriate value to use for non-energy impacts because the attribution rate would be higher than that of energy savings, reflecting the lower

[28] Non-energy impact estimates are currently available for some prescriptive measures only. A number of PAs report that no NEI estimates are available for their programs.

incidence of free ridership for NEIs. A positive correlation between program attribution and the level of NEIs experienced by participants would indicate lower free ridership rates for NEIs than for energy savings.

DNV KEMA used program attribution rates, NEI expectation information, and the realized non-energy impacts to examine differences in attribution rates between participants who realize NEIs and those who do not report NEIs. Information regarding attribution and participant expectations of NEIs was available from the 2010 participant FR/SO study for the entire prescriptive sample and a portion of the custom measure NEI sample. To leverage the large quantity of data collected for the studies, we combined the prescriptive and custom samples into a one analysis group for each fuel type in order to explore the relationship between attribution, expectations and NEIs.

Exploring the relationship between attribution and NEIs allows us to make recommendations concerning accurate reporting of the NEIs associated with energy saving measures. Further, we examine whether the customer's expectation of NEIs and the program's influence on that expectation, appears to be a source of potential differences in the program attribution collected through the 2010 FR/SO survey,

The following sections present the results of the NEI and attribution analyses and discuss the potential relationship between expected NEIs and program marketing.

4.2.1 NEIs and Attribution

DNV KEMA used four separate analyses to explore the relationship between program the NEIs and the program attribution:

- A high level comparison of overall NEI values by attribution scores
- A visual inspection of plots of NEI to energy savings ratios and attribution scores
- An examination of the correlation statistics for NEI to energy savings ratios and attribution scores
- A comparison of approaches to estimate net NEIs

We present the results of these analyses below.

High level comparison of NEI values and attribution scores

First, measures were grouped by attribution level. We compared the average NEI and attribution values to determine if a relationship existed between the two metrics. Table 4-25 and Table 4-26 show the average NEI, and the NEI per kWh and therm for electric and gas measures respectively. The ability to identify trends was limited by the low number of cases with zero or low attribution, and high number of cases with 100 percent attribution. However the data does indicate that higher NEI to savings ratios for both electric and gas measures do correspond with low to zero attribution. The average NEIs per measure did not present a consistent trend, because NEI values tend to increase as project size increases, but attribution scores and project size were not closely related.

Table 4-25 NEIs by Attribution Level for Electric Projects

Attribution Group	n	Average NEI	NEI/kWh	90% CI Low	90% CI High	Stat Sig
Zero	11	$ 368.97	$ 0.01	$ (0.00)	$ 0.02	No
Low (0% < Attr <= 25%)	4	$ 10,257.79	$ 0.23	$ (0.03)	$ 0.48	No
Moderate (25% < Attr <= 75%)	46	$ 2,494.41	$ 0.03	$ 0.01	$ 0.05	Yes
High (75% < Attr < 100%)	114	$ 1,497.32	$ 0.02	$ 0.01	$ 0.03	Yes
100%	258	$ 1,782.21	$ 0.03	$ 0.02	$ 0.04	Yes

Table 4-26 NEIs by Attribution Level for Gas Projects

Attribution Group	n	Average NEI	NEI/Therm	90% CI Low	90% CI High	Stat Sig
Zero	18	$ 258.30	$ 0.68	$ (0.04)	$ 1.40	No
Moderate (25% < Attr <= 75%)	46	$ 896.04	$ 0.43	$ 0.14	$ 0.72	Yes
High (75% < Attr < 100%)	35	$ 1,560.66	$ 0.28	$ 0.11	$ 0.46	Yes
100%	67	$ 257.76	$ 0.27	$ 0.06	$ 0.47	Yes

Visual inspection of NEI values and attribution scores

The next analysis examined the relationship between attribution and the ratio of NEIs to savings by reporting category graphically. The plots showed that variance in observed NEIs was high for all reporting categories and attribution levels. Most measures had relatively low NEI to savings ratios regardless of their attribution. While the measures with the highest NEI to savings ratios frequently also had high attribution, the majority of the measures with low NEI to savings ratios also have high attribution. The lack of diversity in attribution obscures our ability to discern relationships through visual inspection. Figure 4-1 and Figure 4-2 show the plot of NEI to savings ratios and attribution levels for electric and gas respectively.[29]

[29] In order to better display the variance among measures, two extreme data points in the electric plot and seven in the gas plot are not displayed. In the electric plot the two points (0.88, 7.25) and (1,13.48) are both lighting measures. In the gas plot five of the measures are HVAC: (0.50,65.58), (0,25.61), (0.97,19.44), (0.88,9.03), (0.88,11.02); and two are Water Heater measures: (1,35.12), (0.88,6.43).

Figure 4-1 - Plot of NEI to kWh Ratio vs. Attribution by reporting category

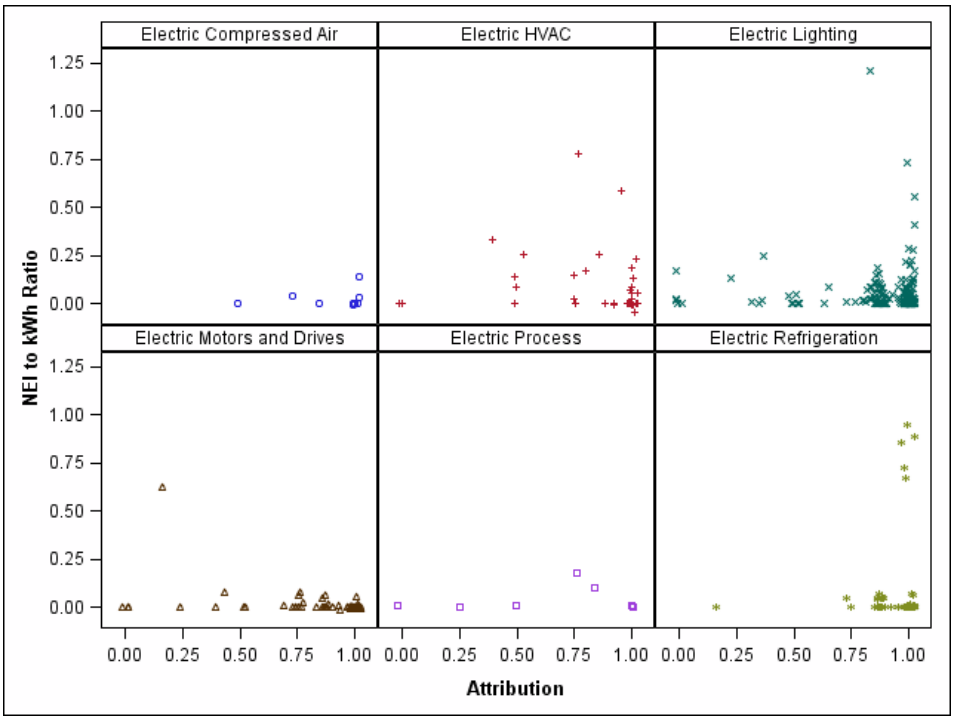
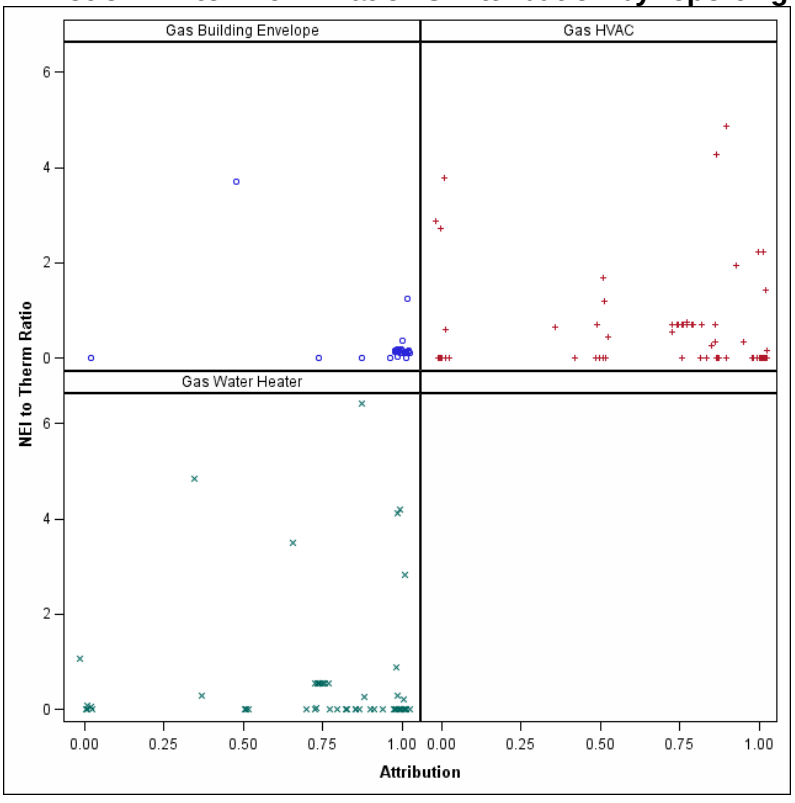


Figure 4-2 - Plot of NEI to Therm Ratio vs. Attribution by reporting category



Correlation of NEI to energy savings ratios and attribution

Third, we examined the Pearson correlation between the "NEI to savings ratio" and attribution. Table 4-27 shows the overall results for electric and gas measures by reporting category and for prescriptive and custom measures separately.

Of the nine categories for which we had enough data to calculate a correlation, five had negative correlations and four have positive correlations. This indicated that there was no systemic correlation across reporting categories. Additionally, only one of these correlations was statistically significant at the 10 percent significance level (p-value $\leq$ 0.10). This was for motors and drives, with a statistically significant negative correlation.

When we look separately by Prescriptive and Custom, the motors and drives negative correlation remained statistically significant for both, though less strongly for prescriptive. This one fairly consistent negative correlation was associated with relatively low overall NEI per unit ($0.01/kWh), so the effect of this correlation on overall NEI is limited.

Correlation for compressed air was borderline statistically significant and negative for prescriptive but for custom it was positive and not statistically significant. The small n's for compressed air also prevented us from drawing conclusions. Custom building envelope had a positive correlation and was statistically significant.

The correlation results provided some evidence of a relationship between NEIs and attribution. Four out of the five statistically significant correlations were negative, but only five of the nine overall correlations were negative. This provided some evidence that projects with higher NEI to savings ratios were more likely to have low attribution. However, given the limited number of observations in our sample that actually had low attribution, this finding was not robust.

Table 4-27 Pearson Correlations by fuel type and reporting categories

Fuel Type	Reporting Category	Overall			Prescriptive			Custom		
		n	Pearson Correlation Coefficient	P-Value	n	Pearson Correlation Coefficient	P-Value	n	Pearson Correlation Coefficient	P-Value
Electric	Building Envelope	1	N/A	N/A	0	N/A	N/A	1	N/A	N/A
	CHP/Cogen	1	N/A	N/A	0	N/A	N/A	1	N/A	N/A
	Compressed Air	9	0.17	0.65	6	-0.73	0.10	3	0.50	0.67
	HVAC	37	-0.03	0.87	27	-0.07	0.74	10	-0.06	0.86
	Lighting	205	-0.01	0.91	163	-0.01	0.92	42	0.00	0.99
	Motors and Drives	67	-0.30	0.02	50	-0.26	0.07	17	-0.89	0.00
	Process	7	0.12	0.80	0	N/A	N/A	7	0.12	0.80
	Refrigeration	78	0.01	0.94	30	0.04	0.83	48	0.05	0.75
Gas	Building Envelope	32	-0.23	0.20	2	N/A	N/A	30	0.32	0.08
	HVAC	73	-0.14	0.25	50	-0.13	0.35	23	0.02	0.91
	Water Heater	61	0.04	0.77	47	0.02	0.88	14	0.24	0.40

Comparison of approaches to estimating net NEIs

Finally, we compared the ratio of net NEIs to gross savings using the current calculation method used by the PAs and two alternative calculation methods. By comparing different methods of calculating net NEIs were used in an effort to determine whether the current method of calculation is systemically under- or over- estimating net NEIs.

The three approaches are:

- Approach 1 is consistent with the PAs' current method of estimating net NEIs;
- Approach 2 is the most accurate method if NEIs and attribution are correlated; and
- Approach 3 provides us a way to directly compare the results from the methodology differences in approach 1 and 2.

Table 4-28 and the formulas below summarize the three approaches used in this analysis. Each approach calculated a ratio of net NEIs to Gross savings that could be applied to gross savings to estimate net NEIs. However, the approaches differed in how attribution was treated: Approaches 1 and 3 used attributions at the reporting category level, while approach 2 used individual measure level attributions. The approaches also differed in the sample of measures that were included in the analysis. Approach 1 used the full 2010 FR/SO and NEI study samples, while the sample used in approaches 2 and 3 were restricted to only measures that were included in both the 2010 FR/SO and NEI samples. Using the same sample in the latter two approaches allowed a direct comparison of how changing level at which attribution is applied changed the results.

Notation: The following terms were used in the Net NEI estimation formulas:

ATTR	=	Attribution
W	=	Weighting factor for an individual measure used to expand from the sample to the population
NEI	=	NEI study estimate of Gross NEIs
Gross	=	Tracking Estimate of Gross Savings
FULLN	=	Set of measures in the full sample used in the NEI study
FULLF	=	Set of measures in the full sample used in the 2010 FR/SO study
Intersect	=	Set of measures included in both the NEI study and 2010 FR/SO study samples
j	=	Individual measure in the Intersection sample (measures that were in both the 2011 FR/SO sample and the NEI study sample)

Approach1:

$$\frac{Net\ NEI}{Gross\ Savings} = \sum_{j=1}^{FULLF} ATTR_j W_j \times \sum_{j=1}^{FULLN} NEI_j W_j \div \sum_{j=1}^{FULLN} Gross_j W_j$$

Approach2:

$$\frac{Net\ NEI}{Gross\ Savings} = \sum_{j=1}^{Intersect} ATTR_j NEI_j W_j \div \sum_{j=1}^{Intersect} Gross_j W_j$$

Approach3:

$$\frac{Net\ NEI}{Gross\ Savings} = \sum_{j=1}^{Intersect} ATTR_j W_j \times \sum_{j=1}^{Intersect} NEI_j W_j \div \sum_{j=1}^{Intersect} Gross_j W_j$$

Table 4-28 Net NEI Estimation approaches

Approach	Label	Purpose	Aggregate or Individual Attribution	Attribution Sample	NEI per gross savings sample
1	Basic, Full samples	Simplest application of FRSO and NEI factors using all available data	Aggregate	Full FRSO	Full NEI
2	Detailed, Intersection sample	Most accurate if attribution and NEI are correlated	Individual	Intersection	Intersection
3	Basic, Intersection sample	Consistent comparison for correlation exploration	Aggregate	Intersection	Intersection

Table 4-29 and Table 4-30 show the inputs and resultant net NEI per gross savings ratios for the three calculation approaches by reporting category.

For electric measures, the overall value of the NEI to savings ratio was consistent across all three approaches. Additionally, approach 2 and 3 varied only slightly when we compare results at the reporting category level. The reporting category where the 3 approaches gave the most different results was motors and drives, it was also the one place where we saw a statistically significant overall correlation, and the difference between 2 and 3 is in the expected direction (the negative correlation between NEIs and attribution implies that approach 2 would have a lower estimate than approach 3). Approach 1 is different for motors and drives as well, indicating the effect of different samples.

For gas measures, approach 2 and 3 had only slight variance: none of the reporting categories, or the overall estimate ever had more than a five percent difference. Approach 1 had considerably different values due to the difference in populations used, but the overall value for approach 1 was also within 10 percent of the other two approaches.

Table 4-29 NEIs by Reporting Category with Alternate Estimation Methods (Electric)

Reporting Category		Attribution		Gross NEI Per Gross kWh		Net NEI per gross kWh		
		Full FRSO Sample	Intersection Sample	Full NEI Sample	Interesection Sample	Approach 1 Basic, Full Samples	Approach 2, Detailed, Intersection Samples	Approach 3, Basic, Intersection Samples
Electric Building Envelope	**Estimate**	**26%**	**100%**	**$ 0.004**	**$ 0.000**	**$ 0.001**	**$ 0.000**	**$ 0.000**
	n	**3**	**1**	**4**	**1**	**3**	**1**	**1**
	StdErr	**17.93%**	**0.00%**	**$ 0.001**	**$ 0.000**	**$ 0.001**	**$ 0.000**	**$ 0.000**
Electric CHP/Cogen	Estimate	93%	100%	$ (0.015)	$ (0.012)	$ (0.014)	$ (0.012)	$ (0.012)
	n	5	1	6	1	5	1	1
	StdErr	9.54%	0.00%	$ 0.004	$ 0.000	$ (0.004)	$ 0.000	$ (0.000)
Electric Compressed Air	**Estimate**	**81%**	**95%**	**$ 0.061**	**$ 0.032**	**$ 0.049**	**$ 0.032**	**$ 0.031**
	n	**89**	**9**	**12**	**9**	**12**	**9**	**9**
	StdErr	**2.98%**	**2.24%**	**$ 0.042**	**$ 0.035**	**$ 0.034**	**$ 0.035**	**$ 0.033**
Electric HVAC	Estimate	83%	87%	$ 0.046	$ 0.058	$ 0.038	$ 0.050	$ 0.051
	n	320	37	47	37	47	37	37
	StdErr	1.64%	5.05%	$ 0.011	$ 0.012	$ 0.009	$ 0.011	$ 0.011
Electric Lighting	**Estimate**	**85%**	**88%**	**$ 0.031**	**$ 0.031**	**$ 0.027**	**$ 0.028**	**$ 0.027**
	n	**977**	**205**	**252**	**206**	**252**	**205**	**205**
	StdErr	**1.03%**	**2.78%**	**$ 0.005**	**$ 0.005**	**$ 0.005**	**$ 0.005**	**$ 0.005**
Electric Motors and Drives	Estimate	87%	94%	$ 0.007	$ 0.004	$ 0.006	$ 0.002	$ 0.004
	n	296	67	92	67	92	67	67
	StdErr	1.34%	0.79%	$ 0.002	$ 0.002	$ 0.002	$ 0.001	$ 0.002
Electric Refrigeration	**Estimate**	**93%**	**94%**	**$ 0.045**	**$ 0.043**	**$ 0.041**	**$ 0.041**	**$ 0.040**
	n	**247**	**78**	**120**	**78**	**120**	**78**	**78**
	StdErr	**1.40%**	**1.05%**	**$ 0.009**	**$ 0.011**	**$ 0.008**	**$ 0.011**	**$ 0.010**
Overall	Estimate	85%	89%	$ 0.030	$ 0.028	$ 0.025	$ 0.025	$ 0.025
	n	1,934	433	578	434	578	433	433
	StdErr	0.00%	2.22%	$ 0.004	$ 0.004	$ 0.003	$ 0.004	$ 0.004

Table 4-30 NEIs by Reporting Category with Alternate Estimation Methods (Gas)

Reporting Category		Attribution		Gross NEI Per Gross kWh		Net NEI per gross kWh		
		Full FRSO Sample	Intersection Sample	Full NEI Sample	Interesection Sample	Approach 1 Basic, Full Samples	Approach 2, Detailed, Intersection Samples	Approach 3, Basic, Intersection Samples
Gas Building Envelope	**Estimate**	**75%**	**88%**	**$ 0.51**	**$ 0.13**	**$ 0.38**	**$ 0.12**	**$ 0.12**
	n	**43**	**32**	**48**	**32**	**43**	**32**	**32**
	StdErr	**4.86%**	**5.31%**	**$ 0.16**	**$ 0.07**	**$ 0.12**	**$ 0.07**	**$ 0.06**
Gas HVAC	Estimate	69%	78%	$ 0.34	$ 0.40	$ 0.23	$ 0.30	$ 0.31
	n	182	73	91	73	91	73	73
	StdErr	2.92%	3.91%	$ 0.05	$ 0.07	$ 0.04	$ 0.06	$ 0.06
Gas Hot Water	**Estimate**	**85%**	**85%**	**$ 0.22**	**$ 0.14**	**$ 0.19**	**$ 0.12**	**$ 0.12**
	n	**129**	**61**	**70**	**61**	**70**	**61**	**61**
	StdErr	**2.74%**	**2.96%**	**$ 0.18**	**$ 0.05**	**$ 0.15**	**$ 0.05**	**$ 0.05**
Overall	**Estimate**	**70%**	**80%**	**$ 0.33**	**$ 0.33**	**$ 0.24**	**$ 0.25**	**$ 0.26**
	n	**358**	**166**	**211**	**166**	**211**	**166**	**166**
	StdErr	**2.07%**	**2.79%**	**$ 0.05**	**$ 0.05**	**$ 0.04**	**$ 0.04**	**$ 0.04**

Of our four analysis methods, two, the correlation analysis and the comparison of net NEI estimation methods, found some evidence of a relationship between NEIs and attribution. In both cases the strongest evidence for a relationship came for the motors and drives reporting category, which plays a small role in the program's overall NEI estimates. The high attributions from the FR/SO study may be preventing us from seeing more evidence. Eighty-five percent of the intersection sample for electric and 61% of the intersection sample for gas had attributions above 75%.

