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# Massachusetts Electric and Gas Program Administrators

## Stage 1 Results and Stage 2 Detailed Research Plan—Commercial and Industrial New Construction Non-Energy Impacts Study

**March 20, 2015**

**Prepared by:**

**DNV GL**

DNV·GL

# Massachusetts Electric and Gas Program Administrators

## Stage 1 Results and Stage 2 Detailed Research Plan—Commercial and Industrial New Construction Non-Energy Impacts Study

**March 20, 2015**



Part of the Special and Cross-Cutting Evaluation Program Area

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# 1. EXECUTIVE SUMMARY

DNV GL and Tetra Tech (the Evaluation Team) were engaged by the Massachusetts Program Administrators (PAs) and the Energy Efficiency Advisory Council (EEAC) to quantify participant non-energy impacts (NEIs) associated with the 2013 Commercial and Industrial (C&I) New Construction (NC) program. This program provides incentives and technical services to C&I customers that are building new facilities, undergoing major renovations of an existing facility, or replacing failed equipment (natural replacement measures).

A major consideration when estimating NEIs for NC measures is distinguishing between NEIs that result from the measure being *new* versus being *energy efficient*, since some type of new equipment would be installed—regardless of participation in an energy efficiency program—when building a new facility, undergoing a major retrofit, or replacing failed equipment. Therefore, only NEIs associated with moving from a standard piece of new equipment to an energy efficient piece of equipment are relevant.

Interview respondents often have difficulty self-reporting NEIs associated with NC measures, because they do not have a point of comparison to gauge the difference between operating costs and/or sales for the new energy efficient equipment versus costs/sales for a hypothetical baseline equipment that is "new but not energy efficient." Our work plan for this study established a two-stage research effort to address this concern.

This report presents the methods and results of Stage 1, which was designed to assess the most effective means of obtaining information necessary for computing NEIs associated with NC measures. It also outlines a preliminary work plan for Stage 2 of the study, through which the Evaluation Team will estimate NEIs associated with NC measures. As discussed later in this report, the Evaluation Team determined that the Stage 2 research should be limited to "true" NC measures (new buildings or major renovation) only.

## 1.1 EVALUATION OBJECTIVES

The Evaluation Team identified the following objectives for this study:

**Stage 1 objectives**

- Review NC measures installed during 2013 to define these measures in terms of (1) types of new construction, and (2) measure category/end use
- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses through in-depth interviews (IDIs) from various marker actors
- Determine whether NEIs from new construction measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi panel, or other techniques
- Recommend an approach for the Stage 2 analysis.

**Stage 2 objectives**

- Employ the techniques identified through Stage 1 to establish baseline conditions for NEIs associated with true NC measures (i.e., excluding replace on failure and upstream measures).
- Apply techniques identified through Stage 1 to quantify NEIs for C&I true new construction projects completed in 2013. NEIs include any positive or negative effects beyond energy savings that are attributable to energy efficiency programs. Examples of positive NEIs include reduced labor or non-labor operations and maintenance (O&M) costs, and increased sales. Negative NEIs include increased labor or O&M costs, or reduced productivity or sales. We will estimate gross NEIs per unit of energy savings resulting from new construction electric and gas measures separately.

## 1.2 OVERVIEW OF APPROACH

In order to quantify the NEIs associated with the NC program in 2013, the Evaluation Team first reviewed the methodology used in a related study that examined NEIs associated with the 2012 C&I Retrofit program.[1]

The Evaluation Team considered using the same approach as the 2012 study, but ultimately decided to conduct the current study in two stages. The two-stage approach was selected due to uncertainty regarding respondents' ability to conceptualize cost and revenue changes associated with program-rebated measures relative to a hypothetical scenario using non-efficient technologies.

Stage 1 of this project consisted of the following tasks:

1. *Data mining* – DNV GL analyzed the 2013 program tracking data and the 2012 NEI C&I Retrofit study results to support the remaining tasks in the Stage 1 research.
2. *Sample development* – We used information from the data mining task to identify samples of interviewees from the following groups:
   a. PA staff who market the new construction programs
   b. Design firms (engineers and architects)
   c. Manufacturers and suppliers of energy efficient technologies
   d. Energy managers and operations groups of large institutional participants (e.g., large customers with multiple facilities such as college campuses, government offices, or manufacturing facilities).

[1] Final Report – Commercial and Industrial Non-Energy Impacts Study. Prepared by DNV GL for the Massachusetts Program Administrators and EEAC Consultants. June 29, 2012.

3. *Development of in-depth interview guides* – We drafted separate in-depth interview guides for each of the four groups mentioned in task 2 to determine appropriate means of establishing baseline conditions.
4. *In-depth interviews* – We conducted interviews with various market actors to determine the most effective means of obtaining NEI information for new construction measures.
5. *Reporting* – We drafted this report summarizing Stage 1 research and presenting a detailed work plan for Stage 2 research.

## 1.3 STAGE 1 RESULTS AND CONCLUSIONS

### 1.3.1 Stage 1 results

Table 1-1 characterizes the new construction program as it is carried out at each PA, according to statements by PA staff during our interviews. This includes the portion of the program that falls into each measure category. The measure categories are as follows:

- True new construction, which refers to new buildings and major renovation projects.
- Natural replacement (replace on failure), which is defined differently across the PAs. Consequently, it is not possible to identify a standard definition of natural replacement measures from existing practices. However, "natural replacement" generally refers to equipment that is replaced at the end of its useful service life and which—for baseline purposes—is compared to standard efficiency new equipment rather than the equipment it is replacing.
- Upstream lighting, which the PAs currently classify as new construction because the rebated measures largely consist of commodity products (bulbs) that are assumed to replace failed equipment. A detailed analysis of whether upstream measures were correctly classified as new construction was outside the scope of this study; however, the PAs did report that 100 percent of upstream measures are currently reported under the NC program. Upstream lighting incentives are managed by a working group of PA staff, for which Rich Boehler is the chair. The majority of upstream rebates go to small/medium-sized companies, including restaurants, retail, and small office. This is true statewide. PAs primarily market upstream incentives to distributors, with limited marketing to customers (e.g., brochures). The distributors do most of the direct marketing to customers. Upstream rebates are paid to distributors and manufacturer representatives in approximately the following proportions:
  - 30 percent counter sales
  - 5 percent online
  - 65 percent distributors or manufacturers' reps.