When we held the samples constant and compared the PA's current estimation method for net NEIs to an alternative approach that should result in more accurate NEIs, we found only small differences in the ratios. Our analysis of the relationship between attribution and NEIs supports continuing the PA's existing estimation method for net NEIs. Further analysis of the correlation between NEIs and attribution using different attribution scores may help shed more light on their relationship.

4.2.2 NEI Expectations and program marketing

DNV KEMA analyzed the attribution of measures for all respondents who answered the NEI expectations question in the 2010 FR/SO Study, weighted by the 2010 FR/SO study survey weights and savings. NEIs were expected for only 37% of electric measures and 33% of gas measures. Of those who expected NEIs, the program influenced this expectation in 71% of electric measures and 86 percent of gas measures. This indicates that the program is effectively marketing NEIs for close to 30 percent of installed measures overall.

The attribution of measures where the respondent expected NEIs did not vary significantly from those who did not; however, installers of both electric and gas measures who expected NEIs had slightly higher attribution when the program influenced their expectation of NEIs. This provides some evidence that effective program marketing of NEI benefits both improves attribution rates and appears to be captured using the current evaluation approach for attribution Table 4-31 indicates average attribution by fuel type, expectation of NEIs and program influence on expectation of NEIs.

Table 4-31 Average Attribution
by Fuel Type and Program Influence on Expectation of NEIs

Fuel Type	NEI Expectation	Program Influence on NEI Expectation	n	Average Attribution
Electric	Expected NEIs	Influenced	431	92%
		Did not Influence	98	86%
	Did not Expect NEIs		939	89%
Gas	Expected NEIs	Influenced	89	71%
		Did not Influence	14	67%
	Did not Expect NEIs		217	75%

The analysis of the NEIs for measures in the NEI study sample, found that those who expected NEIs also reported greater NEIs both in terms of average value of NEIs and in terms of ratio of NEIs to savings, as shown in Table 4-32.

Table 4-32 NEI Values by Fuel Type Expectation of NEIs

Fuel Type	NEI Expectation	n	Average NEI	NEI/Therm	90% CI Low	90% CI High
Electric	Expected NEIs	150	$ 2,872	$ 0.04	$ 0.02	$ 0.06
	Did Not Expect NEIs	281	$ 1,154	$ 0.02	$ 0.01	$ 0.03
Gas	Expected NEIs	72	$ 1,434	$ 0.35	$ 0.20	$ 0.50
	Did Not Expect NEIs	94	$ 343	$ 0.30	$ 0.13	$ 0.46

4.3 ANALYSIS OF SPILLOVER

DNV KEMA used information provided by the in-depth interviews to provide evidence of like and unlike spillover resulting from the installed measures. As reported in Section 3.4.3, while we attempted to obtain sufficient information to estimate program-attributable spillover savings, respondents were only able to identify instances in which the program measures resulted in installation of additional equipment. In some cases, respondents identified the specific facilities at which the spillover measures were installed, while others only knew that they bought additional equipment of a certain type at one of the facilities. Few respondents provided sufficient measure descriptions to estimate spillover savings. Therefore, results of our spillover analysis were limited to the percent of respondents that reported installing measures of the same type (like spillover) and a different type (unlike spillover) at one of their facilities.

Table 4-32 presents the (unweighted) percent of interview respondents that reported installing spillover either like or unlike spillover measures at one of their reported facilities. Of the 789 measures sampled for the NEI study, 109 reported projects that KEMA determined to be likely spillover. 103 described unlike spillover projects, while only nine described like spillover projects. Of reporting categories where spillover was observed, electric building envelope and compressed air projects showed the greatest rate of spillover, with 25% of projects citing a spillover project. While HVAC, lighting and motors projects led to spillover installations in many different categories, refrigeration installations led primarily to water heating projects and respondents with spillover who installed process and compressed air projects most often installed large HVAC projects.

These results suggest that Massachusetts energy efficiency programs did result in substantial unlike spillover. However, a more targeted study is required in order to provide precise spillover estimates.

Table 4-33 Incidence of Like and Unlike Spillover by Program Measure, Spillover Measure *

Fuel Type	Program Measure	Like Spillover	Unlike Spillover by Spillover Measure and Savings Level									Overall
			Building Envelope	Compressed Air	HVAC	Lighting	Motors and Drives	Refrigeration	Water Heat	Process	Unlike Overall	
Electric	Building Envelope n=4	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	25.00%	0.00%	**25.00%**	**25.00%**
	CHP/ Cogen n=6	**0.00%**	0.00%	16.70%	16.70%	0.00%	0.00%	0.00%	0.00%	0.00%	**16.70%**	**16.70%**
	Comp. Air n=12	**0.00%**	8.30%	0.00%	8.30%	0.00%	0.00%	8.30%	0.00%	0.00%	**25.00%**	**25.00%**
	HVAC n=47	**0.00%**	2.10%	0.00%	6.40%	6.40%	4.30%	4.20%	2.10%	0.00%	**19.10%**	**19.10%**
	Lighting n=252	**2.00%**	0.80%	0.80%	4.00%	6.00%	0.80%	1.60%	4.00%	0.00%	**15.10%**	**16.70%**
	Motors and Drives n=92	**2.20%**	1.10%	1.10%	2.20%	2.20%	0.00%	1.10%	4.40%	2.20%	**14.10%**	**15.20%**
	Process n=10	**0.00%**	0.00%	0.00%	10.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**10.00%**	**10.00%**
	Refrig. n=120	**0.00%**	0.80%	0.00%	0.80%	0.80%	0.00%	0.80%	8.30%	0.00%	**10.00%**	**10.00%**
	Other n=35	**0.00%**	2.90%	0.00%	0.00%	0.00%	0.00%	2.90%	0.00%	2.90%	**5.70%**	**5.70%**
Gas	Building Envelope n=48	**0.00%**	4.20%	0.00%	4.20%	4.20%	0.00%	6.30%	0.00%	0.00%	**10.40%**	**10.40%**
	HVAC n=90	**1.10%**	5.60%	0.00%	4.40%	5.50%	5.50%	1.10%	0.00%	0.00%	**12.20%**	**13.30%**
	Water Heater n=70	**1.40%**	0.00%	0.00%	0.00%	10.00%	1.40%	4.30%	1.40%	0.00%	**10.00%**	**10.00%**

*Results reflect the percent of un-weighted survey respondents reporting spillover

5. CONCLUSIONS

5.1 OVERVIEW

The overall goal of this study was to estimate non-energy impacts (NEIs) associated with the Massachusetts PA's C&I programs. To accomplish this goal DNV KEMA obtained self-reported non-energy impact estimates resulting from 788 electric and gas energy efficiency measures installed in 2010 through both prescriptive and custom programs. Our analysis clearly identified the presence of NEIs resulting from energy efficiency programs, providing statistically significant NEI estimates, and also significant correlations between the program savings and the level of NEIs reported.

DNV KEMA used energy industry experts to conduct in-depth interviews with program participants. We limited the sample of prescriptive measures to those measures that had a corresponding completed interview from the 2010 participant FR/SO study. For custom measures, we exhausted the pool of measures with corresponding completed interviews from the 2010 participant FR/SO study, but supplemented the sample with additional records from the population of 2010 custom measures. Using the same measures as the 2010 participant FR/SO study allowed us to link the NEI analysis to attribution estimates provided by the previous study.

DNVA KEMA obtained information regarding the cost and revenue changes resulting from the installed measures that occurred within businesses relative to 13 mutually exclusive NEI categories. Interviewers probed respondents to provide details of the resulting changes, identify the appropriate metrics for quantifying the impacts, and to obtain estimates of those metrics. This information was used to construct a series of NEI formulas that we then used to monetize impacts associated with each NEI category. The evaluation team used ratio estimation to extrapolate results to the population of measures and estimate average NEIs per unit of energy savings. We provided separate average NEI estimates for prescriptive and custom electric and gas measures aggregated into 15 separate reporting categories. In nearly all cases, we found statistically significant average NEIs per unit of energy savings.

For all prescriptive measures and the portion of custom measures also included in the 2010 participant FR/SO study, the evaluation team used the previously estimated attribution rates to examine the relationship between program-attribution and expected and realized NEIs. This provided valuable information concerning the use of independently derived attribution rates in estimating net non-energy impacts.

Finally, the evaluation team used survey responses to obtained estimates of the incidence of like and unlike spillover.

5.2 KEY FINDINGS

5.2.1 NEI Estimates

Table 5-1 summarizes the results of the NEI estimates.

Table 5-1 Summary of NEI Estimates

Electric measures	n	Average Annual NEI per Measure*	NEI/kWh	90% CI Low	90% CI High	Stat Sig
Precriptive						
HVAC	27	$ 7,687	$ 0.0966	$ 0.0544	$ 0.1389	Yes
Lighting	163	$ 1,636	$ 0.0274	$ 0.0176	$ 0.0372	Yes
Motors and Drives	50	$ 541	$ 0.0043	$ (0.0005)	$ 0.0091	No
Refrigeration	30	$ 5	$ 0.0013	$ (0.0002)	$ 0.0028	No
Other	32	$ 28	$ 0.0039	$ (0.0002)	$ 0.0079	No
Total	*302*	*$ 1,439*	*$ 0.0274*	*$ 0.0188*	*$ 0.0360*	*Yes*
Custom						
CHP/Cogen	6	$ (12,949)	$ (0.0147)	$ (0.0247)	$ (0.0047)	Yes
HVAC	20	$ 5,584	$ 0.0240	$ 0.0003	$ 0.0477	Yes
Lighting	89	$ 5,686	$ 0.0594	$ 0.0318	$ 0.0871	Yes
Motors and Drives	42	$ 1,433	$ 0.0152	$ (0.0005)	$ 0.0309	No
Refrigeration	90	$ 1,611	$ 0.0474	$ 0.0244	$ 0.0705	Yes
Other	29	$ 15,937	$ 0.0562	$ 0.0038	$ 0.1087	Yes
Total	*276*	*$ 4,454*	*$ 0.0368*	*$ 0.0231*	*$ 0.0506*	*Yes*

Gas measures	n	Average Annual NEI per Measure**	NEI/Therm	90% CI Low	90% CI High	Stat Sig
Prescriptive						
Building Envelope	2	$ 1,551	$ 3.6151	$ 2.6418	$ 4.5885	Yes
HVAC	50	$ 755	$ 1.3464	$ 0.5433	$ 2.1496	Yes
Water Heater	47	$ 129	$ 0.2604	$ (0.0012)	$ 0.5221	No
Total	*99*	*$ 439*	*$ 0.8344*	*$ 0.3634*	*$ 1.3053*	*Yes*
Custom						
Building Envelope	46	$ 922	$ 0.4774	$ 0.1258	$ 0.8290	Yes
HVAC	41	$ 2,798	$ 0.2291	$ 0.1522	$ 0.3060	Yes
Water Heater	23	$ 803	$ 0.1824	$ (0.4953)	$ 0.8601	No
Other	2	$ 1,905	$ 0.5253	$ (5.6577)	$ 6.7083	No
Total	*112*	*$ 1,940*	*$ 0.2473*	*$ 0.1490*	*$ 0.3455*	*Yes*

* Equals (NEI/kWh) x (Average annual kWh)
**Equals (NEI/therm) x (Average annual therm)

Prescriptive electric measures

- DNV KEMA captured NEI information for 302 prescriptive electric measures, and provided separate statistically significant NEI estimates grouped into the following reporting categories: lighting, motors and drives, HVAC, and all other prescriptive.
- HVAC measures showed the highest estimated NEI $0.097kWh, while lighting showed the second highest NEI both in terms of NEI / kWh ($0.027/kWh) and average annual NEI ($1,636).
- We also found a strong, statistically significant correlation between savings and NEI values.

- The resource savings that were reported by respondents was for natural gas savings. Further, only HVAC measures resulted in statistically significant annual resource savings at 964 therms.

Prescriptive gas results

- DNV KEMA captured NEI information for 98 prescriptive gas measures, and provided separate statistically significant NEI estimates for the following reporting categories: building envelope and HVAC.
- Building Envelope measures exhibited the highest estimated NEI/therm ($3.62/therm), which also resulted in the largest average NEI ($1,551). However, while significant, this measure's NEI was estimated from only two responses. HVAC had the second highest NEI both in terms of NEI / kWh ($1.35/therm) and average NEI ($755).
- The correlation between NEIs and savings was not statistically significant.

Custom electric measures

- DNV KEMA captured NEI information for 276 custom electric measures, and provided separate statistically significant NEI estimates grouped into the following reporting categories: CHP/Cogeneration, HVAC, lighting, refrigeration, and other.
- Lighting resulted in the highest NEI/kWh ($0.06/kWh) and second highest in average NEI ($5,686). NEIs for cogeneration showed negative results because the energy efficient equipment required increased preventative maintenance and increase administrative costs.
- CPH/CoGen shows a large negative annual NEI of -$12,949 (-$0.15/kWh)
- We also found a strong, statistically significant correlation between savings and NEI values.

Custom gas results

- DNV KEMA captured NEI information for 112 custom gas measures, and provided separate statistically significant NEI estimates for the following reporting categories: building envelope, HVAC, and other.
- HVAC showed the highest estimated average NEI ($2,798) at $0.23/therm. Building Envelope had the second highest estimated average NEI ($922) and the highest NEI/therm ($0.76/therm).
- We found a strong and statistically significant correlation between NEIs and savings.

Industry level results

- Manufacturing sector experienced the highest average NEIs ($4,162) for prescriptive electric measures. Manufacturers were most likely to have NEIs resulting from multiple NEI categories, such as O&M, material handling, and material movement cost reductions as well as increased productivity and sales. The Public Order and Safety sector experienced the second highest average impacts ($3,908).
- Manufacturing, and offices have the highest average NEIs for custom electric measures.

- For custom gas measures, manufacturing sector experiences the highest statistically significant average impacts. Manufacturing was most likely to see NEIs resulting from categories such as O&M, material handling, and movement cost reductions as well as increased productivity and sales. These impacts were found across end uses such as building envelope, HVAC, lighting and water heating process equipment. Industry sector Public Assembly also experienced a high average impact but is not statistically significant.

Resource savings

- DNV KEMA only found statistically significant resource savings associated with water usage for prescriptive gas measures.

5.2.2 Analysis of Attribution

- Of our four analysis methods, two, the correlation analysis and the comparison of net NEI estimation methods, found some evidence of a relationship between NEIs and attribution.
- In both cases the strongest evidence for a relationship came for the motors and drives reporting category, which plays a small role in the program's overall NEI estimates.
- The high attributions from the FR/SO study may be preventing us from seeing more evidence.
- Eighty-five percent of the intersection sample for electric and 61 percent of the intersection sample for gas had attributions above 75 percent.
- Our analysis of the relationship between attribution and NEIs supports continuing the PA's existing estimation method for net NEIs. Further analysis of the correlation between NEIs and attribution using different attribution scores may help shed more light on their relationship.
- We found evidence that effective program marketing of NEI benefits both improves attribution rates and appears to be captured using the current evaluation approach for attribution.
- Those who expected NEIs also reported greater NEIs both in terms of average value of NEIs and in terms of ratio of NEIs to savings

5.2.3 Spillover

- Massachusetts energy efficiency programs did result in substantial unlike spillover. However, a more targeted study is required in order to provide precise spillover estimates.

5.3 RECOMMENDATIONS

- National Grid and NStar should use the measure mappings provided in Appendix G to apply the appropriate NEIs to their existing programs. The remaining PAs should use the gross NEI per kWh and therm savings estimates presented in Table 1-2 to estimate NEIs,

provided estimates were statistically significant. For measures corresponding to non-significant NEI estimates, the PAs should use $0.

- PAs should continue their current practice of applying the attribution rate used for estimating net energy savings to estimate net NEIs. We did not find sufficient evidence to justify altering this approach. We recommend further study of this relationship.
- DNV KEMA recommends further study of unlike spillover. Evidence provided by this report suggests high potential for unlike savings, particularly among multiple location companies. However, such a study will require more a focused engineering based approach to obtain the necessary engineering parameters needed to estimate savings. The study should also account for spillover resulting from measures installed across multiple locations.
- The PAs should continue to promote NEIs in program marketing, as their current efforts appear to be effective in driving awareness of NEIs as a source of value... Data obtained for this NEI study may provide valuable insights into key touch points for account managers promoting the programs.
- The NEI study was able to provide some evidence for resource NEIs. Capturing these effects directly in program tracking data or through on-site interviews would be best.

5.4 LIMITATIONS

- This study was primarily focused on estimating monetary NEIs associated with C&I programs. While the evaluation team did capture information pertaining to resource savings, we did not obtain sufficient data to obtain statistically reliable resource savings estimates.
- Spillover information obtained through this study was not sufficient to quantify like and unlike spillover savings associated with program measures. This is largely due to the level of complexity in the NEI interview itself, which required individuals with extensive knowledge of the business impacts associated with the installed measures. These individuals often did not have knowledge of the engineering specifications needed to estimate spillover.

  Our analysis indicated that it is important to consider technology purchases across all locations of a company when examining spillover, rather than looking at each location separately. Investment decisions in one location frequently influence subsequent decisions at other locations. Conducting spillover analysis at the facility level can result in ignoring spillover from additional locations.
- Our research approach focused primarily on identifying annual NEIs. Consequently, the results may under estimate NEIs associated with one-time costs or benefits.
- The NEI estimates provided by this study were largely influenced by O&M cost reductions. In a number of instances this change in O&M costs resulted from decreased repair costs associated with the new, high efficiency (high quality) equipment. Due to number of assumptions required to depreciate the installed equipment and amortize the cost differential, our estimates assumed that this cost differential occurs annually, over the life of the equipment. This may over estimate NEIs associated with older measures. Further

research is required to examine the appropriate treatment of NEIs associated with maintenance over time.