**Table 1-1. PA New Construction Considerations Based on In-depth Interview Results**

| PA | Major Renovation and New Buildings | Upstream Lighting | Natural Replacement | Notes |
|---|---|---|---|---|
| NSTAR | 33% | 27% | 40% | Focused on new buildings and major renovation. Retrofit consists only of those projects implemented only for efficiency reasons, and where the equipment has not passed its program-defined end of useful life.<br><br>For true new construction, with larger projects they get involved early on and participate in the design process. For smaller projects they are less involved, but pay a higher percentage of the modeling costs. |
| National Grid | 5% | 70% | 25% | New construction is defined as past the EUL if still in service. A bit squishier on custom.<br><br>Under National Grid, large account reps keep regular contact with large accounts, both related to billing and energy efficiency. National Grid contracts with a variety of subcontractors to implement various programs. One of the major points of this call was to get contact information for individuals at these third parties, as well as in the marketing and sales groups.<br><br>Their true new construction program has been struggling, but they have plans and staff set up to make major improvements this year, and they expect it to grow as a percent of savings. |
| Unitil | 5% | 10% | 85% | HVAC = new construction with exceptions. Required = new construction. Desired = retrofit. Most lighting is retrofit. Some retrofit projects do not pass cost/benefit, so are done as part of new construction.<br><br>Their program is divided up between the 30 largest customers and everyone else. The top 30 have account reps. For the rest, they pull permits for them and make calls occasionally. The top 30 make up 90 percent of electric and 50 percent of gas savings. |
| Liberty | - | - | 100% | New construction is defined as past the EUL if still in service. They shift projects from retrofit to new construction if incremental cost justification is not there. Replace on burnout is not common for participants. It would be low-attribution.<br><br>They have 25 customers, which are key accounts, who they interact with regularly. The rest of the customers come to them. |
| Cape Light | 45% | 45% | 10% | Qualitative responses – percentages estimated. New construction vs. retrofit based on whether the equipment is still functioning, or if it is past its useful life. They do a lot more retrofit work than natural replacement because of the direct install programs. |

### 1.3.2 Stage 1 conclusions

The Stage 1 research provided the following conclusions.

**The analysis of NEIs associated with new construction measures should focus on true new construction only.** While the PAs currently classify true new construction (i.e., major renovation and new buildings), replace on failure, and 100 percent of upstream measures as new construction, the Evaluation Team concluded that the Stage 2 research should focus on true NC at this time. DNV GL will employ the technique outlined in Section 6 to isolate true NC measures from the 2013 program tracking information.

**Self-reports by end users would not provide an effective means for estimating NEIs associated with most new construction measures.** Facility managers reported that if NEIs were assessed on new construction projects, they were typically determined by design engineers during the project or facility design phase. This was particularly true of heating and cooling measures.

**Self-reports by engineering firms will provide valuable insights to estimating NEIs across the range of projects for which they perform engineering services.** Engineering firms responsible for the design process often make recommendations concerning the operational cost and production impacts resulting from various equipment options. These firms can provide valuable information concerning the existence and magnitude of NEIs. However, the 2012 C&I Retrofit NEI study demonstrated that obtaining NEIs directly from self-reported interview responses required conducting a lengthy and intricate in-depth interview. Attempting such an interview with engineering firms is likely to result in incomplete interview responses, as such firms represent a challenging group with which to maintain lengthy phone interviews. Further, respondents' ability to recall decisions on individual projects may be limited. Given engineering firms' breadth of knowledge across multiple projects, however, we believe it will be valuable to conduct in-depth interviews with this group to gather information regarding key parameters to consider, and scenarios for which those factors may vary when estimating NEIs.

**An engineering-based approach is warranted to estimate NEIs**. The data mining results suggest that we may be able to utilize the standardized formulas developed through the 2012 C&I NEI Retrofit study as a basis for many NEI computations. DNV GL's engineers can use measure descriptions, TRMs, and data provided by existing C&I market characterization studies to construct sets of scenarios for examining operational cost and revenue changes that may result from energy efficient equipment relative to standard efficiency measures. Engineers can then use their expertise in conjunction with the available data to construct estimates of these cost and revenue changes for each measure category.

**(Optional) Various individuals may be able to serve on a Delphi panel to provide valuable information regarding NEI estimates, and to ensure their soundness.** The approach outlined in this document does not recommend the added expense of a Delphi panel to verify estimates from the Engineering review; however, if additional validation of engineering based estimates is required, the Delphi panel approach outlined this document would allow estimates to be reviewed and refined by a panel of experts will help validate assumptions made during the estimation process and provide stakeholders with added confidence that NEI results are consistent with observed values. Once engineering-based

NEIs estimates were derived, DNV GL could construct research instruments that clearly define the scenarios, and the cost and revenue parameters used to construct them. This would provide respondents with a frame of reference for assessing whether the estimates were reasonable or should be adjusted. Panel participants could include national and local engineering firms, representatives of public agencies who oversee capital investments in public buildings, and large institutional customers. DNV GL identified this as an optional research task that is not essential for providing estimates, but the proposed scope of work does not include the Delphi panel.

**A limited survey effort may be suitable to select measures**. The approach outlined in this document does not recommend using self-reports to estimate NEIs for new construction measures, because such an approach would not yield reliable estimates for most measures. However, an approach similar to the 2012 C&I NEI Retrofit study could be used for the following measures, with the noted limitations:

- Natural replacement – Facility managers are able to estimate NEIs associated with natural replacement measures, making these measures a suitable candidate for a self-report approach. However, only one of the PAs distinguishes natural replacement measures in its tracking data. Because NEIs associated with some natural replacement measures were included in the 2012 C&I NEI Retrofit study, including these measures in the current study would require re-visiting estimates from the previous study.
- Industrial process measures – Measures installed at industrial facilities are most suitable for a self-report/in-depth interview approach. These investments are typically custom measures. Facility managers have intimate knowledge of their operations and the impact various technologies have on them. However, self-reported results are unlikely to result in improved benefits over the engineering-based approach outlined above, as the sample size is likely to be small.