- NEIs may be underestimated simply due to the nature of self report surveys. Survey respondents were frequently able to identify NEIs, but we found that, for the same measure type, some did and some did not see the same NEIs across multiple respondents. For example, labor costs associated with less frequent changing of light bulbs were an NEI we would expect to find at most sites. While this was cited frequently, many sites either did not experience this impact, or it did not occur to them during the survey despite probing.
- There was an increased chance of self selection bias because much of the sample consisted of people who agreed to be interviewed twice. This was true for all of the prescriptive measures and many of the custom measures.
- The following factors may limit the applicability of NEI estimates in other jurisdictions:
    - Values were specific to Massachusetts customers. For example the general cost of labor in MA may be higher than that in a Midwestern state.
    - The mix of measures assumes C&I programs that are retrofits, which consisted of a mix of early replacement and replace on failure measures. Additional steps should be taken to address new construction.
- The following limitations apply to the applicability of this research to future years:
    - The confidence intervals reported do not correct for the 2010 population size.

Significant program changes in terms of mix of measures, or favoring early replacement over replace on failure could make the NEI values from this study less applicable.

Appendix A. DEFINITIONS

Like spillover – Energy savings resulting from program influenced installation of energy-efficient equipment of the same type (i.e. the same measure, capacity, and efficiency level).

Non-energy benefits (or NEBs) – Positive NEIs, while negative NEIs (non-energy costs) reflect ways that energy efficiency measures result in adverse effects.

Non-electric benefits (or NEBs) – Positive NEIs, relative to electric measures only.

Non-Energy Impacts – *Non-Energy Impacts* (NEIs) include positive or negative effects attributable to energy efficiency programs apart from energy savings.

Participant benefits (or NEIs) – Monetary and non-monetary benefits (positive or negative) that directly benefit a program partner, stakeholder, trade ally, participant, or the participant's household." Examples include lower operations and maintenance costs, or increased sales or revenue."[30]

Participant spillover – Energy savings resulting from program influenced installation of energy efficiency measures that did not receive program incentives.

Resource savings – Quantities of water or fuel savings resulting from the installed measures, such as fuel oil, kerosene, propane, or natural gas savings.

Unlike spillover - reflected energy savings resulting from program influenced installation of energy-efficient equipment of a different type (i.e. different measure, capacity, or efficiency level).

Societal benefits (or NEIs) – Benefit society at large and can be provided via monetary savings to the energy provider that can be passed on to the society at large via energy price reductions or lower price increases, or benefits that directly benefit the society at large. Examples include reduced carbon emissions and lower water treatment costs.

[30] Hall, Nick, Jeff Riggert, and Tom Talerico. TechMarket Works. *Focus on Energy Statewide Evaluation Non-Energy Benefits Cross-cutting Report: Year 1 Efforts*: *Focus on Energy*." State of Wisconsin Department of Administration Division of Energy. January 30, 2003

Appendix B. DETAILED SAMPLING PLAN: PRESCRIPTIVE MEASURES

INTRODUCTION

This memo presented the revised sampling approach for the Non-Energy Impacts (NEI) interviews associated with prescriptive measures for the Massachusetts Multi-Evaluation Tasks for Massachusetts Energy Efficiency Programs in the Special Cross-sector Studies Area. KEMA selected the prescriptive measure NEI sample from the 1,506 prescriptive projects that received surveys during the 2010 participant FR/SO, enabling us to examine potential differences in the free ridership rate on savings and NEIs. The prescriptive measure NEI study included 200 completed interviews across electric and gas projects.[31] Revisions to the sampling plan presented in this memo included the following:

- We provided a range for the expected precision of NEI estimates by varying the error ratio. The conservative estimate assumed an error ratio of 1.6, based on the 2007 custom NEBs study and presented in the original sampling plan. We also presented the expected precision assuming an error ratio of 1.0 (Optimistic Precision), which may be more representative of prescriptive measure NEIs;
- We provided alternative scenarios for sampling that expanded the scope of the prescriptive NEI study beyond 200 completed interviews. For each scenario, we provided optimistic precision estimates based on a 1.0 error ratio and also the conservative precision estimates based on an error ratio of 1.6. We also presented budgetary implications of each alternative scenario.

This memo is divided to the following sections:

- **Overview of Prescriptive Measure Sampling Approach**: Presented an overview of the general sampling approach;
- **Establishing Target Completes for Electric and Gas Measures**: Discussed separating the 200 completed interviews into those used to obtain NEI data associated with electric and gas measures;
- **Electric Measures Sample Design**: Provided details of the sampling approach for the electric measure sample;
- **Gas Measures Sample Design**: Provided details of the sampling approach for the gas measure sample; and
- **Potential Reporting Categories**: Presented our recommend approaches for grouping measures for analysis purposes.
- **Alternative Sample Design Scenarios**: Presented our alternative sample designs that expanded the scope of the prescriptive study beyond 200 interviews.

[31] "Multi-evaluation Tasks for Massachusetts Energy Efficiency Programs in the Special and Cross-sector Studies Area. Proposed 2012 Research Activities. Commercial and Industrial Non-Energy Impacts Study. Revised Work Plan." Prepared for the Massachusetts PAs. December 9, 2011.

OVERVIEW OF PRESCRIPTIVE MEASURE SAMPLING APPROACH

KEMA employed a proprietary sampling tool that used Model Based Statistical Sampling (MBSS) to produce an optimally allocated sample for stratified ratio estimation. The tool maximized precision based on the population characteristics (in this case, gross estimated savings) and the expected variance in the population on the variable being estimated. For this study, that variable was non-energy impacts. This tool is appropriate when there is a relationship between the characteristic and the variable of interest. While the 2007 TecMarket Works NEI study only found a low correlation between NEIs and energy savings, given a sufficient sample size we can accurately determine the ratio of NEIs to savings for "typical" cases[32]. The standard deviation, mean and correlation reported in the 2007 study indicated that the error ratio for the ratio of NEIs to savings about 1.6.[33] Because the 2007 study focused on custom measures, we expected this measure of variability to represent a high end estimate for prescriptive measures. For sampling purposes we used an error ratio of 1.0, which should provided a more reasonable estimate of variance for the measures in this study. The tool also produced anticipated precision estimates for each group in the population. We provided precision estimates using each of the aforementioned error ratios in this memo: "optimistic precisions" employed the 1.0 error ratio, while "conservative precisions" employed the 1.6 error ratio.

Because the sample size was already determined for the NEI study, the tool was used to efficiently stratify and allocate the sample within the strata. The sampling unit was measure group installed at a site (a project), and the tool optimized the sample by selecting a higher proportion of projects with large estimated savings. This resulted in higher precision levels than a random sample within the measure group.

We employed the following steps to select a sample of 125 electric and 75 gas measures from respondents to the 2010 participant FR/SO2010 participant FR/SO survey. This approach allowed us to select a sample that preserved heterogeneity of the population while reducing the variance within sample segments.

Aggregate measure categories into 2010 participant FR/SO reporting categories

KEMA stratified respondents to the 2010 participant FR/SO2010 participant FR/SO survey (the previous study) according to measure groupings reported in the final report. The previous study stratified their sample frame by "measure categories[34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44]"

[32] – Non-Electric Benefits of the Custom Projects Program A Look at the Effects of Custom Projects in Massachusetts. TecMarket Works. September 25, 2007.

[33] The *error ratio* measures the variability of individual NEI values around the ratio line defined by

NEI = (Constant) x (Savings).

An error ratio of 1.6 means that the standard deviation of NEI for a given savings level is 160% of the mean NEI estimated by this equation. For example, if the mean NEI is estimated to be 30% of the mean savings (constant = 0.30), individual NEI values would have a standard deviation 1.6 x 30% = 48% of their estimated savings.

[34] 2010 Cape Light Compact C&I Free-Ridership and Spillover Study Final Sample Plan. Tetra Tech. April 21, 2011

[35] 2010 New England Gas Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 12, 2011

[36] 2010 Nstar Free-Ridership and Spillover Study Proposed Sample Plan. Tetra Tech. March 4, 2011.

[37] 2010 Berkshire Gas Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 13, 2011.

[38] 2011 National Grid Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 16, 2011.

identified by the evaluation team and the individual PAs. The PAs later requested that measures be re-classified for reporting purposes, which we refer to as the 2010 participant FR/SO reporting categories[45]. Determining the representativeness of a sample stratified by this classification of measures required us to map respondents to the previous study and the population of measures to their respective 2010 participant FR/SO reporting categories.

Establish strata by 2011 reporting category and NEI expectation

Our sample design further stratified electric and gas measures within each 2010 participant FR/SO measure category into two groups which separated customers who expected NEIs prior to participation from those who did not expect NEIs. We used 2010 participant FR/SO2010 participant FR/SO survey responses to create separate strata based on participants' expectations for NEIs prior to participating in their respective program. This information allowed us to contrast NEI estimates and program attribution for groups who did and did not expect NEIs prior to participation, providing valuable information for examining the potential impact of NEIs on free-ridership rates and net NEIs.

Optimize sample by creating size of savings strata and allocate sample targets

Within each 2010 participant FR/SO reporting group by NEI expectation grouping, we further separated projects into groups based on energy savings. We used KEMA's MBSS software to identify the critical values for defining size strata, and the desired number of completes from each stratum to achieve optimal precision. After determining the optimal overall precision we re-allocated target completes to better represent sub-populations with lower savings. While this improved precision in the smaller groups, it did sacrifice some of the overall precision.

ESTABLISHING TARGET COMPLETES FOR ELECTRIC AND GAS MEASURES

As discussed in the December 9, 2011 work plan, development of the sampling plan required the evaluation team to establish the target number of completed interviews for prescriptive electric and gas measures. KEMA recommended the following number of interviews from electric and gas measures:

- **Electric measures** – KEMA recommended completing 125 interviews for prescriptive electric measures in order to provide sufficient data to achieve an approximately 25 percent precision with an 80 percent confidence interval for electric measure NEI estimates;

[39] 2010 Unitil Free-Ridership Study Proposed Sample Plan. Tetra Tech. April 8, 2011.
[40] 2010 Columbia Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 11, 2011.
[41] National Grid Free-Ridership and Spillover Study Proposed Sample Plan. Tetra Tech. March 4, 2011.
[42] 2011 Unitil Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 9, 2011.
[43] 2010 Nstar Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 13, 2011.
[44] 2010 Western Massachusetts Electric Company Free-Ridership Study Sample Plan. Tetra Tech. July 15, 2011.
[45] We refer to the re-classified measure groupings as "2011 FR/SO reporting categories." This classification was defined by the PAs and the evaluation team during the reporting phase of that study. While KEMA will aggregate some of the 2011 FR/SO reporting categories for sampling, we will not re-assign measures to new disaggregated categories.

- **Gas measures** – KEMA recommended completing 75 interviews for prescriptive gas measures in order to provide sufficient data to achieve approximately 25 percent precision with an 80 percent confidence interval for gas measure NEI estimates.

PRESCRIPTIVE ELECTRIC MEASURE SAMPLE DESIGN

This section reports the results of implementing the sampling approach to define the sample of electric measures for the study.

KEMA used the eight reporting categories for electric measures from the 2010 participant FR/SO study in the sample design as shown in **Appendix Table B-1**. To identify these reporting categories, we adopted the same mapping of measures to end uses for each PA used in the 2010 participant FR/SO study.

Appendix Table B-1 2010 participant FR/SO Reporting Measure Categories - Electric

2011 FR/SO Reporting Category
Compressed Air
HVAC
Lighting
Motors and Drives
Process
Refrigeration
Building Envelope
Comprehensive

Appendix Table B-2 shows the distribution of projects by reporting category and their response to the NEI expectation question NE1 in the 2010 participant FR/SO2010 participant FR/SO survey. We targeted completes for each 2010 participant FR/SO reporting category by NEI expectation.

Appendix Table B-2 2010 participant FR/SO2010 participant FR/SO survey Responses by NEI Expectation and 2010 participant FR/SO Reporting Category - Electric

2011 FR/SO Resporting Category	NEI Expectation		Total FR/SO Survey Responses
	Expected	Did Not Expect	
Compressed Air	6	10	16
HVAC	20	42	62
Lighting	286	483	769
Motors and Drives	58	52	110
Process	2	0	2
Refrigeration	10	48	58
Building Envelope	1	0	1
Comprehensive	87	172	259
Total	**470**	**807**	**1,277**

Next, KEMA used the MBSS tool to identify critical kWh values to optimally segment the sample by kWh savings. Appendix Table B-3 shows the final stratification of the sample, defined by the combination of 2010 participant FR/SO reporting category and NEI expectation, and kWh savings as reported in the tracking data. The sampling process identified 23 strata for the NEI sample (Appendix Table B-3). KEMA allocated the 125 completed interviews to these 23 strata.

Because lighting projects make up 77 percent of savings in the population, simply setting target complete according to the optimal allocation for overall precision would have allocated roughly 75 percent of the sample to lighting projects. In order to improve precisions for non-lighting measures, we re-allocated a portion of the lighting targets to other measure categories. We also re-allocated a small number of targets to improve anticipated precision for participant expected NEIs, but this did not substantially change overall precision. While these changes resulted in a lessening of the anticipated overall precision (from 11 percent to 26 percent at the 80 percent confidence level), it improved precision for the non-lighting categories and participant expected NEIs substantially.

Appendix Table B-3 Final Stratification – Prescriptive Electric

2011 FR/SO Reporting Category	NEI Expectation	Size	2011 FR/SO Completes	Min kWh	Max kWh	Percent Pop Weighted kWh	NEI Study Target Completes
Compressed Air	Expected	All	6	11,302	44,990	0.1%	2
	Not Expected	All	10	14,420	180,456	0.2%	2
HVAC	Expected	Small	15	1,523	140,499	0.4%	5
		Medium	4	154,886	251,406	0.6%	4
		Large	1	871,825	871,825	0.3%	1
	Not Expected	Small	30	800	306,947	1.7%	6
		Large	12	332,683	509,037	2.2%	5
Lighting	Expected	Small	226	219	124,902	11.8%	12
		Large	60	125,746	2,023,465	18.7%	12
	Not Expected	Small	393	70	118,613	17.2%	13
		Large	90	122,148	1,570,270	29.8%	13
Motors and Drives	Expected	Small	44	6,819	146,588	1.5%	6
		Large	14	164,359	378,717	2.2%	6
	Not Expected	Small	42	5,842	761,883	3.9%	8
		Large	10	761,883	952,909	5.0%	7
Process	Expected	All	2	101,856	230,310	0.3%	2
Refrigeration	Expected	All	10	1,057	19,342	0.0%	2
	Not Expected	All	48	358	20,455	0.2%	2
Building Envelope	Expected	All	1	375	375	0.0%	1
Comprehensive	Expected	Small	62	298	18,248	0.6%	4
		Large	25	19,748	137,402	0.9%	3
	Not Expected	Small	116	262	19,599	1.0%	5
		Large	56	20,596	90,336	1.5%	4
Total			**1,277**	**70**	**2,023,465**	**100.0%**	**125**

PRESCRIPTIVE GAS MEASURE SAMPLE DESIGN

KEMA used the four reporting categories for gas measures from the 2010 participant FR/SO study in the sample design as shown in Appendix Table B-4. To identify these reporting categories, we adopted the same mapping of measures to end uses for each PA used in the 2010 participant FR/SO study.

Appendix Table B-4 2010 participant FR/SO Gas Reporting Categories

2011 FR/SO Reporting Category
Building Envelope
HVAC
Water Heating
Process

Appendix Table B-5 shows the distribution of gas projects by reporting category and their response to the NEI expectation question NE1 in the 2010 participant FR/SO2010 participant FR/SO survey.

Appendix Table B-5 2010 participant FR/SO2010 participant FR/SO survey Responses by NEI Expectation and 2010 participant FR/SO Reporting Category -Gas

2011 FR/SO Reporting Category	NEI Expectation		Total 2011 FR/SO Survey Responses
	Expected	Did Not Expect	
Building Envelope	0	3	3
HVAC	44	72	116
Water Heater	29	80	109
Process	1	0	1
Total	**74**	**155**	**229**

Appendix Table B-6 shows the final stratification of the gas sample, defined by the combination of 2010 participant FR/SO reporting category, NEI expectation, and therm savings (as reported in the tracking data). This sampling process provided for the nine total strata for the NEI sample seen in Appendix Table B-6. KEMA allocated the 75 completed interviews to these nine strata. The only re-allocation from the optimal sample design was to improve anticipated precision when the participant expected NEIs. This resulted in overall precision worsening from 14 percent to 26 percent.

Appendix Table B-6 Final Stratification – Prescriptive Gas

2011 FR/SO Reporting Category	NEI Expectation	Size	2011 FR/SO Completes	Min Therms	Max Therms	Percent Pop Weighted Therms	NEI Study Target Completes
Building Envelope	Not Expected	All	3	18	840	0.4%	1
HVAC	Expected	Small	38	8	1,467	7.2%	10
		Large	6	1,566	2,934	11.4%	6
	Not Expected	Small	65	15	1,440	10.8%	15
		Large	7	1,488	7,440	21.8%	7
Water Heater	Expected	Small	29	17	618	3.9%	5
	Not Expected	Small	68	17	386	15.8%	18
		Large	12	618	7,638	26.5%	12
Process	Expected	All	1	1,536	1,536	2.3%	1
Total			**229**	**8**	**7,638**	**100.0%**	**75**

POTENTIAL REPORTING CATEGORIES FOR PRESCRIPTIVE MEASURES

Our ability to provide stable NEI estimates depended upon the number of observations sampled and the variation in NEI values per unit of savings for a given level of aggregation of measures. While we could compute NEI estimates for any specified measure category contained in the sample data, estimates for finer categories in general will have worse precision for a given confidence level (eg. 80 percent confidence level). In this section, we presented the expected precision of electric and gas NEI estimates for different measure groupings. In the tables that follow, the expected precision X for an 80 percent confidence interval indicates that we are 80 percent confident that the true NEI value is within plus or minus X percent of the estimated value.

Electric measures

The sample size of 125 for the prescriptive electric programs would not include enough completed surveys to offer stable, meaningful results in all of the reporting categories used for the 2010 participant FR/SO study due to limited number of survey respondents and expected variation in NEI estimates in each category. Appendix Table B-7 below shows our proposed reporting groups and our anticipated precisions at the 80 percent confidence level for each grouping.

Appendix Table B-7 Proposed Measure Groupings for NEI Analysis – Prescriptive Electric

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
Lighting	769	50	77%	23%	37%
Motors and Drives	124	27	13%	33%	53%
HVAC	62	21	5%	31%	49%
Other	336	27	5%	32%	51%
Overall	**1,291**	**125**	**100%**	**18%**	**29%**

* Our optimistic precision estimates assumed an error ratio of 1.0, while the conservative precisions assumed an error ratio of 1.6.

In addition to reporting groups, we provided results by the expectation of NEIs as reported by respondents to the 2010 participant FR/SO2010 participant FR/SO survey. Appendix Table B-8 shows the expected precision for these two groups.

Appendix Table B-8 Expected Precisions by Expectation of NEIs – Prescriptive Electric

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
Expected	471	60	37%	27%	43%
Not Expected	820	65	63%	24%	39%
Overall	**1,291**	**125**	**100%**	**18%**	**29%**

* Our expected precisions assumed an error ratio of 1.0, while the conservative precisions assumed an error ratio of 1.6.

Gas measures

The sample size of 75 for the prescriptive gas programs would not include enough completed surveys to offer meaningful results in all of the reporting categories used for the 2010 participant FR/SO study. Appendix Table B-9 below shows our proposed reporting groups and our anticipated precisions at the 80 percent confidence level for each grouping.