Consequently, DNV GL does not recommend a separate survey estimate for these two groups of measures.

## 1.4 STAGE 2 PLAN

The proposed Stage 2 methodology consists of the following research tasks. Each of these tasks is discussed in detail in section 6 of this report:

1. Project management and working group
2. In-depth interview and Delphi-panel recruitment sample selection
3. In-depth interview and Delphi-panel recruitment guide development
4. In-depth interview administration
5. Analysis of existing data and scenario analysis
6. Engineering review – detailed methodology
7. Estimation of NEIs
8. Reporting.

*Optional expansion scope* – DNV GL could conduct a parallel study to obtain self-reported NEI information from industrial customers only. This option would require an additional interview effort similar to the process employed by the 2012 C&I NEI Retrofit study.

# 2. INTRODUCTION

DNV GL and Tetra Tech (the Evaluation Team) were engaged by the Massachusetts Program Administrators (PAs) and the Energy Efficiency Advisory Council (EEAC) to quantify participant non-energy impacts (NEIs) associated with the 2013 Commercial and Industrial (C&I) New Construction program. This report presents the results of Stage 1 of our analysis—which consisted of researching and examining appropriate methods—and describes the detailed research plan for quantifying NEIs in Stage 2.

## 2.1 STUDY APPROACH

The New Construction (NC) program is administered by the Massachusetts PAs for both electric and gas measures. It provides incentives and technical services to C&I customers that are building new facilities, undergoing major renovations of an existing facility, or replacing failed equipment (natural replacement measures).

In order to quantify the NEIs associated with this program in 2013, the Evaluation Team first reviewed the methodology used in a related study that examined NEIs associated with the 2012 C&I Retrofit program (2012 C&I NEI Retrofit study).[2] This prior study used the following approach:

- The Evaluation Team conducted a series of in-depth interviews with program participants. Respondents provided detailed information concerning the cost and revenue changes that resulted from installing program-rebated measures relative to their experience with the previously installed technologies.
- This information was used to compute the change in costs and sales/production impacts that resulted from the installed measures. For example, many lighting measures resulted in time saved from not replacing bulbs due to the extended bulb life, so we used data on the number of hours saved and average wages to compute NEIs.
- NEIs associated with natural replacement measures were adjusted to reflect only NEIs associated with the measure being energy efficient, and excluded NEIs associated with the measure being new (since any alternative technology would also be new).

The Evaluation Team considered using the same approach for the 2013 C&I New Construction study, but ultimately decided to conduct this study in two stages. The two-stage approach was selected due to uncertainty regarding respondents' ability to conceptualize cost and revenue changes associated with program-rebated measures relative to a hypothetical scenario using non-efficient technologies.

[2] Final Report – Commercial and Industrial Non-Energy Impacts Study. Prepared for the Massachusetts Program Administrators and EEAC Consultants. Prepared by DNV GL. June 29, 2012.

For NC measures, the issue of NEIs resulting from a measure being new versus being energy efficient is of particular interest, since some type of new equipment would have been installed regardless of participation in an energy efficiency program. Therefore, only NEIs associated with moving from a standard piece of new equipment to an energy efficient piece of equipment are relevant. With the exception of natural replacement measures, NC measures are typically installed at entirely new facilities or existing facilities that have undergone major renovation (true new construction). Natural replacement measures face a similar challenge: NEIs associated with the measure being new is not applicable since the measure was going to be replaced anyway. This adds complexity to the estimation of NEIs for these measures, since there is often no pre-existing point of comparison to gauge the difference between operating costs and/or sales for the two levels of energy efficiency.

Consequently, the primary concern in estimating NEIs associated with NC measures is whether and how respondents are able to gauge the change in cost and revenues relative to standard efficiency measures. Our revised work plan established a two-stage research effort to address this concern. In Stage 1, the Evaluation Team obtained information from a range of market actors to answer the following research questions:

- Can self-reports effectively identify NEI information for NC measures?
- What is the appropriate respondent group(s) for providing the required information?
- How do potential respondents conceptualize and articulate NEI estimates relative to baseline (standard efficiency) measures?
- What is the most effective line of questioning to elicit accurate responses?
- Are non-survey techniques, such as use of a Delphi panel or engineering estimates, more appropriate for estimating NEIs associated with NC measures?[3]

Our methodology for the Stage 1 research is detailed in section 4 of this report, and our findings are presented in section 5. Section 6 of this document presents our detailed work plan for Stage 2 of this analysis, which reflects lessons learned from Stage 1 research.

## 2.2 EVALUATION OBJECTIVES

The Evaluation Team identified the following objectives for this study:

**Stage 1 objectives**

- Review NC measures installed during 2013 to define these measures in terms of (1) types of new construction and (2) measure category/end use

[3] A Delphi panel is a process in which a panel of experts is recruited and given repeated rounds of a survey to review and advise on the accuracy of information presented to them. After each round, the data are analyzed and then reported back to the panel to allow them to provide further recommendations to the estimates that were revised based on their responses from the previous round of interviews.

- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses through in-depth interviews (IDIs) from various marker actors
- Determine whether NEIs from new construction measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi panel, or other techniques
- Recommend an approach for the Stage 2 analysis.

**Stage 2 objectives**

- Employ the techniques identified through Stage 1 to establish baseline conditions for NEIs associated with true NC measures (i.e., excluding replace on failure and upstream measures).
- Apply techniques identified through Stage 1 to quantify NEIs for C&I true new construction projects completed in 2013. NEIs include any positive or negative effects beyond energy savings that are attributable to energy efficiency programs. Examples of positive NEIs include reduced labor or non-labor operations and maintenance (O&M) costs, and increased sales. Negative NEIs include increased labor or O&M costs, or reduced productivity or sales. We will estimate gross NEIs per unit of energy savings resulting from new construction electric and gas measures separately.