Appendix Table B-9 Proposed Measure Groupings for NEI Analysis – Prescriptive Gas

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
HVAC	116	38	51%	35%	39%
Water Heater	109	35	46%	41%	46%
Other	4	2	3%	167%	187%
Overall	**208**	**75**	**100%**	**26%**	**30%**

* Optimistic precisions assumed an error ratio of 1.0, while the conservative precisions assumed an error ratio of 1.6.

In addition to reporting groups, we provided results by the expectation of NEIs as reported by respondents to the 2010 participant FR/SO2010 participant FR/SO survey. Appendix Table B-10 shows the expected precision for these two groups.

Appendix Table B-10 Expected Precisions by Expectation of NEIs – Prescriptive Gas

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
Expected	74	22	25%	45%	51%
Not Expected	155	53	75%	32%	36%
Overall	**208**	**75**	**100%**	**26%**	**30%**

* Our expected precisions assumed an error ratio of 1.0, while the conservative precisions assumed an error ratio of 1.6.

ALTERNATIVE SAMPLE DESIGNS

This section presented two alternative sample designs for electric measures and one alternative sample design for gas measures that provided increased estimates of precision by expanding the number of completed interviews. In all scenarios the timing of the final report remained the same.

Electric Measures

Scenario 1: Original Budget Scenario

The original budget allowed for 125 completed interviews as detailed above in Appendix Table B-7.

Scenario 2: High Precision

Scenario 2 provided the highest anticipated precisions considered, and the highest cost. It increased the number of completes almost fourfold from 125 to 443. This scenario provided for a census of all non-lighting 2010 participant FR/SO reporting category, while including completed interviews for lighting measures to achieve 80/11 precision for lighting.[46] The number of completes for optimal precision and the expected and conservative estimates of precision for each or the proposed NEI Study reporting groups are shown below in Appendix Table B-11.

[46] Improving expected precision to 80/10 for lighting would require an additional 26 completes.

Appendix Table B-11 Expected Precisions – Prescriptive Electric Scenario 2: High Precision

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
Lighting	769	128	77%	11%	18%
Motors and Drives	124	67	13%	7%	21%
HVAC	62	38	5%	16%	34%
Other	336	210	5%	9%	19%
Overall	**1,291**	**443**	**100%**	**9%**	**14%**

* Optimistic precisions assumed an error ratio of 1.0 and used an expected response rate of 2/3 in the measure groups where we took a census, while the conservative precisions assumed an error ratio of 1.6 and a response rate of 1/2 in the measure groups where we took a census.

Scenario 3: Recommended approach

Scenario 3, the approach we recommend if the scope is expanded, combined the first two scenarios to limit the increase in costs, while increasing precision in the measures categories that matter most. It provided similar overall precision to Scenario 2 at greatly reduced cost. This scenario targeted 317 completed interviews, keeping the same number of targeted completes for lighting presented in Scenario 2 and also retaining Scenario 2's census of all non-lighting 2010 participant FR/SO categories with the exception of the comprehensive category.

We reduced the targets for the comprehensive 2010 participant FR/SO measure category to the level of Scenario 1. The comprehensive category was a catch-all "other" categories with a variety of small measures in it. In total it represents less than four percent of savings across 2011 programs, but included almost one fourth of the total installed measures. We chose to reduce the targeted number of completed interviews in this category because the combination of low savings and a high number of varied measures makes achieving precise results for this category both expensive and less meaningful.

Our recommended number of completes for each or the proposed NEI Study reporting groups are shown below in Appendix Table B-12. We again presented both optimistic and conservative estimates of expected precision, based on a 1.0 and 1.6 error ratios, respectively.

Appendix Table B-12 Expected Precisions – Prescriptive Electric Scenario 3: Recommended Approach

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
Lighting	769	128	77%	11%	18%
Motors and Drives	124	67	13%	7%	21%
HVAC	62	38	5%	16%	34%
Other	336	64	5%	31%	51%
Overall	**1,291**	**297**	**100%**	**9%**	**15%**

* Optimistic precisions assumed an error ratio of 1.0 and used an expected response rate of 2/3 in the measure groups where we took a census, while the conservative precisions assumed an error ratio of 1.6 and a response rate of 1/2 in the measure groups where we took a census.

Scenario Comparison

Appendix Table B-13 shows precisions by 2010 participant FR/SO study reporting groups. While we recommended aggregating these groups in some way similar to the proposed NEI study reporting groups above (depending on the actual precision of the results), these disaggregated precision estimates assisted in selecting which sampling scenario to pursue.

Appendix Table B-13 Expected Precisions – Prescriptive Electric Scenario Comparison

2010 participant FR/SO Study Reporting Group	Percent of Pop Weighted kWh	Scenario 1 (Original Budget) Precision (Expected*/ Conservative*)	Scenario 2 (High Precision) Precision (Optimistic*/ Conservative*)	Scenario 3 (Recommended) Precision (Optimistic*/ Conservative*)
Compressed Air	0.3%	78% / 125%	29% / 70%	29% / 70%
HVAC	5.2%	31% / 49%	16% / 34%	16% / 34%
Lighting	77.3%	23% / 37%	11% / 18%	11% / 18%
Motors and Drives	12.8%	33% / 53%	7% / 21%	11% / 21%
Process	0.3%	76% / 122%	76% / 195%	76% / 195%
Refrigeration	0.2%	96% / 154%	17% / 34%	17% / 34%
Building Envelope	0.0%	0% / 0%	0% / 0%	0% / 0%
Comprehensive	3.9%	38% / 60%	8% / 16%	38% / 60%
Overall	**100.0%**	**18% / 29%**	**9% / 14%**	**9% / 15%**

* Optimistic precisions assumed an error ratio of 1.0 and used an expected response rate of 2/3 in the measure groups where we took a census, while the conservative precisions assumed an error ratio of 1.6 and a response rate of 1/2 in the measure groups where we took a census.

In Appendix Table B-14 we presented the total number of completes and the additional budget required for each of the electric scenarios.

Appendix Table B-14 Additional Cost Estimates – Prescriptive Electric Scenarios

Scenario		Target Completes	Additional Funds Required	Precision Optimistic	Precision Conservative
1	Original Budget	125	$0	18%	29%
2	High Precision	443	$133,000	9%	14%
3	Recommended	297	$72,000	9%	15%

Gas

Scenario 1: Original Budget Scenario

The original budget allowed for 75 completed surveys as detailed above in Appendix Table B-9.

Scenario 2: Recommended approach

We recommend taking a census of gas measures. We estimated that a census of measures would provide between 9 percent and 15 percent overall relative precision depending on the number of completed surveys achieved and the observed variance in responses. Appendix Table B-15 shows the number of completed interviews and the estimated relative precisions based on taking a census of all gas measures completed in the 2010 participant FR/SO study.

Appendix Table B-15 Expected Precisions – Prescriptive Gas Scenario 2: Recommended Approach

NEI Study Reporting Group	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Weighted kWh	Optimistic Precision at 80% Confidence*	Conservative Precision at 80% Confidence*
HVAC	116	77	51%	11%	18%
Water Heater	109	73	46%	15%	24%
Other	4	3	3%	103%	167%
Overall	**208**	**153**	**100%**	**9%**	**15%**

* Optimistic precisions assumed an error ratio of 1.0 and used an expected response rate of 2/3 in the measure groups where we took a census, while the conservative precisions assumed an error ratio of 1.6 and a response rate of 1/2 in the measure groups where we took a census.

Scenario Comparison

Appendix Table B-16 shows precisions by 2010 participant FR/SO study reporting groups. While we recommend aggregating these groups to the proposed NEI study reporting groups above (depending on the actual precision of the results), these disaggregated precision estimates assisted in selecting which sampling scenario to pursue.

Appendix Table B-16 Expected Precisions – Prescriptive Electric Scenario Comparison

2010 participant FR/SO Study Reporting Group	Percent of Pop Weighted kWh	Scenario 1 Precision (Optimistic*/ Conservative*)	Scenario 2 Precision (Optimistic*/ Conservative*)
Building Envelope	0.4%	219% / 246%	79% / 219%
HVAC	51.1%	35% / 39%	11% / 18%
Water Heater	46.2%	41% / 46%	15% / 24%
Process	2.3%	190% / 214%	119% / 190%
Overall	**100.0%**	**26% / 30%**	**9% / 15%**

* Optimistic precisions assumed an error ratio of 1.0 and used an expected response rate of 2/3 in the measure groups where we took a census, while the conservative precisions assumed an error ratio of 1.6 and a response rate of 1/2 in the measure groups where we took a census.

In Appendix Table B-17 we presented the total number of completes and the additional budget required for each of the gas scenarios.

Appendix Table B-17 Additional Cost Estimates – Prescriptive Gas Scenarios

Scenario		Target Completes	Additional Funds Required	Precision Optimistic	Precision Conservative
1	Original Budget	75	$0	26%	30%
2	Recommended	153	$34,000	9%	15%

Appendix C. DETAILED SAMPLING PLAN: CUSTOM MEASURES

INTRODUCTION

This memo presented the sampling approach for the Non-Energy Impacts (NEI) interviews associated with custom measures for the Massachusetts Multi-Evaluation Tasks for Massachusetts Energy Efficiency Programs in the Special Cross-sector Studies Area. We drew the custom measure NEI sample from the following:

- DNV KEMA used a census of custom measure NEI sample from the 1,205 custom projects that received surveys during the 2010 participant FR/SO. This enabled us to examine potential differences in the free efficiency ridership rate on savings and NEIs.
- We supplemented this sample with additional measures that did not receive surveys during the 2010 participant FR/SO in order to obtain better precision in our estimates.

The proposed custom measure NEI study included 461 completed interviews across electric and gas projects. The sampling plan presented in this memo included the following:

1. We provided a range for the expected precision of NEI estimates by varying the error ratio. Our "conservative" estimate assumes an error ratio of 1.6, based on the 2007 custom NEBs study.
2. We also presented the an optimistic estimate of precision which assumes an error ratio of 1.2, which may be more representative of variance within strata for this study due to our ability to classify projects by reporting category, program, and savings levels.

This memo is divided into the following sections:

- **Overview of Custom Measure Sampling Approach**: Presented an overview of the general sampling approach;
- **Custom Electric Measure Sample Design**: Provided details of the proposed sampling approach for the electric measure sample;
- **Custom Gas Measure Sample Design**: Provided details of the proposed sampling approach for the gas measure sample; and
- **Custom Study Costs**: Presented the budget for the proposed custom study.

OVERVIEW OF CUSTOM MEASURE SAMPLING APPROACH

DNV KEMA employed a proprietary sampling tool that uses Model Based Statistical Sampling (MBSS) to produce an optimally allocated sample for stratified ratio estimation. The tool maximized precision based on the population characteristics (in this case, gross estimated savings) and the expected variance in the population on the variable being estimated. For this study, that variable was non-energy impacts. This tool is appropriate when there is a relationship between the characteristic and the variable of interest. The 2007 TecMarket Works NEI study found a low correlation between NEIs and energy savings; however, given a

larger sample size we can accurately determine the ratio of NEIs to savings for "typical" cases.[47] The standard deviation, mean and correlation reported in the 2007 study found an error ratio for the ratio of NEIs to savings of approximately 1.6.[48] DNV KEMA expected this measure of variability can be reduced by stratifying the population to a finer level. For sampling purposes we used an error ratio of 1.2, which provided a more optimistic estimate of variance for the measures in this study. The tool also produced anticipated precision estimates for each group in the population. We provided precision estimates using each of the aforementioned error ratios in this memo: "optimistic precisions" employed the 1.2 error ratio, while "conservative precisions" employed the 1.6 error ratio.

The tool was used to determine the sample sizes and efficiently stratify and allocate the sample within the strata. The sampling unit was measure group installed at a site (a project), and the tool optimized the sample by selecting a higher proportion of projects with large estimated savings. This resulted in higher precision levels than a random sample within the measure group.

The following steps were followed to select our sample from projects eligible for the 2010 participant FR/SO2010 participant FR/SO survey. This approach allowed us to select a sample that preserved heterogeneity of the population while reducing the variance within sample segments.

Assigned measures to 2010 participant FR/SO certainty and non-certainty strata

Most of the custom measures eligible for the study were sampled for the 2010 participant FR/SO2010 participant FR/SO survey with certainty (a census was attempted for most programs). Based on the sample plans for the 2010 participant FR/SO study, DNV KEMA defined measures as "sampled with certainty" when we determined that surveys were attempted with all measures for a particular program or measure type within a program. We gave priority to measures completed in the 2010 participant FR/SO study over the additional sample in order to leverage the attribution results from the 2010 participant FR/SO study.

Assigned measures PA and program

DNV KEMA defined strata based on PA and program to reflect the heterogeneity of custom measures installed by the different PAs and programs. This also better aligned the NEI strata with those used in the 2010 participant FR/SO analysis.

Aggregated measure categories into 2010 participant FR/SO reporting categories

Where possible, DNV KEMA assigned measures to measure groupings consistent with 2010 participant FR/SO (the previous study) final report. The previous study stratified their sample frame by "measure categories[49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59]" identified by the evaluation team and

[47] – Non-Electric Benefits of the Custom Projects Program A Look at the Effects of Custom Projects in Massachusetts. TecMarket Works. September 25, 2007.

[48] The *error ratio* measures the variability of individual NEI values around the ratio line defined by

NEI = (Constant) x (Savings).

An error ratio of 1.6 means that the standard deviation of NEI for a given savings level is 160% of the mean NEI estimated by this equation. For example, if the mean NEI is estimated to be 30% of the mean savings (constant = 0.30), individual NEI values would have a standard deviation 1.6 x 30% = 48% of their estimated savings.

[49] 2010 Cape Light Compact C&I Free-Ridership and Spillover Study Final Sample Plan. Tetra Tech. April 21, 2011

the individual PAs. The PAs later requested that measures be re-classified for reporting purposes, which we refer to as the 2010 participant FR/SO reporting categories.[60] A small subset of electric measures either did not have the necessary information for this classification, nor had information that the measure fell into multiple categories. We included this subset of measures in the "Comprehensive" sampling category. We mapped respondents to the previous study and the population of measures to their respective 2010 participant FR/SO reporting categories.

Optimized sample by creating size of savings strata and allocate sample targets

Within each grouping defined by Certainty, PA, Program and 2010 participant FR/SO reporting group, the projects were further separated into groups based on energy savings. DNV KEMA's MBSS software was used to identify the critical values for defining strata by size (savings), and the desired number of completes from each stratum to achieve optimal precision. After determining the optimal overall precision, sample sizes for a few strata were increased to ensure better representation of the sub-populations with lower savings.

CUSTOM ELECTRIC MEASURE SAMPLE DESIGN

This section reports the results of implementing the sampling approach to define the sample of electric measures for the study.

Certainty vs. Non-Certainty by program and PA

KEMA used the eight reporting categories for electric measures from the 2010 participant FR/SO study in the sample design as shown in Appendix Table C-1.

[50] 2010 New England Gas Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 12, 2011

[51] 2010 Nstar Free-Ridership and Spillover Study Proposed Sample Plan. Tetra Tech. March 4, 2011.

[52] 2010 Berkshire Gas Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 13, 2011.

[53] 2011 National Grid Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 16, 2011.

[54] 2010 Unitil Free-Ridership Study Proposed Sample Plan. Tetra Tech. April 8, 2011.

[55] 2010 Columbia Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 11, 2011.

[56] National Grid Free-Ridership and Spillover Study Proposed Sample Plan. Tetra Tech. March 4, 2011.

[57] 2011 Unitil Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 9, 2011.

[58] 2010 Nstar Free-Ridership and Spillover Gas Study Proposed Sample Plan. Tetra Tech. July 13, 2011.

[59] 2010 Western Massachusetts Electric Company Free-Ridership Study Sample Plan. Tetra Tech. July 15, 2011.

[60] We refer to the re-classified measure groupings as "2011 FR/SO reporting categories." This classification was defined by the PAs and the evaluation team during the reporting phase of that study. While KEMA will aggregate some of the 2011 FR/SO reporting categories for sampling, we will not re-assign measures to new disaggregated categories.

Appendix Table C-1 2010 participant FR/SO Reporting Measure Categories - Electric

2011 FR/SO Reporting Category
Compressed Air
HVAC
Lighting
Motors and Drives
Process
Refrigeration
Building Envelope
Comprehensive

Next, DNV KEMA used the MBSS tool to identify critical kWh values to optimally segment the sample by kWh savings. The sampling process identified 74 strata for the NEI sample. Appendix Table C-2 shows the final stratification without the kWh savings segmentation. DNV KEMA allocated 310 completed interviews to these 74 strata.

Appendix Table C-2 Final Stratification – Custom Electric

PA	Program	2010 participant FR/SO Reporting Category	Certainty	Pop Measures	Percent of Pop kWh	NEI Study Target Completes
CLC	Med. and Large C&I Retrofit	Lighting	Yes	1	0%	1
	Small C&I Retrofit	Lighting	No	1	0%	1
		Motors and Drives	Yes	2	0%	1
	Small Govt. Retrofit	Lighting	No	1	0%	1
Ngrid	EI	Building Envelope	No	5	0%	3
		CHP/Cogen	No	11	10%	8
		Compressed Air	No	12	4%	8
		HVAC	No	42	11%	19
		Lighting	No	97	6%	19
		Motors and Drives	No	72	9%	31
		Process	No	15	4%	10
		Refrigeration	No	28	2%	16
		Other	No	23	5%	10
Nstar	BS	CHP/Cogen	No	4	1%	3
		Compressed Air	No	3	0%	2
		HVAC	No	67	17%	28
		Lighting	No	220	19%	69
		Motors and Drives	No	10	2%	7
		Process	No	4	1%	3
		Refrigeration	No	62	4%	30
		Other	No	4	1%	3
	SBS	HVAC	No	1	0%	1
		Refrigeration	No	194	2%	34
Unitil	Large C&I Retrofit	Process	Yes	2	0%	2
Overall				**881**	**100%**	**310**

In determining the final sample size and distribution, we attempted to target a relative precision of 80/10 for each reporting category using optimistic assumptions (1.2 error ratio). For the building envelope, CHP/Cogen, Compressed Air, Process and Comprehensive categories, an expected relative precision of 80/10 was unattainable even with a census of measures. Appendix Table C-3 shows the expected precisions at 80 percent confidence for the proposed custom electric sample for each 2010 participant FR/SO Reporting Groups. This stratification resulted in interviews from 310 completed measures to achieve the desired level of precision.

Appendix Table C-3 Expected Precisions – Custom Electric Sample by 2010 participant FR/SO Reporting Group

2010 participant FR/SO Reporting Group	Pop Measures	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop kWh	Optimistic Precision at 80% Confidence	Conservative Precision at 80% Confidence
Building Envelope	5	1	3	0%	57%	76%
CHP/Cogen	15	5	11	11%	15%	41%
Compressed Air	15	6	10	5%	11%	33%
HVAC	110	36	48	28%	10%	13%
Lighting	320	79	91	25%	10%	13%
Motors and Drives	84	26	39	10%	10%	15%
Process	21	11	15	6%	16%	34%
Refrigeration	284	73	80	8%	10%	14%
Other	27	8	13	7%	26%	36%
Overall	**881**	**245**	**310**	**100%**	**5%**	**8%**

CUSTOM GAS MEASURE SAMPLE DESIGN

DNV KEMA used the four reporting categories for gas measures from the 2010 participant FR/SO study in the sample design as shown in Appendix Table C-4. To identify these reporting categories, we adopted the same mapping of measures to end uses for each PA used in the 2010 participant FR/SO study.

Appendix Table C-4 2010 participant FR/SO Gas Reporting Categories

2010 participant FR/SO Reporting Category
Building Envelope
HVAC
Water Heater
Process
Other

Appendix Table C-5 shows the final stratification of the gas sample, defined by the combination of PA, program, 2010 participant FR/SO reporting category, and therm savings (as reported in the tracking data). Whereas the 2010 participant FR/SO sample was primarily not a census, a census of custom gas projects were included in this study, except for HVAC,

which did not require a census. The sampling process provided for 50 total strata. The NEI sample in Table 5 shows the segmentation of measures prior to adding the segmentation by therm savings. DNV KEMA allocated the 151 completed interviews across the strata.

Appendix Table C-5 Final Stratification – Custom Gas

PA	Program	2010 participant FR/SO Reporting Category	Pop Measures	Percent of Pop Therms	NEI Study Target Completes
Berkshire Gas	Custom	Building Envelope	7	0%	4
		HVAC	12	3%	8
		Water Heater	3	0%	1
		Process	1	0%	1
Columbia Gas	Large Custom	Building Envelope	3	1%	2
		HVAC	18	29%	12
		Water Heater	2	3%	1
		Process	3	5%	2
	Small Custom	Building Envelope	31	2%	20
		HVAC	61	8%	12
		Water Heater	35	1%	10
NStar	Custom Gas	Building Envelope	7	1%	4
		HVAC	50	21%	22
		Water Heater	6	2%	4
		Other	8	5%	5
NGrid	Retro-C	Building Envelope	34	2%	22
		HVAC	29	13%	12
		Water Heater	9	1%	6
		Process	4	2%	2
New England Gas	Custom	Process	1	1%	1
Overall			**324**	**100%**	**151**

In determining the final sample size and distribution, we attempted to target a relative precision of 80/10 for each reporting category using optimistic assumptions. The only 2010 participant FR/SO reporting category for which we did not conduct a census was HVAC. For HVAC, we were able to achieve 80/10 precision with optimistic assumptions by interviewing less than a census. Appendix Table C-6 shows the expected precisions at 80 percent confidence for the proposed custom gas sample for each 2010 participant FR/SO Reporting Group.

Appendix Table C-6 Expected Precisions – Custom Gas Sample by 2010 participant FR/SO Reporting Group

2010 participant FR/SO Study Reporting Group	Pop Measures	2010 participant FR/SO Completes	NEI Study Target Completes	Percent of Pop Therms	Expected Precision at 80% Confidence	Conservative Precision at 80% Confidence
Building Envelope	82	38	52	6%	13%	17%
HVAC	170	49	66	74%	10%	13%
Water Heater	55	18	22	8%	48%	64%
Process	9	1	6	8%	28%	37%
Other	8	0	5	5%	30%	41%
Overall	**324**	**106**	**151**	**100%**	**8%**	**11%**

Appendix D. PRESCRIPTIVE MEASURE INTERVIEW GUIDE

MA NEI Interview

Contact_____

Company: _____

Clean_Phone: _____

Address: _____

Alternate phone: _____

Reporting Category 1: _____ Measure ID1:_____

Reporting Category 2 _____ Measure ID2:_____

PA Name: __ Program Name:___ _____

Participation Date: _____

Call #	Date	Time	Notes (include message left, best time to call, best way to contact, and whether survey was completed)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Final Disposition: O complete O refused O no answer O mid-terminate O other (specify_____)

Interview Length:_____

Purpose of the Interview

Determine whether measures resulted in non-energy impacts (NEIs –"any positive or negative effect beyond energy savings that are attributable to energy efficiency programs")

Identify sources of NEIs that resulted from the installed measures

Obtain estimates of non-energy impacts (NEI)

Seek monetized non-energy benefits or costs

If respondents cannot monetize NEIs, guide respondents through relevant probes to obtain the necessary information for imputing monetized estimates of NEI;

Obtain measures of spillover – Participant spillover is energy savings resulting from program influenced installation of energy efficiency measures that did not receive program incentives. We will obtain estimates of both like and un-like spillover.

Like spillover –energy savings resulting from program influenced installation of energy-efficient equipment of the same type (i.e. the same measure, capacity, and efficiency level)

Unlike spillover –energy savings resulting from program influenced installation of energy-efficient equipment of the a different type (i.e. different measure, capacity, or efficiency level)

Introduction and Screening

[Get <<CONTACT>> on the phone]

Hello, my name is __ and I am calling from KEMA Consulting on behalf of <<PA NAME>> and <<PROGRAM>>

I'm calling to get some feedback on how the energy efficiency improvements you made through <<PROGRAM>> have affected your organization's costs and revenues. Someone else from KEMA called you a few days ago to set up this interview.

Are you still the person at <<COMPANY>> most familiar with the outcomes of your organization's participation and experience with the <<PROGRAM>> program?

[If necessary] Last Spring, someone from the evaluation team spoke you about your participation in the <<PA NAME>> <<PROGRAM>> program around <<PARTICIPATION DATE>>.

[If "No"] Who is the right person to talk to? [Get name and contact information. Attempt to reach]

[Once correct person on phone]: All of your answers are confidential and will only be reported in aggregate.

[If asked]: You can verify the legitimacy of this research by calling _____ at _____

[If asked]: KEMA is an independent contractor hired to do this research.

[If different contact, record information below]

Name:__ _____

Phone: _____; Alt Phone:_____

Address:

_____

About the Respondent

Let's start by getting a little information about your organization and you. These questions help us put the rest of your answers in context.

F1. What is the major economic activity at <<ADDRESS>>?

F2. How many full-time equivalent employees work at <<ADDRESS>>? [Bracket if don't know. Start at 100 employees and go up or down]

F3. What is the total square footage of conditioned space at <<ADDRESS>>? [Bracket if don't know. Start at 10,000 square feet and go up or down.]

AR1. What is your job title?

AR2. What are your responsibilities?

AR3. How long have you done that?

Equipment Verification

My records show that you have installed the following measures through <<PROGRAM>>:

MEASURE 1).____

MEASURE 2:____

MEASURE 3:____

MEASURE 4: ____

MEASURE 5:____

MEASURE 6:____

MEASURE 7:____

MEASURE 8:____

EV2. Is this equipment still installed?

1 Yes [Go to EV5]

2	No	[Go to EV3]
97	Don't know	[Ask for alternate contact who could answer]
98	Refused	[Ask for alternate contact who could answer]

EV3. Why was it removed?

EV4. What, if anything, did you install in its place? [Skip to instructions after EV6.]

EV5. Is this equipment still operational?

1	Yes	[Go to NEI section]
2	No	[Go to EV6]
97	Don't know	[Ask for alternate contact who could answer]
98	Refused	[Ask for alternate contact who could answer]

EV6. Why not?

[Continue survey with any measures still installed.

If all measures no longer installed, ask NEI sections if reason for removal might be relevant to NEI. For example, *"It increased O&M costs too much."* If reason for removal not relevant to NEI, end interview.]

NEI Questions

[This section is about potential NEIs associated with the measures verified in the EV section above. If a multi location contact (i.e. one contact with multiple locations each participating in programs), try to get them to talk about the measures in terms of the average effects across measure groups (lighting, hvac, refrigeration, motors, compressed air, building envelope, water, process, and comprehensive). If they are unable to do that, get them to talk about MEASURE CAT 1 and MEASURE CAT 2 specifically for as many locations as possible]

DK = Don't know]

Now I'd like to ask you some questions about possible non-energy effects associated with the installation of these measures. By non-energy effects, I mean costs or benefits other than savings on your energy bills that your organization realized as a result of installing these measures. We're trying to estimate monetary costs or benefits, so for some of these categories, I'm going to try to convert time into money.

First, I'm going to go through a checklist of cost and benefit categories and ask you if your organization realized any costs or benefits in each one. Then we'll go back through and explore each relevant category in more depth.

You're going to need to explore all of the following non-electric resources. Money is applicable to all NEI sections. Water should mostly be covered in the Water Usage section. The MMBTU resources are probably in Other Costs, but could be spread throughout the entire survey.

Non Electric Resources, 2010							
		MMBTU					
Money	Water (gallons)	Avoided Natural Gas	No. 2 Distillate	No. 4 Fuel Oil	Propane	Wood	Kerosene

NEI Table1

Did your organization experience any changes in each of these categories because of any of the *high efficiency* <MEASURE CAT 1> / <MEASURE CAT 2> you installed?

[In the table below, write in the measure group or the measure that they answer about into the title row.

As you go through table, read the definition for each NEI category

Go through all the categories for Measure Cat 1 then come back and go through them a 2nd time for Measure Cat 2]

Question #	Category	Measure Cat 1	Measure Cat 2	Definition
OM1.	Annual operations and maintenance costs?	1.Yes 2.No 97. Don't know → [Ask for alternate contact who could answer] 98.Refused	1.Yes 2.No 97. Don't know → [Ask for alternate contact who could answer] 98.Refused	Anything that is spent (both time and parts) on maintaining an existing equipment, like installing new light bulbs or tuning up an air conditioner. This could be work done by contractors or in-house staff. Buying new light bulbs would be included, but new fixtures would NOT be included
LA1.	Administration costs?			The company's time costs from the back office people, such as accounting
SH1.	Materials handling?			Time and costs for people in the loading docks and warehouses
TM1.	Materials movement?			Time and costs (gas, vehicles, pay) for truck drivers, both deliveries and pickups
OL1.	Other labor?			Any labor not included in O&M, Administration, materials handling, or materials movement
FW1.	Water usage and wastewater?			Utility charges for water usage and wastewater
SD1.	Product spoilage?			Costs for lost or damaged product
SW1.	Waste disposal?			Costs for disposal of all solid and gaseous wastes (i.e. pollution)

IL1.	Fees?			Includes insurance, inspections, permits, and legal fees
OC1.	Other costs?			Includes any other costs we have not yet discussed
PR1.	Sales?			Sales revenues
RR1.	Rent revenues?			Revenue associated with rent
OR1.	Other revenue?			Includes any revenues from any sources we have not yet discussed

[Ask each of the next sections if change indicated in table above.]

NEI Questions –Operations and Maintenance

[This section is only for the measure(s) that were covered in the 2010 survey. You will ask respondents about potential NEIs associated with the measures verified in the EV section above. Again, respondents will be asked about NEIs associated with up to two measure categories only, *unless they are a multi-address contact.* If more than two measures were installed, then we restricted the sample to only two.

Reread the definition for this section when you get here.

This section refers to anything that's spent (both time and parts) maintaining an existing equipment, like installing new light bulbs or tuning up an air conditioner. This could be work done by contractors or in-house staff. Buying new light bulbs would be included, but new fixtures would NOT be included.]

OPERATIONS AND MAINTENANCE ----------(MEASURE CAT 1)

Let's start with operation and maintenance costs associated with <MEASURE CAT 1>.

OM2. Overall, did your annual O&M costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed? [Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to O&M measure cat 2]

98. Refused [Go to O&M measure cat 2]

OM3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual operation and maintenance costs?

[Record dollars, if respondent can't answer, GOTO OM5, Record (-96) if don't know and additional data provided below, (-97) if don't know and no additional data below, (-98) if refused; (-99) if not applicable)]

$_____

___ [Check here if used OM5]

-96 Don't know, additional data below → [Skip to OM5]

-97 Don't know, no additional data → [Skip to OM5]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

OM4 How did you estimate this amount?

[probe: what parts of the O&M costs were reduced/increased]

[Goto next O&M for Measure cat 2 if respondent answers OM4]

OM5 In which of the following categories did the installation of <MEASURE CAT 1> <increase / decrease> your O&M costs?

Column B. [Indicate whether it is an increase, decrease or did not change]

Column C. [Indicate how/why it changed]

Column D. [Indicate dollar value of change.]

[If labor, ask hours and loaded cost of labor, or hours and hourly rate. Be sure to put the hours and the value on the sheet, and indicate the total in column D on the correct line. Check the loaded value box if they told you fully loaded value.]

[If parts and supplies changed and they have trouble quantifying, try to determine what parts, the number of units, and average price. Be sure to put the value on the sheet, and indicate the total in column D on the correct line]

[If training costs changed, and they have trouble quantifying, try to determine hours of training and cost per hour. Also try to determine whether training costs impacted labor costs and if these changes are reflected above]

OM5 Category	**B** **1 Increase** **2 Decrease** **3 No change**	**C** **How so**	**D** **$ Value**
1 Internal labor			$_____ ☐ loaded value
2 External services/labor			
3 Parts & Supplies			
4 Training			
31. Fuel saved		Natural Gas No.2 Distillate No.4 Fuel Oil Propane Wood Kerosene	
99 Other			

OPERATIONS AND MAINTENANCE ----------(MEASURE CAT 2)

[If respondent does not have 2nd measure, skip to next NEI category]

Now let's talk about operation and maintenance costs associated with <MEASURE CAT 2>.

OM22. Overall, did your annual O&M costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed? [Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI category]

98. Refused [Go to next NEI category]

OM23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual operation and maintenance costs?

[Record dollars, if respondent can't answer, GOTO OM25, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used OM25]

-96 Don't know, additional data below → [Skip to OM25]

-97 Don't know, no additional data → [Skip to OM25]

-98 Refused → [Skip to next NEI category]

-99 Not applicable / Skipped → [Skip to next NEI category]

OM24 How did you estimate this amount?

[probe: what parts of the O&M costs were reduced/increased]

_____

_____

_____

[Goto next NEI category if respondent answers OM4]

OM25 In which of the following categories did the installation of <MEASURE CAT 2> <increase / decrease> your O&M costs?

OM25 Category	**B** **1 Increase** **2 Decrease** **3 No change**	**C** **How so**	**D** **$ Value**
1.Internal labor			$_____ ☐ loaded value
2. External services/labor			
3. Parts & Supplies			
4. Training			
31. Fuel saved		Natural Gas No.2 Distillate No.4 Fuel Oil Propane Wood Kerosene	
99. Other			

NEI Questions –Administration

Reread definition when you enter this section

This section refers to the company's time costs from the office people, like accounting.]

ADMINISTRATION----------(MEASURE CAT 1)

Now let's talk about administration costs that changed because of the installation of <MEASURE CAT 1>?

LA2. Overall, did your annual administration costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97.DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Administration, measure cat 2]

98. Refused [Go to Administration, measure cat 2]

LA3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual administration costs?

[Record dollars, if respondent can't answer, GOTO LA5, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used LA5]

-96 Don't know, additional data below → [Skip to LA5]

-97 Don't know, no additional data → [Skip to LA5]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

LA4 How did you estimate this amount?

[probe: what parts of the administration costs were reduced/increased

Make sure no overlap with previous categories]

_____

_____

_____

[Goto Administration, Measure cat 2 if respondent answers LA4]

LA5 In which of the following categories did the installation of <MEASURE CAT 1> <increase / decrease> your administration costs?

Column B. [Indicate whether it is an increase, decrease or did not change]

Column C. [Indicate how/why it changed]

Column D. [Indicate dollar value of change.

If labor ask hours and loaded cost of labor, or hours and hourly rate. Be sure to put the hours and the value on the sheet, and indicate the total in column D on the correct line

If training costs changed, and they have trouble quantifying, try to determine hours of training and cost per hour. Also try to determine whether training costs impacted labor costs and if these changes are reflected above]

Make sure no overlap with previous categories.

LA5 Category	**B** **1 Increase** **2 Decrease** **3 No change**	**C** **How so**	**D** **$ Value**
1. Internal labor			$_____ ☐ loaded value
2. External services/labor			
4. Training			
99. Other			

ADMINISTRATION----------(MEASURE CAT 2)

[If respondent does not have 2nd measure, skip to next NEI category]

Now let's talk about administration cost changes because of <MEASURE CAT 2>.

LA22. Overall, did your annual administration costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI category

98. Refused [Go to next NEI category]

LA23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual administration costs?

[Record dollars, if respondent can't answer, GOTO LA25, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used LA25]

-96 Don't know, additional data below → [Skip to LA25]

-97 Don't know, no additional data → [Skip to LA25]

-98 Refused → [Skip to Next NEI category]

-99 Not applicable / Skipped → [Skip to Next NEI category]

LA24 How did you estimate this amount?

[Probe: What parts of the administration costs were reduced/increased

Make sure no overlap with previous categories]

_____

_____

_____

[Goto next NEI section if respondent answers LA24]

LA25 In which of the following categories did the installation of <MEASURE CAT 2> <increase / decrease> your administration costs?

Make sure no overlap with previous categories.

LA25 Category	**B** **1 Increase** **2 Decrease** **3 No change**	**C** **How so**	**D** **$ Value**
1. Internal labor			$_____ ☐ loaded value
2. External services/labor			
4. Training			
99. Other			

NEI Questions – Materials Handling

Reread this definition when you enter this section:

This section refers to the company's time and costs for people in the loading docks and warehouses.]

MATERIALS HANDLING----------(MEASURE CAT 1)

Now let's talk about your materials handling costs because of <MEASURE CAT 1>

SH2. Overall, did your annual materials handling costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Materials Handling, measure cat 2]

98. Refused [Go to Materials Handling, measure cat 2]

SH3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual materials handling costs?

[Record dollars, if respondent can't answer, GOTO SH5, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used SH5]

-96 Don't know, additional data below → [Skip to SH5]

-97 Don't know, no additional data → [Skip to SH5]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

SH4 How did you estimate this amount?

[probe: what parts of the materials handling costs were reduced/increased

Make sure no overlap with previous categories]

_____

_____

_____

[Goto Materials Handling, Measure cat 2 if respondent answers SH4]

SH5 In which of the following categories did the installation of <MEASURE CAT 1> <increase / decrease> your materials handling costs? [

Column B. [Indicate whether it is an increase, decrease or did not change]

Column C. [Indicate how/why it changed]

Column D. [Indicate dollar value of change.

If supplies, verify not included in previous sections. If changed and they have trouble quantifying, try to determine what parts, the number of units, and average price. Be sure to put the value on the sheet, and indicate the total in column D on the correct line

If labor, verify not already included in previous sections, then ask hours and loaded cost of labor, or hours and hourly rate. Be sure to put the hours and the value on the sheet, and indicate the total in column D on the correct line]

Make sure no overlap with previous categories.

SH5 Category	**B** **1 Increase** **2 Decrease** **3 No change**	**C** **How so**	**D** **$ Value**
1.Internal labor			$_____ ☐ loaded value
2.External labor/ services			
99.Other			

MATERIALS HANDLING----------(MEASURE CAT 2)

[If respondent has only 1 measure, go to next NEI section.]

Now lets talk about changes to your materials handling costs because of <MEASURE CAT 2>

SH22.Overall, did your annual materials handling costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all Probe: DK because some went up and some went down? If so, change to 3; else Go to next NEI Section]

98. Refused [Go to next NEI Section]

SH23.By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual materials handling costs?

[Record dollars, if respondent can't answer, GOTO SH25, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used SH25]

-96 Don't know, additional data below → [Skip to SH25]

-97 Don't know, no additional data → [Skip to SH25]

-98 Refused → [Skip to Next NEI section]

-99 Not applicable / Skipped → [Skip to Next NEI section]

SH24 How did you estimate this amount?

[probe: what parts of the materials handling costs were reduced/increased

Make sure no overlap with previous categories]

_____

_____

_____

[Goto next NEI section if respondent answers SH24]

SH25 In which of the following categories did the installation of <MEASURE CAT 2> <increase / decrease> your materials handling costs? [

Make sure no overlap with previous categories.

SH25 Category	**B** **1 Increase** **2 Decrease** **3 No change**	**C** **How so**	**D** **$ Value**
1.Internal labor			$_____ ☐ loaded value
2.External labor/ services			
99.Other			

NEI Questions –Materials Movement

Reread the definition when you enter this section:

This section refers to time and costs (gas, vehicles, pay) for truck drivers, both deliveries and pickups]

MATERIALS MOVEMENT----------(MEASURE CAT 1)

Now let's talk about changes to your materials movement costs because of <MEASURE CAT 1>.