# 3. BACKGROUND AND PRELIMINARY RESEARCH

Estimating NEIs requires information concerning changes to the participant's costs (e.g., operations and maintenance, waste management, or administration costs), production output, or revenues resulting from the installed measure.

In the 2012 C&I NEI Retrofit study, the baseline conditions for natural replacement measures were determined by identifying the costs and revenues prior to the replacement of the non-energy efficient equipment. Interviewed respondents were able to use their experience prior to the installation of the incentivized measure as a frame of reference for cost or revenue changes to assess the NEIs. However, only cost and revenue changes associated with equipment being energy efficient (not being new) were relevant. Thus, the NEI value should reflect the incremental difference in costs or benefits of the new energy efficient equipment relative to new standard efficiency equipment; this can be difficult for participants to conceptualize and self-report for a number of reasons.

First, in the case of a new facility, there was not a pre-existing structure that participants could use as a reference point to compare cost and revenue changes. While some of the existing literature suggested using experience at a different facility as a point of comparison, there may be many dissimilarities between operations at the new facility and other facilities for which respondents do not account. In the case of a major retrofit, it is not appropriate to compare current operations to the previous facility because the renovated facilities are often so drastically altered that the pre-renovated facility does not offer a valid point of comparison. For natural replacement measures, participants may have similar difficulty identifying an appropriate comparison point that only accounts for the NEIs associated with the equipment being energy efficient (not "new").

Therefore, for all types of NC projects—natural replacement, major renovation, and new construction—a key challenge for deriving NEI estimates is the ability of end-users to conceptualize changes relative to the counterfactual baseline if asked in an interview. Determining how best to overcome this challenge was the primary focus of the Stage 1 research.

As a preliminary research activity, the Evaluation Team conducted a literature review to determine if existing NEI research could provide a suitable approach to estimate baseline conditions to isolate NEIs. The studies reviewed by the Evaluation Team are listed below. These studies employed a range of survey techniques that included direct query, conjoint analysis, market actor interviews, and on-site visits. They also used a range of techniques to establish the baseline conditions, which included comparing the installed technology to building codes, standard efficiency measures, or the respondent's previous experience in other facilities with standard efficiency measures.

**NYSERDA 2004**[4]

- Approach – Used the direct query method (asked program participants, contractors, architects, and engineers to assign a value to each NEI in terms of percentage of the project's estimated energy savings), and collected data to estimate NEIs through in-person interviews, focus groups, mail and telephone surveys, field observations, and site visits.
- NEI categories – Maintenance costs, equipment performance, tenant satisfaction, tenant comfort, building aesthetics/appearance, noise levels, lighting/quality of light, building safety, environmental effects, equipment lifetime, ability of tenants to stay in their units.
- Baseline for NEIs – On-site interviews with building owners. For the Small Commercial Lighting Program (SCLP), the study also used the ASHRAE 90.1 1989 standard and minimum efficiency levels required by the National Appliance Energy Conservation Act (NAECA).

**Barkett et al. 2006**[5]

- Approach – Combination of (1) the direct query method of C&I program participants and non-participants and (2) a conjoint analysis approach, which gave respondents hypothetical situations of products from which to choose.
- NEI categories – Lighting quality, thermal comfort and HVAC effectiveness, occupant productivity, noise levels, doing good for the environment, O&M costs, indoor air quality, ease of selling/leasing.
- Baseline for NEIs – Asked the respondent to compare their old and new buildings and/or similar buildings in the area just meeting levels required by the State Energy Code.

**Bemont and Skumatz 2007**[6]

- Approach – Interviews with a random sample of developers, owners, architects, engineers, vendors, participants, and non-participants. Asked participants whether they were aware of NEIs that were read from a list of pre-defined NEI choices.
- NEI categories – Equipment performance, productivity, tenant satisfaction, comfort, appearance, quality of light, building safety, noise, equipment lifetime, sick days.

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[4] New York Energy Smart Program Evaluation and Status Report. 2004. *New York Energy Smart Program Evaluation and Status Report, Volume 2.* Report to the Systems Benefit Charge Advisory Group.

[5] Brent Barkett, Nicole Wobus, Rachel Freeman, Daniel Violette, Scott Dimetrosky. 2006. *Non-Energy Impacts (NEI) Evaluation.* Prepared for the New York State Energy Research and Development Authority. Prepared by Smith Blue Consulting & Quantec, LLC.

[6] Dawn Bemont & Lisa Skumatz. 2007. *New Non-Energy Benefits (NEBs) results in the commercial / industrial sectors: Findings from incentive, retrofit, and technical assistance /new construction programs.* ECEEE 2007 Summer Study, *Skumatz Economic Research Association.*

- Baselines for NEIs – Standard efficiency equipment.

**Bicknell and Skumatz 2004**[7]

- Approach – Computer-assisted telephone interviewing (CATI) surveys and in-depth interviews with owners, developers, architects, and engineers. The owners/occupants and facility managers were asked about NEI valuations based on their experience, whereas specifiers/decision makers were asked about their perceptions of the NEIs and perceptions of the value to owners.
- NEI categories – Maintenance costs, equipment performance, tenant satisfaction, tenant comfort, building aesthetics/appearance, noise levels, lighting/quality of light, building safety, environmental effects/benefits, equipment lifetime, ability of tenants to stay in unit.
- Baseline for NEIs – Not specifically stated.

**Mills et al. 2005**[8]

- Approach – Compared NEIs on new construction commissioning to existing building commissioning, and reviewed Lawrence Berkeley National Laboratory (LBNL) publications and project files.
- NEI categories – Reduced change orders, safety impacts, O&M costs.
- Baseline for NEIs – Review of literature.

Our review of these studies provided limited methodological guidance in developing baseline conditions for the present study beyond those used in the 2012 C&I NEI Retrofit study. While each study used various techniques to address baseline conditions, the Evaluation Team did not find that any of them convincingly overcame the challenge of establishing baseline conditions.