TM2. Overall, did your annual materials movement costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Materials Movement, measure cat 2]

98. Refused [Go to Materials Movement, measure cat 2]

TM3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual materials movement costs?

[Record dollars, if respondent can't answer, GOTO TM5, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used TM5]

-96 Don't know, additional data below → [Skip to TM5]

-97 Don't know, no additional data → [Skip to TM5]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

TM4 How did you estimate this amount?

[probe: what parts of the materials movement costs were reduced/increased

Make sure no overlap with previous categories]

_____

_____

_____

[Goto Materials Movement, Measure cat 2 if respondent answers TM4]

TM5 In which of the following categories did the installation of <MEASURE CAT 1> <increase / decrease> your materials movement costs? [

Column B. [Indicate whether it is an increase, decrease or did not change]

Column C. [Indicate how/why it changed]

Column D. [Indicate dollar value of change.

If service/parts verify not included in previous sections. If costs changed and they have trouble quantifying, try to determine what parts, the number of units, and average price. Be sure to put the value on the sheet, and indicate the total in column D on the correct line

If fuel costs changed and they have trouble quantifying, try to determine what types of fuel (diesel), the quantities that changed (# gallons), and the average unit price ($/gallon).

If labor, verify not already included in previous sections, then ask hours and loaded cost of labor, or hours and hourly rate. Be sure to put the hours and the value on the sheet, and indicate the total in column D on the correct line]

Make sure no overlap with previous categories.

TM5 Category	B **1 Increase** **2 Decrease** **3 No change**	C **How so**	D **$ Value**
7. Fleet service & parts			
8. Fuel			
1. Internal labor			$_____ ☐ loaded value
2.External labor/ services			
99.Other			

MATERIALS MOVEMENT----------(MEASURE CAT 2)

[If respondent has only 1 measure, go to next NEI section.]

Now lets talk about changes to your materials movement costs because of <MEASURE CAT 2>

TM22. Overall, did your annual materials movement costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI Section]

98. Refused [Go to next NEI Section]

TM23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual materials movement costs?

[Record dollars, if respondent can't answer, GOTO TM25, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used TM25]

-96 Don't know, additional data below → [Skip to TM25]

-97 Don't know, no additional data → [Skip to TM25]

-98 Refused → [Skip to Next NEI section]

-99 Not applicable / Skipped → [Skip to Next NEI section]

TM24 How did you estimate this amount?

[probe: what parts of the materials movement costs were reduced/increased

Make sure no overlap with previous categories]

_____

_____

_____

[Goto next NEI section if respondent answers TM24]

TM25 In which of the following categories did the installation of <MEASURE CAT 2> <increase / decrease> your materials movement costs? [

Make sure no overlap with previous categories.

TM25 Category	B **1 Increase** **2 Decrease** **3 No change**	C **How so**	D **$ Value**
7. Fleet service & parts			
8. Fuel			
1. Internal labor			$_____ ☐ loaded value
2.External labor/ services			
99.Other			

NEI Questions –Other Labor

Reread definition when you enter this section:

This section refers to the any other labor at the company not covered in O&M, Administration, Materials Handling or Materials Movement categories.]

OTHER LABOR----------(MEASURE CAT 1)

Now let's talk about other labor costs that changed because of the installation of <MEASURE CAT 1>? By other, I'm referring to any labor we did not already talk about in previous categories.

OL2. Overall, did your other annual labor costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97.DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Other Labor, measure cat 2]

98. Refused [Go to Other Labor, measure cat 2]

OL3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your other annual labor costs?

[Record dollars, if respondent can't answer, GOTO OL5, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used OL5]

-96 Don't know, additional data below → [Skip to OL5]

-97 Don't know, no additional data → [Skip to OL5]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

OL4 How did you estimate this amount?

[probe: what parts of the labor costs were reduced/increased

Make sure no overlap with previous categories]

_____

_____

_____

[Goto Other Labor measure cat 2 if respondent answers OL4]

OL5 In which of the following categories did the installation of <MEASURE CAT 1> <increase / decrease> your other labor costs?

Column B. [Indicate whether it is an increase, decrease or did not change]

Column C. [Indicate how/why it changed]

Column D. [Indicate dollar value of change.

If labor ask hours and loaded cost of labor, or hours and hourly rate. Be sure to put the hours and the value on the sheet, and indicate the total in column D on the correct line

If training costs changed, and they have trouble quantifying, try to determine hours of training and cost per hour. Also try to determine whether training costs impacted labor costs and if these changes are reflected above]

Make sure no overlap with previous categories.

OL5 Category	B **1 Increase** **2 Decrease** **3 No change**	C **How so**	D **$ Value**
1. Internal labor			$_____ ☐ loaded value
2. External services/labor			
4. Training			
99. Other			

OTHER LABOR----------(MEASURE CAT 2)

[If respondent does not have 2nd measure, skip to next NEI category]

Now let's talk about other labor cost changes because of <MEASURE CAT 2>.

OL22. Overall, did your other annual labor costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI category

98. Refused [Go to next NEI category]

OL23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your other annual labor costs?

[Record dollars, if respondent can't answer, GOTO OL25, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used OL25]

-96 Don't know, additional data below → [Skip to OL25]

-97 Don't know, no additional data → [Skip to OL25]

-98 Refused → [Skip to Next NEI section]

-99 Not applicable / Skipped → [Skip to Next NEI section]

OL24 How did you estimate this amount?

[probe: what parts of the other costs were reduced/increased

Make sure no overlap with previous categories]

_____

_____

_____

[Goto next NEI section if respondent answers OL24]

OL25 In which of the following categories did the installation of <MEASURE CAT 2> <increase / decrease> your other labor costs?

Make sure no overlap with previous categories.

OL25 Category	B **1 Increase 2 Decrease 3 No change**	C **How so**	D **$ Value**
1. Internal labor			$_____ ☐ loaded value
2. External services/labor			
4. Training			
99. Other			

NEI Questions –Water Usage and Wastewater

Reread definition when you enter this section:

This section refers to the company's costs for water usage and wastewater.]

WATER USAGE----------(MEASURE CAT 1)

Now let's talk about changes to your water usage and wastewater costs because of <MEASURE CAT 1>.

FW2. Overall, did your annual water usage and wastewater costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Water Usage, measure cat 2]

98. Refused [Go to Water Usage, measure cat 2]

FW3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual water usage and wastewater costs?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Measure cat 2]

-97 Don't know, no additional data → [Skip to Measure cat 2]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

FW4 How did you estimate this amount?

[probe: what parts of the water usage and wastewater costs were reduced/increased

If respondent has difficulty estimating amount, ask for gallons of water change and average price per gallon

Make sure no overlap with previous categories.

FW5 Category	**B** **1 Increase 2 Decrease 3 No change**	**C** **How so**	**D** **$ Value**
32. Water usage costs			
33. Water gallons			
34. Wastewater			

WATER USAGE----------(MEASURE CAT 2)

[If respondent does not have 2nd measure, skip to next NEI category]

Now let's talk about changes to your water usage and wastewater costs because of <MEASURE CAT 2>.

FW22. Overall, did your annual water usage and wastewater costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI category]

98. Refused [Go to next NEI category]

FW23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual water usage and wastewater costs?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Next NEI Section]

-97 Don't know, no additional data → [Skip to Next NEI Section]

-98 Refused → [Skip to Next NEI Section]

-99 Not applicable / Skipped → [Skip to Next NEI Section]

FW24 How did you estimate this amount?

[probe: what parts of the water usage and wastewater costs were reduced/increased

If respondent has difficulty estimating amount, ask for gallons of water change and average price per gallon

Make sure no overlap with previous categories.]

FW25 Category	**B** **1 Increase 2 Decrease 3 No change**	**C** **How so**	**D** **$ Value**
32. Water usage costs			
33. Water gallons			
34. Wastewater			

NEI Questions – Product Spoilage

Reread definition when you enter this section:

This section refers to the company's costs for lost or damaged products, including production defects.]

PRODUCT SPOILAGE ---------- (MEASURE CAT 1)

Now let's talk about your company's changes to costs for product spoilage because of <MEASURE CAT 1>

SD2. Overall, did your annual product spoilage costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Product Spoilage, measure cat 2]

98. Refused [Go to Product Spoilage, measure cat 2]

SD3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual product spoilage costs?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Measure cat 2]

-97 Don't know, no additional data → [Skip to Measure cat 2]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

SD4 How did you estimate this amount?

[probe: what parts of the product spoilage costs were reduced/increased

Make sure no overlap with previous categories.]

PRODUCT SPOILAGE---------- (MEASURE CAT 2)

[If respondent does not have 2nd measure, skip to next NEI category]

Now let's talk about product spoilage cost changes because of <MEASURE CAT 2>.

SD22.Overall, did your annual product spoilage costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI category]

98. Refused [Go to next NEI category]

SD23.By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual product spoilage costs?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Next NEI Section]

-97 Don't know, no additional data → [Skip to Next NEI Section]

-98 Refused → [Skip to Next NEI Section]

-99 Not applicable / Skipped → [Skip to Next NEI Section]

SD24 How did you estimate this amount?

[probe: what parts of the product spoilage costs were reduced/increased

Make sure no overlap with previous categories.]

NEI Questions – Waste Disposal

[This section refers to any costs the company incurs from disposal of all solid and gaseous wastes (ie. Pollution).]

WASTE DISPOSAL----------(MEASURE CAT 1)

Now let's talk about changes to your waste disposal costs because of <MEASURE CAT 1>

SW2. Overall, did your annual waste disposal costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all Probe: DK because some went up and some went down? If so, change to 3; else go to waste disposal, measure cat 2]

98. Refused [Go to waste disposal, measure cat 2]

SW3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual waste disposal costs?

[Record dollars, if respondent can't answer, GOTO SW5, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used SW5]

-96 Don't know, additional data below → [Skip to SW5]

-97 Don't know, no additional data → [Skip to SW5]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

SW4 How did you estimate this amount?

[probe: what parts of the waste disposal costs were reduced/increased

Make sure no overlap with previous categories]?

[Goto next Waste Disposal, Measure cat 2 if respondent answers SW4]

SW5 In which of the following categories did the installation of <MEASURE CAT 1> <increase / decrease> your waste disposal costs? [

Column B. [Indicate whether it is an increase, decrease or did not change]

Column C. [Indicate how/why it changed]

Column D. [Indicate dollar value of change.

If waste materials have changed and they have trouble quantifying, try to determine what materials changed, whether they generated more or less of that type of waste materials, the number of units change, and average price per unit. Be sure to put the value on the sheet, and indicate the total in column D on the correct line

If waste handling costs include labor, verify not already included in previous sections, then ask hours and loaded cost of labor, or hours and hourly rate. Be sure to put the hours and the value on the sheet, and indicate the total in column D on the correct line

If they have trouble quantifying permit costs, try to determine what waste materials they need permits for and the average cost of the permit]

Make sure no overlap with previous categories.

SW5 Category	B 1 Increase 2 Decrease 3 No change	C How so	D $ Value
9. Waste materials			
10. Waste handling			
11. Permits			
99. Other			

WASTE DISPOSAL----------(MEASURE CAT 2)

[If respondent has only 1 measure, go to next NEI section.]

Now lets talk about changes to your waste disposal costs because of <MEASURE CAT 2>

SW22. Overall, did your annual waste disposal costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all Probe: DK because some went up and some went down? If so, change to 3; else [Go to next NEI Section]

98. Refused [Go to next NEI Section]

SW23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual waste disposal costs?

[Record dollars, if respondent can't answer, GOTO SW25, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used SW25]

-96 Don't know, additional data below → [Skip to SW25]

-97 Don't know, no additional data → [Skip to SW25]

-98 Refused → [Skip to Next NEI Section]

-99 Not applicable / Skipped → [Skip to Next NEI Section]

SW24 How did you estimate this amount?

[probe: what parts of the waste disposal costs were reduced/increased

Make sure no overlap with previous categories]?

[Goto next NEI section if respondent answers SW24]

SW25 In which of the following categories did the installation of <MEASURE CAT 2> <increase / decrease> your waste disposal costs?

Make sure no overlap with previous categories.

SW25 Category	B 1 Increase 2 Decrease 3 No change	C How so	D $ Value
9. Waste materials			
10. Waste handling			
11. Permits			
99. Other			

NEI Questions –Fees

This section refers to the company's fees including insurance, inspections, permits and legal fees.]

FEES ---------- (MEASURE CAT 1)

Now let's talk about how <MEASURE CAT 1> changed your company's fees.

IL2. Overall, did your fees increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Fees, measure cat 2]

98. Refused [Go to Fees, measure cat 2]

IL3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual fees?

[Record dollars, if respondent can't answer, GOTO IL5, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used IL5]

-96 Don't know, additional data below → [Skip to IL5]

-97 Don't know, no additional data → [Skip to IL5]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

IL4 How did you estimate this amount?

[probe: what parts of the fees were reduced/increased

If respondent has difficulty estimating amount, ask them to estimate insurance, inspections, and legal fees separately.

Make sure no overlap with previous categories]

[Goto Fees, Measure cat 2 if respondent answers IL4]

IL5 In which of the following categories did the installation of <MEASURE CAT 1> <increase / decrease> your company's annual fees?

Make sure no overlap with previous categories.

IL5 Category	B 1 Increase 2 Decrease 3 No change	C How so	D $ Value
21. Insurance			
22. Licensing			
23. Inspections			
24. Legal fees			
99. Other			

FEES ---------- (MEASURE CAT 2)

[If respondent does not have 2nd measure, skip to next NEI category]

Now let's talk about how <MEASURE CAT 2> changed your company's fees.

IL22. Overall, did your annual fees increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI category]

98. Refused [Go to next NEI category]

IL23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual fees?

[Record dollars, if respondent can't answer, GOTO IL25, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used IL25]

-96 Don't know, additional data below → [Skip to IL25]

-97 Don't know, no additional data → [Skip to IL25]

-98 Refused → [Skip to Next NEI Section]

-99 Not applicable / Skipped → [Skip to Next NEI Section]

IL24 How did you estimate this amount?

[probe: what parts of the fees were reduced/increased

If respondent has difficulty estimating amount, ask them to estimate insurance, inspections, permits and legal fees separately

Make sure no overlap with previous categories]

[Goto next NEI section if respondent answers IL24]

IL25 In which of the following categories did the installation of <MEASURE CAT 2> <increase / decrease> your company's annual fees?

Make sure no overlap with previous categories.

IL25 Category	B 1 Increase 2 Decrease 3 No change	C How so	D $ Value
21. Insurance			
22. Licensing			
23. Inspections			
24. Legal fees			
99. Other			

NEI Questions – Other costs

[This section refers to any other costs not yet covered in the survey.]

OTHER COSTS---------- (MEASURE CAT 1)

Now let's talk about any other non-energy related costs that changed because of <MEASURE CAT 1>.

OC2. Overall, did these other costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all Probe: DK because some went up and some went down? If so, change to 3; else go to other costs, measure cat 2]

98. Refused [Go to other costs, measure cat 2]

OC3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual other costs?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Measure cat 2]

-97 Don't know, no additional data → [Skip to Measure cat 2]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

OC4 How did you estimate this amount?

Make sure no overlap with previous categories.

OTHER COSTS---------- (MEASURE CAT 2)

[If respondent does not have 2nd measure, skip to next NEI category]

Now let's talk about how your other costs changed because of <MEASURE CAT 2>.

OC22. Overall, did these other costs increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all Probe: DK because some went up and some went down? If so, change to 3; else [Go to next NEI category]

98. Refused [Go to next NEI category]

OC23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual other costs?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Next NEI section]

-97 Don't know, no additional data → [Skip to Next NEI section

-98 Refused → [Skip to Next NEI section]

-99 Not applicable / Skipped → [Skip to Next NEI section]

OC24 How did you estimate this amount?

Make sure no overlap with previous categories.

NEI Questions – Sales

[This section refers to any sales changes the company experienced due to installing the measures.]

SALES----------(MEASURE CAT 1)

Now let's talk about any changes to your company's sales because of <MEASURE1>

PR2. Overall, did your annual sales levels increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Sales, measure cat 2]

98. Refused [Go to Sales, measure cat 2]

PR3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual sales levels?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Measure cat 2]

-97 Don't know, no additional data → [Skip to Measure cat 2]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

PR4 How did you estimate this amount?

[Probe: what parts of the sales were reduced/increased

Make sure no overlap with previous categories.]

SALES ----------(MEASURE CAT 2)

[If respondent has only 1 measure, go to next NEI section.]

Now let's talk about any changes to your company's sales because of <MEASURE2>

PR22.Overall, did your annual sales levels increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI section]

98. Refused [Go to next NEI section]

PR23.By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual sales levels?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Next NEI Section]

-97 Don't know, no additional data → [Skip to Next NEI Section]

-98 Refused → [Skip to Next NEI Section]

-99 Not applicable / Skipped → [Skip to Next NEI Section]

PR24 How did you estimate this amount?

[Probe: what parts of the production or revenues were reduced/increased

Make sure no overlap with previous categories]?

_____

_____

_____

NEI Questions – Rent Revenue

This section refers to any rent revenue changes the company experienced due to installing the measures.]

RENT REVENUE----------(MEASURE CAT 1)

Now let's talk about any rent revenue changes your company experienced because of <MEASURE1>

RR2. Overall, did your annual rent revenues increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to Rent Revenues, measure cat 2]

98. Refused [Go to Rent Revenues, measure cat 2]

RR3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual rent revenues?

[Record dollars, if respondent can't answer, GOTO RR5, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used RR5]

-96 Don't know, additional data below → [Skip to RR5]

-97 Don't know, no additional data → [Skip to RR5]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

RR4 How did you estimate this amount?

Make sure no overlap with previous categories

[Goto Rent Revenues, Measure cat 2 if respondent answers RR4]

RR5 In which of the following categories did the installation of <MEASURE CAT 1> <increase / decrease> your rent revenues? [

Column B. [Indicate whether it is an increase, decrease or did not change]

Column C. [Indicate how/why it changed]

Column D. [Indicate dollar value of change.]

Make sure no overlap with previous categories

RR5 Category	B 1 Increase 2 Decrease 3 No change	C How so	D $ Value
13. # units produced			
14. Per unit production costs			
15. Revenue per unit			

RENT REVENUE ----------(MEASURE CAT 2)

[If respondent has only 1 measure, go to next NEI section.]

Now let's talk about any rent revenue changes your company experienced because of <MEASURE2>

RR22. Overall, did your annual rent revenues increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI section]

98. Refused [Go to next NEI section]

RR23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual rent revenues?

[Record dollars, if respondent can't answer, GOTO RR25, then come back and fill in the total here and check the space under the estimate]

$_____

___ [Check here if used RR25]

-96 Don't know, additional data below → [Skip to RR25]

-97 Don't know, no additional data → [Skip to RR25]

-98 Refused → [Skip to Next NEI Section]

-99 Not applicable / Skipped → [Skip to Next NEI Section]

RR24 How did you estimate this amount?

Make sure no overlap with previous categories

[Goto next NEI section if respondent answers RR24]

RR25 In which of the following categories did the installation of <MEASURE CAT 2> <increase / decrease> your rent revenues? [

Column B. [Indicate whether it is an increase, decrease or did not change]

Column C. [Indicate how/why it changed]

Column D. [Indicate dollar value of change.]