Our concerns with the reviewed studies include the following:

- The research pointed to the need to contrast the installed measures to standard efficiency equipment; however, a number of studies used ASHRAE or local building codes to establish baseline conditions, not standard equipment.

[7] Charles Bicknell & Lisa Skumatz. 2004. *Non-Energy Benefits (NEBs) in the Commercial Sector: Results from Hundreds of Buildings.* ACEEE Proceedings 2004, Skumatz Economic Research Association.

[8] Evan Mills, Norman Bourassa, Mary Ann Piette, Hannah Friedman, Tudi Haasl, Tehesia Powell, and David Claridge. 2005. *The Cost-Effectiveness of Commissioning New and Existing Commercial Buildings.* National Conference on Building Commissioning: May 4-6, 2005. Prepared by the Lawrence Berkeley National Laboratory, Portland Energy Conservation Inc., and Texas A&M University.

- The studies did not necessarily capture the full range of cost and revenue changes that may result from the efficient measures.
- Barkett et al. (2006) separated projects into types based on whether or not the new construction replaced a similar building at a different location. It did not distinguish NC measures at a more refined level. The Evaluation Team believed measures should be further separated into the following categories based on distinctions made by the PAs in administering their NC programs: new building, major retrofit, and natural replacement.

We concluded that none of the previous studies offered a single approach that would be appropriate for estimating NEIs associated with the variety of measures covered by the Massachusetts NC program. As such, we proceeded with the Stage 1 research to identify one or more approaches for estimating NEIs associated with the 2013 NC program.

# 4. STAGE 1 METHODOLOGY

## 4.1 TASKS

The Evaluation Team conducted five major tasks to complete Stage 1 of this project:

- *Data mining* – DNV GL analyzed the 2013 program tracking data and the 2012 C&I NEI Retrofit study results to support the remaining tasks in the Stage 1 research.
- *Sample development* – We used information from the data mining task to identify sample of interviewees from the following groups:
- PA staff who market the NC programs
- Design firms (engineers and architects)
- Manufacturers and suppliers of energy efficient technologies
- Energy managers and operations groups of large institutional participant (e.g., large customers with multiple facilities such as college campuses government offices, or manufacturing facilities).
- *Development of in-depth interview guides* – We drafted separate in-depth interview guides for each of the four groups mentioned in task 2 to determine the appropriate means of establishing baseline conditions.
- *In-depth interviews* – We conducted 54 interviews with various market actors to determine the most effective means of obtaining NEI information for new construction measures.
- *Reporting* – We drafted a report summarizing Stage 1 research and presenting a detailed work plan for Stage 2 research.

Below we describe the methodology used for tasks 1 through 4.

## 4.2 DATA MINING

The primary goal of the data mining activity was to provide useful information to support task 2, sample development. As part of this task, DNV GL analyzed the 2013 program tracking data and the 2012 C&I NEI Retrofit study. This analysis consisted of three sub-tasks:

- Review the measure descriptions and 2013 participating customer data to categorize the population of NC measures based on project type (natural replacement, major retrofit, or new building). Unfortunately, only Eversource provided data that allowed for distinction of the three project types. While National Grid reports that it also has a data field that isolates true new construction from replace on failure, neither utility (Eversource nor National Grid) expressed confidence in the reporting of these fields. DNV GL determined that a first step in an NC NEI study would be to leverage the Dodge Players database and tax records to identify projects that are likely “true” NC. In addition, where possible, we identified projects associated with downstream and upstream programs.

- Identify potential sources for NEIs based on data from 2012 C&I NEI Retrofit study. First, we identified the measure types (e.g., compressed air, hot water) in the 2013 NC program tracking data that matched measure types from the 2012 C&I NEI Retrofit study. For each of these measure types, we identified the "NEI sources" (e.g., O&M or labor savings) associated with that measure type that were quantified in the 2012 C&I NEI Retrofit Study using standardized formulas that captured common parameters associated with the cost and revenue changes resulting from the installed measures. This analysis was intended to inform Stage 1 interviews and forthcoming Stage 2 research.
- Identify sample of respondents for conducting Stage 1 in-depth interviews that consisted of the following groups of respondents:
- Design firms (engineers and architects)
- Manufacturers and suppliers of energy efficient technologies
- Energy managers and operations groups of large institutional participants.

## 4.3 SAMPLE DEVELOPMENT

We used information provided by the data mining exercise to inform the sample selection for the in-depth interviews. The following table shows the interviews specified in the work plan compared to the number of interviews completed.

**Table 4-1. Survey Dispositions**

| Category | Work Plan | Completed | Notes |
|---|---|---|---|
| PA staff | 7 | 6 | The 6 PAs were represented by 17 separate respondents |
| Design firms | 15 | 14 | Completes included some contractors |
| Equipment suppliers and manufacturers | 15 | 15 | Completes included some distributors |
| Institutional customers | 20 | 19 | Completes included some "non-institutional" customers |

The following describes the process used to select respondents for each of these groups.

**PA staff** (6 interviews). For this study, DNV GL interviewed a census of NC program marketing staff, as provided by the PAs.

**Design firms** (14 interviews). The Evaluation Team identified those firms responsible for the greatest tracked savings impact in the program tracking data for both electricity and natural gas savings. Each of the selected firms installed measures in the top 25 percent of tracked savings for either electric or gas NC measures, and had an associated engineering firm/implementation contractor. We identified 92 unique vendors who installed 1,312 NC measures that met these criteria. Table 4-2 provides a detailed breakdown of the measures installed by firms included in the sample frame. DNV GL selected vendors based on PA,

project type, and measure type in order to identify how to measure NC NEIs across different measures.