Make sure no overlap with previous categories

RR25 Category	B 1 Increase 2 Decrease 3 No change	C How so	D $ Value
13. # units produced			
14. Per unit production costs			
15. Revenue per unit			

NEI Questions – Other revenues

[This section refers to any other revenues not yet covered in the survey.]

OTHER REVENUES---------- (MEASURE CAT 1)

Now let's talk about any other non-energy related revenues that changed because of <MEASURE CAT 1>.

OR2. Overall, did these other revenues increase or decrease because of any of the *high efficiency* <MEASURE CAT 1> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to other revenues, measure cat 2]

98. Refused [Go to other revenues, measure cat 2]

OR3. By how much did the installation of <MEASURE CAT 1> <increase / decrease> your annual other revenues?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if bracketed]

-96 Don't know, additional data below → [Skip to Measure cat 2]

-97 Don't know, no additional data → [Skip to Measure cat 2]

-98 Refused → [Skip to Measure cat 2]

-99 Not applicable / Skipped → [Skip to Measure cat 2]

OR4 How did you estimate this amount?

Make sure no overlap with previous categories

OTHER REVENUES---------- (MEASURE CAT 2)

[If respondent does not have 2nd measure, skip to next NEI category]

Now let's talk about any other non-energy related revenues that changed because of <MEASURE CAT 2>.

OR22. Overall, did these other revenues increase or decrease because of any of the *high efficiency* <MEASURE CAT 2> you installed?

[Circle all that apply]

1. Increase

2. Decrease

3. Some went up, some went down – don't know overall

97. DK at all [Probe: DK because some went up and some went down? If so, change to 3; else go to next NEI category]

98. Refused [Go to next NEI category]

OR23. By how much did the installation of <MEASURE CAT 2> <increase / decrease> your annual other revenues?

[Record dollars, if respondent can't answer, bracket starting at $100,000]

$_____

___ [Check here if used bracket]

-96 Don't know, additional data below → [Skip to Next NEI Section]

-97 Don't know, no additional data → [Skip to Next NEI Section]

-98 Refused → [Skip to Next NEI Section]

-99 Not applicable / Skipped → [Skip to Next NEI Section]

OR24 How did you estimate this amount? Make sure no overlap with previous categories

Spillover

This section is to ask them about any additional projects they did since participating in the program in 2010. The interviewer will determine if we already know about these projects, and if not, whether they are "like" or "unlike" projects.

When you ask about additional projects, you need to confirm that the project did not involve one of the measures you already talked about with the respondent during the NEI section.

If it is the measures we already know about, skip the rest of these questions for that measure and go to the next measure.

Get detailed information based on the measure type:

Lighting – types (T12, Standard T8, High performance T8, T5, HID, Other) and number of fixtures installed

HVAC – type (packaged AC, rooftop AC, split AC, furnace, boiler, heat pump, geothermal, Other), capacity (tons or MBTU/hr), and SEER or efficiency rating. If something like ducts or fans where capacity and SEER not applicable, get quantity

Motors – number, horsepower, and efficiency rating

Compressed Air – description, number, and size (horsepower or cubic feet/minute) of what was installed

Refrigeration – Number, size (tons or MBTU/hr), and efficiency of units

Building Envelope – square feet heated and cooled space impacted by measure.

Water – Number and description of what was installed. If a water heater, the efficiency rating, MBTU/hr

Please pre-populate the list of additional measures that we have on file for the customer site. You will use this to double-check against any measures the participant discusses with you beyond the two measures that you discussed in the NEI section.

Known Measures:

MEASURE 1:_____

MEASURE 2:_____

MEASURE 3:_____

MEASURE 4: _____

MEASURE 5:_____

MEASURE 6:_____

MEASURE 7:_____

MEASURE 8:_____

Please record any additional measures as necessary.]

S1. . Now I have some questions to ask you about any projects involving energy using equipment that you might have done since the ones we just talked about.

Since participating in <PROGRAM> in 2010, has your company purchased, or installed any energy efficiency equipment in the following categories?

Did you install any energy efficient equipment since 2010	
Lighting	
HVAC	
Motors	
Compressed Air	
Refrigeration	
Building Envelope	
Water	
Other	

[If all No, then end interview]

[If DK, probe for contact who might know]

[For any measure category they say yes to, get detailed information about those measures. Record on next page.]

S2. What did you install?

Equipment 1

Location:_____

Record type: _____

Same Type as a known measure?: _____

Record quantity: _____

Record size or capacity: _____

Efficiency level (Energy Star?):_____

Efficiency level *relative to similar known measure?*

____Same ____Equipment 1 is Higher _____Equipment 1 is Lower

[Probe for "anything else" until they say nothing else. Add additional Equipments as necessary.]

Equipment 2

Location:_____

Record type: _____

Same Type as a known measure?: _____

Record quantity: _____

Record size or capacity: _____

Efficiency level (Energy Star?):_____

Efficiency level *relative to similar known measure?*

____Same ____Equipment 2 is Higher _____Equipment 2 is Lower

Equipment 3

Location:_____

Record type: _____

Same Type as a known measure?: _____

Record quantity: _____

Record size or capacity: _____

Efficiency level (Energy Star?):_____

Efficiency level *relative to similar known measure?*

____Same ____Equipment 3 is Higher _____Equipment 3 is Lower

Equipment 4

Location:_____

Record type: _____

Same Type as a known measure?: _____

Record quantity: _____

Record size or capacity: _____

Efficiency level (Energy Star?):_____

Efficiency level *relative to similar known measure?*

____Same ____Equipment 4 is Higher _____Equipment 4 is Lower

Equipment 5

Location:_____

Record type: _____

Same Type as a known measure?: _____

Record quantity: _____

Record size or capacity: _____

Efficiency level (Energy Star?):_____

Efficiency level *relative to similar known measure?*

____Same ____Equipment 5 is Higher _____Equipment 5 is Lower

[Ask S3 and S4 if the new equipment is the same type as one of the measures we asked the NEI questions for

Else GOTO S5]

S3. Did you install more, less or the same amount of <new equipment> as <equipment we asked NEI questions about>?

[PROBE: We're looking for a percent compared to the amount installed through the program. For example, was it about one- fourth of what you installed through the program, one-half of what you installed through the program, the same (100%) amount as you installed through the program, twice as much as what you installed through the program (200%) or some other amount?

Units of quantity depend on measure type:

Lighting → # of fixtures

HVAC → Tons or MBTU/hr (Millions of BTU per hour)

Refrigeration → Tons

Motors → Total horsepower

Compressed Air → Horsepower or CFM (Cubic feet/minute)

Building Envelope → Total enclosed square feet affected

Water → MBTU/hr (Millions BTU per hour) or varies – confirm unit with respondent

Process → Varies – get units from respondent

Comprehensive → Varies – get units from respondent

S3	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5
1 More (%____) 2 Less (%____) 3 Same (→ S5) 97 (DK) 98 (Ref)					

S4. To confirm, you installed an additional <percentage from S5> of <new equipment> as you got incentives for through the program?

1 Yes

2 No [correct S3]

S5. Did you receive any incentives from energy efficiency programs for this piece of equipment?

S5	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5
1 Yes[Which ones? → S7] 2 No [→ S6] 97 (DK) [→ S7] 98 (Ref)					

S6. Why not?

S6	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5
Record verbatim, then post-code					

1 (The equipment would not qualify)
2 (Too much paperwork)
3 (Cost savings not worth the effort of applying)
4 (Takes too long for approval)
5 (Vendor does not participate in program)
6 (Outside <PA>'s service territory)
7 (No time - needed equipment immediately)
8 (Thought the program ended)
9 (Didn't know the equipment qualified under another program)
10 (Just didn't think of it)
11 (Unable to get rebate--unsure why)
12 (Other) (SPECIFY)
97 (DK)

S7. Did your experience with the projects we discussed earlier [the NEI projects] influence your decision to install any of this equipment?

S7	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5

[If they say yes, get the level of influence of their experience with the NEI projects. Use 0 to 10 scale where 0 = "no influence at all" and 10 = "a great deal of influence"]

S8. Did your participation in any past energy efficiency programs offered by <PA> influence your decision to install any of this equipment?

S8	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5
[Get 0 to 10 influence ranking] 97 (DK) 98 (Ref)					

[If they say yes, get the level of influence of their experience with the NEI projects. Use 0 to 10 scale where 0 = “no influence at all” and 10 = “a great deal of influence”]

S9. Did a contractor, engineer, or designer who helped you with a previous energy efficiency project that influence your decision to install this equipment?

S9	Equipment 1	Equipment 2	Equipment 3	Equipment 4	Equipment 5
[Get 0 to 10 influence ranking] 97 (DK) 98 (Ref)					

[If they say yes, get the level of influence of their experience with the NEI projects. Use 0 to 10 scale where 0 = “no influence at all” and 10 = “a great deal of influence”]

[GOTO next Spillover Equipment]

Thank you. That’s all the questions I have for you today. If necessary, would it be ok for me to call you back to clarify my notes? Once again, thank you for your responses. Have a good day.

Appendix E. CUSTOM MEASURE INTERVIEW GUIDE

MA NEI Custom Interview

Call ID:_____

Contact_____

Company: _____

Clean_Phone: _____

Address: _____

Alternate phone: _____

Reporting Category 1: _____ Measure ID1:_____

Reporting Category 2 _____ Measure ID2:_____

PA Name: __ Program Name:___ _____

Participation Date: _____

Call #	Date	Time	Notes (include message left, best time to call, best way to contact, and whether survey was completed)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Final Disposition: O complete O refused O no answer O mid-terminate
O other (specify_____)

Interview Length:_____

Purpose of the Interview

1. Determine whether measures resulted in non-energy impacts (NEIs –"any positive or negative effect beyond energy savings that are attributable to energy efficiency programs")

2. Identify sources of NEIs that resulted from the installed measures

3. Obtain estimates of non-energy impacts (NEI)

a. Seek monetized non-energy benefits or costs

b. If respondents cannot monetize NEIs, guide respondents through relevant probes to obtain the necessary information for imputing monetized estimates of NEI;

4. Obtain measures of spillover – Participant spillover is energy savings resulting from program influenced installation of energy efficiency measures that did not receive program incentives. We will obtain estimates of both like and un-like spillover.

a. Like spillover – Energy savings resulting from program influenced installation of energy-efficient equipment of the same type (i.e. the same measure, capacity, and efficiency level)

b. Unlike spillover – Energy savings resulting from program influenced installation of energy-efficient equipment of the a different type (i.e. different measure, capacity, or efficiency level)

Introduction and Screening

[Get <<CONTACT>> on the phone]

Hello, my name is __ and I am calling from KEMA Consulting on behalf of <<PA NAME>> and <<PROGRAM>>

I'm calling to get some feedback on how the energy efficiency improvements you made through <<PROGRAM>> have affected your organization's costs and revenues. Someone else from KEMA called you a few days ago to set up this interview.

Are you still the person at <<COMPANY>> most familiar with the outcomes of your organization's participation and experience with the <<PROGRAM>> program?

[If necessary] Last Spring, someone from the evaluation team spoke you about your participation in the <<PA NAME>> <<PROGRAM>> program around <<PARTICIPATION DATE>>.

[If "No"] Who is the right person to talk to? [Get name and contact information. Attempt to reach]

[Once correct person on phone]: All of your answers are confidential and will only be reported in aggregate.

[If asked]: You can verify the legitimacy of this research by calling _____ at _____

[If asked]: KEMA is an independent contractor hired to do this research.

[If different contact, record information below]

Name:__
_____

Phone: _____; Alt phone:_____

Address: _____

About the Respondent

Let's start by getting a little information about your organization and you. These questions help us put the rest of your answers in context.

F1. What is the major economic activity at <<ADDRESS>>?

F2. How many full-time equivalent employees work at <<ADDRESS>>? [Bracket if don't know. Start at 100 employees and go up or down]

F3. What is the total square footage of conditioned space at <<ADDRESS>>? [Bracket if don't know. Start at 10,000 square feet and go up or down.]

AR1. What is your job title?

AR2. What are your responsibilities?

AR3. How long have you done that?

Equipment Verification

My records show that you have installed the following measures through <<PROGRAM>>:

MEASURE 1._____

MEASURE 2:_____

MEASURE 3:_____

MEASURE 4: _____

MEASURE 5:_____

MEASURE 6:_____

MEASURE 7:_____

MEASURE 8:_____

[add additional measures as necessary]

[Ask questions below and fill in table for each measure]

Question	Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6	Measure 7	Measure 8
EV2								
EV3								
EV4								
EV5								
EV6								

EV2. Is this equipment still installed?

1 Yes [Go to EV5]

2 No [Go to EV3]

97 Don't know [Ask for alternate contact who could answer]

98 Refused [Ask for alternate contact who could answer]

EV3. Why was it removed?

EV4. What, if anything, did you install in its place? [Skip to EV7.]

EV5. Is this equipment still operational?

1 Yes [Go to EV7]

2 No [Go to EV6]

97 Don't know [Ask for alternate contact who could answer]

98 Refused [Ask for alternate contact who could answer]

EV6. Why not?

[Continue survey with any measures still installed.

If all measures no longer installed, ask NEI sections if reason for removal might be relevant to NEI. For example, “It increased O&M costs too much.” If reason for removal not relevant to NEI, end interview.]t

EV7. Could you tell me a little more about this project? I only have a brief description in my records, so I’m trying to get a little more detail about it.

[Probes: different pieces; electric vs. gas; connected to any other equipment]

[Ask free-ridership section only if <analysis> ≠ 1 for a measure in a reporting category.

If all measures have <analysis> = 1, skip to EV8]

Free-Ridership

FR1. Next, I have some questions about the effect the incentives from the <PA>and MASS Save program had on your decision to purchase a <MEASURE>.

Without the program, would you say the likelihood of purchasing the <MEASURE> was…

[READ UNBRACKETED OPTIONS]

1	**Very likely**	
2	**Somewhat likely**	
3	**Not very likely**	
4	**Or very unlikely**	
97	[Don’t know]	
98	[Refused]	

TIMING

FR2a. What effect, if any, did program incentives have on your decision to purchase the <MEASURE> when you did. I’m referring to your decision to purchase any <MEASURE>, not just an energy efficient model.

Without the program, would you have purchased them at the same time, earlier, later, or never?

1	[at the Same time]	FR2c
2	[Earlier]	FR2c
3	[Later]	FR2b
4	[Never]	FR2c
97	[Don’t know]	FR2c

Appendix F. DETAILED DISPOSITIONS

F-1 Dispositions By Strata – Prescriptive Electric

Strata	Sampling Measure Group	Size	Frame	Target	Sample Completes	Status
1	Compressed Air	All	6	4	2	Exhausted
2	Compressed Air	Small	5	3	1	Exhausted
3	Compressed Air	Medium	4	2	2	Exhausted
4	Compressed Air	Large	1	1.328265	1	Exhausted
5	HVAC	Small	15	7	9	Exhausted
6	HVAC	Medium	4	6	3	Exhausted
7	HVAC	Large	1	1	0	Exhausted
8	HVAC	Small	29	13	14	Exhausted
9	HVAC	Medium	12	13	1	Exhausted
10	HVAC	Large	1	1.299588	0	Exhausted
11	Lighting	Very Small	135	12	16	Available
12	Lighting	Small	57	12	12	Available
13	Lighting	Medium	49	12	13	Available
14	Lighting	Large	27	12	4	Exhausted
15	Lighting	Very Large	18	12	9	Exhausted
16	Lighting	Very Small	277	14	58	Available
17	Lighting	Small	108	14	28	Available
18	Lighting	Medium	66	14	16	Available
19	Lighting	Large	26	14	6	Exhausted
20	Lighting	Very Large	14	14	1	Exhausted
21	Motors and Drives	Very Small	29	8	14	Exhausted
22	Motors and Drives	Small	11	8	5	Exhausted
23	Motors and Drives	Medium	8	8	8	Exhausted
24	Motors and Drives	Large	6	7	0	Exhausted
25	Motors and Drives	Very Large	5	8.14105	2	Exhausted
26	Motors and Drives	Very Small	28	5	10	Exhausted
27	Motors and Drives	Small	14	5	6	Exhausted
28	Motors and Drives	Medium	6	5	3	Exhausted
29	Motors and Drives	Large	3	4	0	Exhausted
30	Motors and Drives	Very Large	14	24.70786	2	Exhausted
31	Process	All	2	2	1	Exhausted
32	Refrigeration	Small	7	4	1	Exhausted
33	Refrigeration	Large	3	3	0	Exhausted
34	Refrigeration	Small	30	11	18	Exhausted
35	Refrigeration	Medium	13	11	6	Exhausted
36	Refrigeration	Large	6	10	5	Exhausted
37	Building Envelope	All	1	1	0	Exhausted
38	Comprehensive	Small	52	4	5	Available
39	Comprehensive	Large	17	3	0	Exhausted
40	Comprehensive	Small	97	5	19	Available
41	Comprehensive	Large	41	4	2	Exhausted
Total			**1248**	**322.4768**	**303**	

F-2 Dispositions By Strata – Prescriptive Gas

Strata	Sampling Measure Group	Size	Frame	Target	Sample Completes	Status
1	Building Envelope	All	3	2	2	Exhausted
2	HVAC	Small	28	10	22	Exhausted
3	HVAC	Medium	6	10	4	Exhausted
4	HVAC	Large	4	9	0	Exhausted
5	HVAC	Very Small	45	12	10	Exhausted
6	HVAC	Small	18	11	10	Exhausted
7	HVAC	Large	5	11	2	Exhausted
8	HVAC	Very Large	3	12.58462	1	Exhausted
9	Water Heater	Small	17	10	14	Exhausted
10	Water Heater	Large	7	9	6	Exhausted
11	Water Heater	Very Small	42	12	16	Exhausted
12	Water Heater	Small	20	11	6	Exhausted
13	Water Heater	Medium	11	11	3	Exhausted
14	Water Heater	Large	6	11	2	Exhausted
15	Water Heater	Very Large	1	6.3	0	Exhausted
16	Process	All	1	1	0	Exhausted
Total			**217**	**148.8846**	**98**	

F-3 Dispositions By Strata – Custom Electric

Strata	Sampling Measure Group	Size	Frame	Target	Sample Completes	Status
1	Lighting	All	1	1	1	Exhausted
2	Lighting	All	1	1	0	Exhausted
3	Motors and Drives	All	2	1	0	Exhausted
4	Lighting	All	1	1	0	Exhausted
5	Building Envelope	All	5	3	4	Exhausted
6	CHP/Cogen	Small	6	3	4	Exhausted
7	CHP/Cogen	Medium	3	3	1	Exhausted
8	CHP/Cogen	Large	2	2	1	Exhausted
9	Compressed Air	Small	7	3	3	Exhausted
10	Compressed Air	Medium	2	2	1	Exhausted
11	Compressed Air	Large	3	3	0	Exhausted
12	HVAC	Very Small	18	3	3	Available
13	HVAC	Small	7	3	1	Exhausted
14	HVAC	Medium	5	3	2	Exhausted
15	HVAC	Large	5	3	1	Exhausted
16	HVAC	Very Large	7	7	3	Exhausted
17	Lighting	Very Small	58	4	9	Available
18	Lighting	Small	19	4	11	Available
19	Lighting	Medium	10	4	7	Exhausted
20	Lighting	Large	7	4	3	Exhausted
21	Lighting	Very Large	3	3	0	Exhausted
22	Motors and Drives	Very Small	27	6	14	Available
23	Motors and Drives	Small	14	6	9	Available
24	Motors and Drives	Small to Medium	13	5	7	Exhausted
25	Motors and Drives	Medium to Large	9	5	5	Exhausted
26	Motors and Drives	Large	5	5	3	Exhausted
27	Motors and Drives	Very Large	4	4	1	Exhausted
28	Process	Small	8	4	3	Exhausted
29	Process	Medium	4	3	1	Exhausted
30	Process	Large	3	3	0	Exhausted
31	Refrigeration	Very Small	16	4	2	Exhausted
32	Refrigeration	Small	3	3	0	Exhausted
33	Refrigeration	Medium	3	3	0	Exhausted
34	Refrigeration	Large	3	3	1	Exhausted
35	Refrigeration	Very Large	3	3	3	Exhausted
36	Other	Small	16	4	7	Exhausted
37	Other	Medium	5	4	1	Exhausted
38	Other	Large	2	2	0	Exhausted
39	CHP/Cogen	All	4	3	0	Exhausted
40	Compressed Air	Small	2	1	1	Exhausted
41	Compressed Air	Large	1	1	1	Exhausted
42	HVAC	Very Small	26	4	2	Exhausted
43	HVAC	Small	14	4	1	Exhausted