**Table 4-2. Frequency of Measures installed by Selected Vendors**

| PA | Fuel Type of Installed Measures | Project Track | End Use | Number of Measures Installed |
|---|---|---|---|---|
| Berkshire Gas | Gas | Custom | Custom Measures | 2 |
| Cape Light Compact | Electric | Prescriptive | Lighting | 107 |
| National Grid | Gas | Custom | Custom Measures | 19 |
| National Grid | Gas | Custom | HVAC | 17 |
| National Grid | Gas | Custom | Other | 8 |
| NSTAR | Electric | Custom | Custom Measures | 97 |
| NSTAR | Electric | Custom | HVAC | 4 |
| NSTAR | Electric | Prescriptive | Compressed Air | 47 |
| NSTAR | Electric | Prescriptive | HVAC | 201 |
| NSTAR | Electric | Prescriptive | Lighting | 640 |
| NSTAR | Electric | Prescriptive | Motors/Drives | 17 |
| NSTAR | Electric | Prescriptive | Refrigeration | 1 |
| NSTAR | Gas | Custom | Custom Measures | 3 |
| NSTAR | Gas | Prescriptive | HVAC | 5 |
| NSTAR | Gas | Prescriptive | Hot Water | 2 |
| Unitil | Electric | Custom | Custom Measures | 1 |
| WMECO | Electric | Custom | Custom Measures | 56 |
| WMECO | Electric | Prescriptive | Compressed Air | 46 |
| WMECO | Electric | Prescriptive | HVAC | 36 |
| WMECO | Gas | Custom | Custom Measures | 3 |
| **Total** | | | | **1312** |

**Equipment suppliers and manufacturers** (15 interviews). DNV GL identified that there was insufficient information regarding manufacturers and suppliers of energy efficient technology in the program tracking data to create a sample frame for these interviews. While "manufacturer name" was provided for some measures within some PA data, this did not provide enough information to plan and conduct interviews. Instead, we relied on snowball sampling, asking architectural firms, contractors, and institutional customer energy managers for manufacturer and supplier contact information. When we reached manufacturer or supplier representatives, we asked for additional contact information for other manufacturer or supplier representatives.

**Institutional customers** (19 interviews). DNV GL identified all municipal buildings, schools, hospitals, and universities in the 2013 C&I program tracking database, based on building type provided by the PAs. We identified 65 unique institutions that completed NC projects during the program year. In addition, we identified 23 heavy industrial customers in order to collect information on compressed air measures. This was the only building type with this measure. Combined, these 65 institutions represented 26 percent of all measures installed during 2013, as well as 26 percent of the tracked savings.

Table 4-3 provides a detailed breakdown of the number of institutional customers for each PA and building type. Table 4-4 shows the number of measures installed by the selected institutional customers.

**Table 4-3. Number of Institutional Customers by PA and Building Type**

| PA | Building Type | Number of Customers |
|---|---|---|
| Berkshire Gas | Education | 1 |
| Berkshire Gas | Public Assembly | 1 |
| National Grid | Hospital | 2 |
| National Grid | K-12 Schools | 15 |
| National Grid | University | 8 |
| NSTAR | Heavy Industrial | 9 |
| NSTAR | Hospital | 5 |
| NSTAR | K-12 Schools | 14 |
| NSTAR | Public Assembly | 2 |
| NSTAR | University | 11 |
| Unitil | Heavy Industrial | 2 |
| WMECO | Community College | 1 |
| WMECO | Heavy Industrial | 12 |
| WMECO | Hospital | 1 |
| WMECO | K-12 Schools | 3 |
| WMECO | University | 1 |
| **Total** | | **88** |

**Table 4-4. Number of Measures Installed by Selected Institutional Customers**

| PA | Fuel Type of Installed Measures | Building Type | End Use | Number of Measures Installed |
|---|---|---|---|---|
| Berkshire Gas | Gas | Education | Custom Measures | 1 |
| Berkshire Gas | Gas | Education | HVAC | 2 |
| Berkshire Gas | Gas | Education | Hot Water | 2 |
| Berkshire Gas | Gas | Healthcare | HVAC | 2 |
| Berkshire Gas | Gas | Healthcare | Hot Water | 2 |
| Berkshire Gas | Gas | Public Assembly | Custom Measures | 1 |
| Berkshire Gas | Gas | Public Assembly | HVAC | 1 |
| National Grid | Gas | Hospital | Custom Measures | 5 |
| National Grid | Gas | K-12 Schools | Custom Measures | 3 |
| National Grid | Gas | K-12 Schools | HVAC | 12 |
| National Grid | Gas | K-12 Schools | Other | 6 |
| National Grid | Gas | University | Custom Measures | 9 |
| National Grid | Gas | University | HVAC | 3 |
| NSTAR | Electric | Heavy Industrial | Compressed Air | 7 |
| NSTAR | Electric | Heavy Industrial | Custom Measures | 6 |
| NSTAR | Electric | Hospital | Custom Measures | 1 |
| NSTAR | Electric | Hospital | HVAC | 12 |
| NSTAR | Electric | Hospital | Lighting | 14 |
| NSTAR | Electric | Hospital | Refrigeration | 2 |

| PA | Fuel Type of Installed Measures | Building Type | End Use | Number of Measures Installed |
|---|---|---|---|---|
| NSTAR | Electric | K-12 Schools | Custom Measures | 5 |
| NSTAR | Electric | K-12 Schools | HVAC | 21 |
| NSTAR | Electric | K-12 Schools | Hot Water | 3 |
| NSTAR | Electric | K-12 Schools | Lighting | 65 |
| NSTAR | Electric | Public Assembly | Custom Measures | 2 |
| NSTAR | Electric | Public Assembly | HVAC | 5 |
| NSTAR | Electric | Public Assembly | Lighting | 38 |
| NSTAR | Electric | University | Custom Measures | 16 |
| NSTAR | Electric | University | HVAC | 50 |
| NSTAR | Electric | University | Lighting | 109 |
| NSTAR | Electric | University | Refrigeration | 3 |
| NSTAR | Gas | Heavy Industrial | Custom Measures | 3 |
| NSTAR | Gas | Hospital | Custom Measures | 3 |
| NSTAR | Gas | K-12 Schools | Custom Measures | 2 |
| NSTAR | Gas | K-12 Schools | HVAC | 3 |
| NSTAR | Gas | K-12 Schools | Hot Water | 3 |
| NSTAR | Gas | K-12 Schools | Motors/Drives | 1 |
| NSTAR | Gas | University | Custom Measures | 6 |
| NSTAR | Gas | University | HVAC | 4 |
| NSTAR | Gas | University | Lighting | 53 |
| NSTAR | Gas | University | Motors/Drives | 16 |
| Unitil | Electric | Heavy Industrial | Custom Measures | 2 |
| WMECO | Electric | Community College | HVAC | 30 |
| WMECO | Electric | Heavy Industrial | Compressed Air | 16 |
| WMECO | Electric | Heavy Industrial | Custom Measures | 17 |
| WMECO | Electric | Heavy Industrial | Lighting | 9 |
| WMECO | Electric | Hospital | Custom Measures | 6 |
| WMECO | Electric | Hospital | HVAC | 4 |
| WMECO | Electric | Hospital | Lighting | 2 |
| WMECO | Electric | K-12 Schools | Custom Measures | 8 |
| WMECO | Electric | K-12 Schools | HVAC | 6 |
| WMECO | Electric | K-12 Schools | Lighting | 2 |
| WMECO | Electric | University | Custom Measures | 2 |
| **Total** | | | | **606** |

As with the design firm/contractor interviews, DNV GL selected institutional customers to provide coverage by PA, measure type, and building type in order to identify how we might gauge new construction NEIs across those different measure and building types.

## 4.4 IN-DEPTH INTERVIEW GUIDE DEVELOPMENT

DNV GL drafted separate in-depth interview guides for each of the four groups (PA staff, design firms, equipment suppliers and manufacturers, and institutional customers) to determine appropriate means of establishing baseline conditions. Below we describe the in-depth interview guides for each Stage 1 market actor group.

### 4.4.1 PA staff

DNV GL solicited information from these individuals to help determine the “selling points” of NC measures aside from energy efficiency. Internal sales staff were asked how they communicate the value proposition of NC measures for energy savings and non-energy impacts. Specifically, they were asked about their experience with customers’ ability to contrast the energy efficient technology to standard efficiency technology, and how this is

different for each type of new construction measure. Respondents were asked the following types of questions:

- Describe the marketing process of the NC program.
- What are the key selling points of energy efficient measures aside from energy savings?
- When communicating energy savings of the energy efficient equipment, what messaging do you use to help customers relate the efficient equipment to alternative equipment?
- What are customers using for a basis of comparison? Operations at other facilities, or the same facility? Previous employment?
- Why do different types of customers chose energy efficient measures apart from energy efficiency? Do they communicate these reasons?
- Do customers communicate issues with operations and maintenance, waste disposal, administrative costs, permitting, low sales, productivity?
- How do responses to these questions vary for natural replacement, new buildings, or major retrofits?
- Who is best able to communicate these differences?

### 4.4.2 Design firms (engineers and architects)

Similar to the PA interviews, DNV GL solicited information from these individuals to help determine the "selling points" of NC measures aside from energy efficiency when marketing measures directly to end users. Questions for this group were similar to those asked of the PA staff, but we focused the interview on obtaining the following information:

- What are the "selling points" for energy efficient measures, relative to standard efficiency?
- How do these firms view the customer's ability to contrast their operating costs using the energy efficient technology to what they would have been assuming standard efficiency?

### 4.4.3 Suppliers and manufacturers

DNV GL interviewed a sample of manufacturers and distributors to identify the key selling points for energy efficient equipment, and challenges they face in communicating these benefits to vendors and customers. Specifically, we explored how suppliers related the advantages of energy efficient equipment to those received from standard efficiency technologies. Respondents were asked the following types of questions:

- What are the major selling points of energy efficient equipment, apart from energy efficiency in NC projects?

- Do you use improvements to operations and maintenance, waste disposal, administrative costs, permitting, low sales, and productivity in your messaging? How so?
- How do you communicate those benefits to customers and contractors using the equipment in new construction?
- What are you using for a point of comparison?
- How does this messaging differ when talking to engineers/architects versus building managers/owners?
- How does it differ when the equipment is being used for natural replacement, new buildings, or major retrofits?

### 4.4.4 Institutional customers

We used information from these interviews to provide a best-case scenario for a respondent's ability to articulate operational changes resulting from energy efficient measures relative to standard efficiency measures, and how measure and project type influences the ability to respond. We regarded NC program participants with multiple points of contact with the program as being most likely to be able to provide insights into a respondent's ability to conceptualize NEI baseline information. These individuals were likely to have experience managing operations at facilities with similar design features and different investment cycles. Respondents were asked the following types of questions:

- What benefits did they expect from NC measures?
- How does it differ when the equipment is being used for natural replacement, new buildings, or major retrofits?
- Who informed them that those benefits might occur? What messaging did they use to communicate them?
- Did they experience any of those benefits?
- How do they know? What are they using as a point of comparison?
- What were the motivations for investing in energy efficient technologies?

# 5. STAGE 1 RESULTS

## 5.1 DATA MINING RESULTS

This section reports results of the Evaluation Team's data mining exercise to identify potential sources of NEIs resulting from NC measures. Table 5-1, Table 5-2, and Table 5-3 show a mapping of all measure types in the 2013 New Construction program tracking data to measure types from the 2012 C&I NEI Retrofit study. For each of these measure types, we identified the "NEI sources" associated with that measure type that were quantified in the 2012 C&I NEI Retrofit Study using standardized formulas. The tables show the measure types and the formulas used to quantify NEIs.

A review of the tables demonstrates that the potential sources of NEIs for all of the measure groups (except CHP and comprehensive design measures) are identical, with the same six sources/formulas identified by respondents. When respondents attempted to calculate NEIs for their measures, responses fell into either O&M or administrative labor savings. Within these groups, respondents typically estimated the difference in material or labor costs associated with moving to the new, energy efficient equipment. There were some indications that equipment performance, tenant satisfaction, tenant comfort, improvements to building aesthetics/appearance, noise levels, lighting/quality of light, building safety, environmental effects, and equipment lifetime all affected the reported NEIs, but we found no standard formulas/methods respondents used to quantify these effects.