Strata	Sampling Measure Group	Size	Frame	Target	Sample Completes	Status
44	HVAC	Small to Medium	8	4	1	Exhausted
45	HVAC	Medium to Large	6	4	3	Exhausted
46	HVAC	Large	4	3	3	Exhausted
47	HVAC	Very Large	9	9	0	Exhausted
48	Lighting	Very Small	113	12	28	Available
49	Lighting	Small	42	12	12	Available
50	Lighting	Small to Medium	24	12	7	Exhausted
51	Lighting	Medium to Large	17	11	3	Exhausted
52	Lighting	Large	13	11	5	Exhausted
53	Lighting	Very Large	11	11	3	Exhausted
54	Motors and Drives	Small	6	3	1	Exhausted
55	Motors and Drives	Medium	3	3	1	Exhausted
56	Motors and Drives	Large	1	1	1	Exhausted
57	Process	Small	3	2	3	Exhausted
58	Process	Large	1	1	1	Exhausted
59	Refrigeration	Very Small	23	5	6	Available
60	Refrigeration	Small	11	5	6	Available
61	Refrigeration	Small to Medium	9	5	3	Exhausted
62	Refrigeration	Medium to Large	7	5	2	Exhausted
63	Refrigeration	Large	6	4	5	Exhausted
64	Refrigeration	Very Large	6	6	0	Exhausted
65	Other	Small	3	2	0	Exhausted
66	Other	Large	1	1	1	Exhausted
67	HVAC	All	1	1	0	Exhausted
68	Refrigeration	Very Small	76	7	14	Available
69	Refrigeration	Small	45	7	16	Available
70	Refrigeration	Medium	33	7	11	Available
71	Refrigeration	Large	24	7	13	Available
72	Refrigeration	Very Large	16	6	8	Exhausted
73	Process	Small	1	1	1	Exhausted
74	Process	Large	1	1	0	Exhausted
Total			**881**	**310**	**275**	

F-4 Dispositions By Strata - Custom Gas

Strata	Sampling Measure Group	Size	Frame	Target	Sample Completes	Status
1	Building Envelope	Small	5	2	4	Exhausted
2	Building Envelope	Large	2	2	2	Exhausted
3	HVAC	Small	8	4	2	Exhausted
4	HVAC	Medium	3	3	2	Exhausted
5	HVAC	Large	1	1	0	Exhausted
6	Water Heater	All	3	1	1	Exhausted
7	Process	All	1	1	0	Exhausted
8	Building Envelope	Small	2	1	0	Exhausted
9	Building Envelope	Large	1	1	0	Exhausted
10	HVAC	Small	9	4	2	Exhausted
11	HVAC	Medium	5	4	1	Exhausted
12	HVAC	Large	4	4	1	Exhausted
13	Water Heater	All	2	1	1	Exhausted
14	Process	Small	2	1	1	Exhausted
15	Process	Large	1	1	0	Exhausted
16	Building Envelope	Very Small	11	4	4	Exhausted
17	Building Envelope	Small	6	4	3	Exhausted
18	Building Envelope	Medium	5	4	3	Exhausted
19	Building Envelope	Large	4	3	2	Exhausted
20	Building Envelope	Very Large	5	5	2	Exhausted
21	HVAC	Very Small	35	4	6	Available
22	HVAC	Small	16	4	4	Available
23	HVAC	Large	9	3	1	Exhausted
24	HVAC	Very Large	1	1	0	Exhausted
25	Water Heater	Small	24	5	5	Exhausted
26	Water Heater	Large	11	5	6	Exhausted
27	Building Envelope	Small	5	2	2	Exhausted
28	Building Envelope	Large	2	2	1	Exhausted
29	HVAC	Very Small	24	5	6	Exhausted
30	HVAC	Small	11	4	3	Exhausted
31	HVAC	Medium	5	4	2	Exhausted
32	HVAC	Large	5	4	1	Exhausted
33	HVAC	Very Large	5	5	4	Exhausted
34	Water Heater	Small	4	2	2	Exhausted
35	Water Heater	Large	2	2	2	Exhausted
36	Other	Small	6	3	1	Exhausted
37	Other	Large	2	2	0	Exhausted

Strata	Sampling Measure Group	Size	Frame	Target	Sample Completes	Status
38	Building Envelope	Very Small	10	5	6	Exhausted
39	Building Envelope	Small	8	4	7	Exhausted
40	Building Envelope	Medium	6	4	6	Exhausted
41	Building Envelope	Large	5	4	2	Exhausted
42	Building Envelope	Very Large	5	5	2	Exhausted
43	HVAC	Very Small	16	4	3	Exhausted
44	HVAC	Small	6	3	1	Exhausted
45	HVAC	Large	5	3	1	Exhausted
46	HVAC	Very Large	2	2	1	Exhausted
47	Water Heater	Small	6	3	4	Exhausted
48	Water Heater	Large	3	3	2	Exhausted
49	Process	All	4	2	0	Exhausted
50	Process	All	1	1	0	Exhausted
Total			**324**	**151**	**112**	

Appendix G. SENSITIVITY ANALYSIS – IMPACT OF IMPUSTED MISSING VALUES ON RESULTS

DNV KEMA tested the sensitivity of the NEI to savings ratios to the filling of missing values by calculating the ratio of NEIs to savings with the following changes:

1. Dropped 11 observations where the respondent could not assign any value to the NEIs, but indicated that they were sure of a benefit or cost and
2. Set to zero the portion of the NEIs that were filled: ie. if a measure had NEIs reported for Materials Handling and O&M, but did not know a key input for O&M, we set the O&M NEI to zero and retained the Materials Handling NEI in the comparison ratios.

Tables G-1 through G-4 show the final ratios as reported in Section 4 and the comparison ratios created for the sensitivity analysis. Both the Custom Electric and Prescriptive Gas studies showed statistically significant differences when the fill values were removed, while the Prescriptive Electric and Custom Gas studies did not have any statistically significant differences. While statistically significant, the comparison ratios were all well within the 90% confidence interval of the reported ratio.

The values used to fill were not themselves extreme values (being averages), nor were the resulting NEIs that resulted after the fill larger than most. The difference in ratio values could be attributed to having a value vs. not having a value. Since all measures that received a fill value had responses they both experienced NEIs and that they knew that those NEIs were a benefit, ignoring their NEIs by assigning a zero value systemically underestimates the NEIs. By filling the missing values the resulting ratios avoid this systemic underestimation.

Table G-1. Comparison of results with and without imputed missing values – Prescriptive Electric

NEI Reporting Category	Reported Ratio				Comparison Ratio (Without Fill Values)				Significantly Different?
	n	NEI/kWh	90% CI Low	90% CI High	n	NEI/kWh	90% CI Low	90% CI High	
Compressed Air	27	$ 0.0966	$ 0.0544	$ 0.1389	24	$ 0.0948	$ 0.0513	$ 0.1383	No
HVAC	163	$ 0.0274	$ 0.0176	$ 0.0372	161	$ 0.0266	$ 0.0168	$ 0.0364	No
Lighting	50	$ 0.0043	$ (0.0005)	$ 0.0091	49	$ 0.0035	$ (0.0011)	$ 0.0081	No
Motors and Drives	30	$ 0.0013	$ (0.0002)	$ 0.0028	30	$ 0.0013	$ (0.0002)	$ 0.0028	No
Refrigeration	32	$ 0.0039	$ (0.0002)	$ 0.0079	32	$ 0.0039	$ (0.0002)	$ 0.0079	No
Overall	**302**	**$ 0.0274**	**$ 0.0188**	**$ 0.0360**	296	$ 0.0265	$ 0.0180	$ 0.0351	No

Table G-1. Comparison of results with and without imputed missing values – Prescriptive Electric – Prescriptive Gas

NEI Reporting Category	Reported Ratio				Comparison Ratio (Without Fill Values)				Significantly Different?
	n	NEI/Therm	90% CI Low	90% CI High	n	NEI/Therm	90% CI Low	90% CI High	
Building Envelope	2	$ 3.6151	$ 2.6418	$ 4.5885					N/A
HVAC	50	$ 1.3464	$ 0.5433	$ 2.1496	48	$ 0.9568	$ 0.2828	$ 1.6307	Yes
Water Heater	47	$ 0.2604	$ (0.0012)	$ 0.5221	47	$ 0.2247	$ (0.0153)	$ 0.4648	No
Overall	**99**	**$ 0.8344**	**$ 0.3634**	**$ 1.3053**	95	$ 0.6016	$ 0.2060	$ 0.9972	Yes

Table G-1. Comparison of results with and without imputed missing values – Prescriptive Electric - Custom Electric

NEI Reporting Category	Reported Ratio				Comparison Ratio (Without Fill Values)				Significantly Different?
	n	NEI/kWh	90% CI Low	90% CI High	n	NEI/kWh	90% CI Low	90% CI High	
CHP/Cogen	6	$ (0.0147)	$ (0.0247)	$ (0.0047)	6	$ (0.0147)	$ (0.0247)	$ (0.0047)	No
HVAC	20	$ 0.0240	$ 0.0003	$ 0.0477	20	$ 0.0240	$ 0.0003	$ 0.0477	No
Lighting	89	$ 0.0594	$ 0.0318	$ 0.0871	88	$ 0.0595	$ 0.0315	$ 0.0876	No
Motors and Drives	42	$ 0.0152	$ (0.0005)	$ 0.0309	42	$ 0.0152	$ (0.0005)	$ 0.0309	No
Refrigeration	90	$ 0.0474	$ 0.0244	$ 0.0705	90	$ 0.0474	$ 0.0244	$ 0.0705	No
Other	29	$ 0.0562	$ 0.0038	$ 0.1087	28	$ 0.0381	$ (0.0046)	$ 0.0808	Yes
Overall	**276**	**$ 0.0368**	**$ 0.0231**	**$ 0.0506**	274	$ 0.0333	$ 0.0203	$ 0.0462	Yes

Table G-1. Comparison of results with and without imputed missing values – Prescriptive Electric Custom Gas

NEI Reporting Category	Reported Ratio				Comparison Ratio (Without Fill Values)				Significantly Different?
	n	NEI/Therm	90% CI Low	90% CI High	n	NEI/Therm	90% CI Low	90% CI High	
Building Envelope	46	$ 0.4774	$ 0.1258	$ 0.8290	46	$ 0.4774	$ 0.1258	$ 0.8290	No
HVAC	41	$ 0.2291	$ 0.1522	$ 0.3060	40	$ 0.2284	$ 0.1448	$ 0.3119	No
Water Heater	23	$ 0.1824	$ (0.4953)	$ 0.8601	23	$ 0.1824	$ (0.4953)	$ 0.8601	No
Other	2	$ 0.5253	$ (5.6577)	$ 6.7083	2	$ 0.5253	$ (5.6577)	$ 6.7083	No
Overall	**112**	**$ 0.2473**	**$ 0.1490**	**$ 0.3455**	111	$ 0.2468	$ 0.1435	$ 0.3501	No

Appendix H. RECOMMENDED NON-ENERGY IMPACT RATIOS BY PROGRAM ADMINISTRATOR

This appendix provides the specific NEI ratios that DNV KEMA recommends National Grid and NStar apply to their programs. These recommendations are more specific to the individual PA's program mapping than those presented in Section 4. The reporting categories used in this report are aggregations of the categories used by the individual PAs to categorize measures installed through their programs. Both NGrid and NStar requested DNV KEMA provide recommendations as to what NEI ratios apply to the measure groups that they use in their tracking systems. The following tables (Table H-1 and H-2) provide the "best fit" and most conservative options that the PAs have for estimating NEIs in their models using this study.

Table H-1. NGRID Recommended Reporting Categories

Fuel	BCR Activity	Program	Measure	Applicable NEI			
				Best Fit		Conservative	
				Reporting Category	Value	Reporting Category	Value
Electric	C03a Large C&I Retrofit	C03a C&I Large Retrofit	EI Compressed Air	Zero	0.000	Zero	0.000
Electric	C03a Large C&I Retrofit	C03a C&I Large Retrofit	EI Custom	Custom Overall	0.037	Custom Overall	0.037
Electric	C03a Large C&I Retrofit	C03a C&I Large Retrofit	EI HVAC	Prescriptive HVAC	0.097	Prescriptive HVAC	0.097
Electric	C03a Large C&I Retrofit	C03a C&I Large Retrofit	EI Light	Prescriptive Lighting	0.027	Prescriptive Lighting	0.027
Electric	C03a Large C&I Retrofit	C03a C&I Large Retrofit	EI Motors	Zero	0.000	Zero	0.000
Electric	C03a Large C&I Retrofit	C03a C&I Large Retrofit	EI VSDs	Zero	0.000	Zero	0.000
Electric	C03b Small C&I Retrofit	C03b C&I Small Retrofit	SCI	Zero	0.000	Zero	0.000
Electric	C03a Large C&I Retrofit	C03a C&I Large Retrofit	CHP Systems All	Custom CHP/Cogen	-0.015	Custom CHP/Cogen	-0.015
Gas	C03a C&I Retrofit	C&I Retrofit	Pre Rinse Spray Valve	Zero	0.00	Zero	0.00
Gas	C03a C&I Retrofit	C&I Retrofit	Boiler Reset Controls (retrofit only)	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	C03a C&I Retrofit	C&I Retrofit	Steam Traps	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	C03a C&I Retrofit	C&I Retrofit	Thermostat	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	C03a C&I Retrofit	C&I Retrofit	Custom Retrofit	Custom Overall	0.25	Custom Overall	0.25
Gas	C03a C&I Retrofit	C&I Retrofit	Econ Redevelopment - Retrofit	Zero	0.00	Zero	0.00
Gas	C03a C&I Retrofit	C&I Retrofit	Multifamily Retrofit	Zero	0.00	Zero	0.00
Gas	C03b Small C&I Retrofit	C&I Direct Install	Pre Rinse Spray Valve	Zero	0.00	Zero	0.00
Gas	C03b Small C&I Retrofit	C&I Direct Install	Thermostat	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	C03b Small C&I Retrofit	C&I Direct Install	Boiler Reset	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	C03b Small C&I Retrofit	C&I Direct Install	Faucet Aerator	Zero	0.00	Zero	0.00
Gas	C03b Small C&I Retrofit	C&I Direct Install	Low Flow Shower Head	Zero	0.00	Zero	0.00
Gas	C03b Small C&I Retrofit	C&I Direct Install	Pipe Insulation	Zero	0.00	Zero	0.00
Gas	C03b Small C&I Retrofit	C&I Direct Install	Duct Insulation	Prescriptive HVAC	1.35	Zero	0.00
Gas	C03a C&I Retrofit	Commercial Building Practices and Demonstration Program	Commercial Building Practices and Demonstration Program	Zero	0.00	Zero	0.00
Gas	C06x Hard to Measure	Deep Energy Retrofit - Commercial	Deep Energy Retrofit - Commercial	Custom Overall	0.25	Zero	0.00
Gas	C06x Hard to Measure	Business Energy Analyzer	Business Energy Analyzer	Custom Overall	0.25	Zero	0.00

H-2. NStar Recommended Reporting Categories

Fuel	Program	Measure	Applicable NEI			
			Best Fit		Conservative	
			Reporting Category	Value	Reporting Category	Value
Electric	C&I Retrofit	Compressed Air - Custom	Custom Other	0.056	Zero	0.000
Electric	C&I Retrofit	Compressed Air - Prescriptive	Zero	0.000	Zero	0.000
Electric	C&I Retrofit	HVAC - Custom	Custom HVAC	0.024	Custom HVAC	0.024
Electric	C&I Retrofit	HVAC - Prescriptive	Prescriptive HVAC	0.097	Prescriptive HVAC	0.097
Electric	C&I Retrofit	Process	Custom Other	0.056	Zero	0.000
Electric	C&I Retrofit	Lighting - Custom	Custom Lighting	0.059	Custom Lighting	0.059
Electric	C&I Retrofit	Lighting - Prescriptive	Prescriptive Lighting	0.027	Prescriptive Lighting	0.027
Electric	C&I Retrofit	Motors & VFD - Custom	Zero	0.000	Zero	0.000
Electric	C&I Retrofit	Motors & VFD - Prescriptive	Zero	0.000	Zero	0.000
Electric	C&I Retrofit	Refrigeration - Custom	Custom Refrigeration	0.047	Custom Refrigeration	0.047
Electric	C&I Retrofit	Refrigeration - Prescriptive	Custom Refrigeration	0.047	Custom Refrigeration	0.047
Electric	C&I Retrofit	CHP	Custom CHP/Cogen	-0.015	Custom CHP	-0.015
Electric	C&I Retrofit	Food Services - Custom	Custom Other	0.056	Zero	0.000
Electric	C&I Retrofit	Food Services - Prescriptive	Zero	0.000	Zero	0.000
Electric	C&I Small Retrofit	HVAC	Prescriptive HVAC	0.097	Prescriptive HVAC	0.097
Electric	C&I Small Retrofit	Process	Custom Other	0.056	Zero	0.000
Electric	C&I Small Retrofit	Lighting - Fixture	Prescriptive Lighting	0.027	Prescriptive Lighting	0.027
Electric	C&I Small Retrofit	Lighting - Control	Prescriptive Lighting	0.027	Prescriptive Lighting	0.027
Electric	C&I Small Retrofit	Refrigeration	Custom Refrigeration	0.047	Custom Refrigeration	0.047
Electric	C&I Small Retrofit	Motors & VFD	Zero	0.000	Zero	0.000
Electric	C&I Small Retrofit	Hot Water	Zero	0.000	Zero	0.000
Gas	C&I Retrofit	Programmable Thermostats	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	C&I Retrofit	Boiler Reset Controls	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	C&I Retrofit	Steam Traps	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	C&I Retrofit	Ozonated Laundry Systems	Zero	0.00	Zero	0.00
Gas	C&I Retrofit	Custom Retrofit	Custom Overall	0.25	Zero	0.00
Gas	Direct Install	Pre-Rinse Spray Valves	Zero	0.00	Zero	0.00
Gas	Direct Install	Programmable Thermostats	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	Direct Install	Boiler Reset Controls	Zero	0.00	Zero	0.00
Gas	Direct Install	Faucet Aerators	Zero	0.00	Zero	0.00
Gas	Direct Install	Salon Sprayers	Zero	0.00	Zero	0.00
Gas	Direct Install	Pipe Insulation	Zero	0.00	Zero	0.00
Gas	Direct Install	Showerheads	Zero	0.00	Zero	0.00
Gas	Direct Install	Duct Sealing & Insulation	Prescriptive HVAC	1.35	Prescriptive HVAC	1.35
Gas	Direct Install	Custom DI	Custom Overall	0.25	Zero	0.00