Due to data limitations, we were unable to separate NC measures by project type (new construction vs. major renovation or natural replacement) for the majority of the PAs. Exploring this differentiation in detail was a goal of the in-depth interviews.

## Table 5-1. Sources of NEIs by Measure Category

| Measure Category | NEI Source |
|---|---|
| Building shell | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |
| CHP | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| Comprehensive design | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| Compressed air | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |
| Hot water | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |

## Table 5-2. Sources of NEIs by Measure Category, Continued

| Measure Category | NEI Source |
|---|---|
| HVAC | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |
| Lighting | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |
| Motors/drives | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |
| Other | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |

**Table 5-3. Sources of NEIs by Measure Category, Continued**

| Measure Category | NEI Source |
|---|---|
| Process | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |
| Refrigeration | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly loaded wage |
| | (Administrative hours required for old equipment - Administrative hours required for new equipment) x Hourly unloaded wage x Loading factor |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly loaded wage |
| | (Maintenance hours required for old equipment - Maintenance hours required for new equipment) x Hourly unloaded wage x Loading Factor |
| | (Number of parts required for old equipment - Number of parts required for new equipment) x Cost of parts |
| | (Number of maintenance activities per year for old equipment - Number of maintenance activities per year for new equipment) x Cost of maintenance activity |

## 5.2 IN-DEPTH INTERVIEW RESULTS

DNV GL completed in-depth interviews with 17 PA staff members at 6 PAs, 14 design firms, 15 suppliers and manufacturers of energy efficient technology, and 19 institutional customers. The section describes the results of our interviews. First we present interview findings related to the overall program, then findings organized by measure categories (e.g., lighting, HVAC, etc.).

### 5.2.1 New Construction program overview

Table 5-4 characterizes the New Construction program as it is carried out at each PA, according to statements by PA staff during our interviews. This includes the portion of the program that falls into each measure category. The measure categories are as follows:

- True new construction, which refers to new buildings and major renovation projects.
- Natural replacement, which is defined differently by the PAs. However, it generally refers to equipment that is replaced at the end of its useful service life and which—for baseline purposes—is compared to standard efficiency new equipment rather than the equipment it is replacing.
- Upstream lighting – Upstream lighting incentives are managed by a working group of PA staff, for which Rich Boehler is the chair. The majority of upstream rebates go to small/medium-sized companies, including restaurants, retail, and small office. This is true statewide. PAs primarily market upstream incentives to distributors, with limited marketing to customers (e.g., brochures). The distributors do most of the direct marketing to customers. Upstream rebates are paid to distributors and manufacturer representatives in approximately the following proportions:

- 30 percent counter sales
- 5 percent online
- 65 percent distributors or manufacturers' reps.

**Table 5-4. PA New Construction Considerations Based on In-depth Interview Results**

| PA | Major Renovation and New Buildings | Upstream Lighting | Natural Replacement | Notes |
|---|---|---|---|---|
| NSTAR | 33% | 27% | 40% | Focused on new buildings and major renovation. Retrofit consists only of those projects implemented only for efficiency reasons, and where the equipment has not passed its program-defined end of useful life.<br><br>For true new construction, with larger projects they get involved early on and participate in the design process. For smaller projects they are less involved, but pay a higher percentage of the modeling costs. |
| National Grid | 5% | 70% | 25% | New construction is defined as past the EUL if still in service. A bit squishier on custom.<br><br>Under National Grid, large account reps keep regular contact with large accounts, both related to billing and energy efficiency. National Grid contracts with a variety of subcontractors to implement various programs. One of the major points of this call was to get contact information for individuals at these third parties, as well as in the marketing and sales groups.<br><br>Their true new construction program has been struggling, but they have plans and staff set up to make major improvements this year, and they expect it to grow as a percent of savings. |
| Unitil | 5% | 10% | 85% | HVAC = new construction with exceptions. Required = new construction. Desired = retrofit. Most lighting is retrofit. Some retrofit projects do not pass cost/benefit, so are done as part of new construction.<br><br>Their program is divided up between the 30 largest customers and everyone else. The top 30 have account reps. For the rest, they pull permits for them and make calls occasionally. The top 30 make up 90 percent of electric and 50 percent of gas savings. |
| Liberty | - | - | 100% | New construction is defined as past the EUL if still in service. They shift projects from retrofit to new construction if incremental cost justification is not there. Replace on burnout is not common for participants. It would be low-attribution.<br><br>They have 25 customers, which are key accounts, who they interact with regularly. The rest of the customers come to them. |
| Cape Light | 45% | 45% | 10% | Qualitative responses – percentages estimated. New Construction vs. Retrofit based on whether the equipment is still functioning, or if it is past its useful life. They do a lot more retrofit work than natural replacement because of the direct install programs. |

The following sections provide general findings regarding the awareness and prevalence of NEIs in different measure categories.

### 5.2.2 Lighting

From an engineering perspective, the most quantifiable NEIs for lighting result from bulbs that last longer due to LED technology or lighting controls. Simple math allows us to estimate these savings using standard labor rates for replacement, and reliable customer/contractor estimates for the time it takes to replace light bulbs. Because the 2012 C&I NEI Retrofit study showed increased productivity and sales due to better-quality lighting, we can use the results of that study to help estimate NEIs for certain sectors and certain lighting products. NEIs that are harder to estimate include increased safety and decreased insurance rates. Further complicating lighting NEI calculations is the rapid adoption of LEDs by many sectors for some applications. The Massachusetts LED Market Effects Baseline study (ongoing) will provide the necessary data to quantify the extent of baseline creep and its influence on NEIs.

### 5.2.3 HVAC & refrigeration controls

HVAC and refrigeration (HVAC&R) controls present a significant challenge in quantifying NEIs through self-reports. Due to the complexity and variety of options for control systems, the counterfactual conditions for control systems are very difficult for respondents to conceptualize. Control options are often site-specific, and owners are not likely to be aware of the range of options possible for a given scenario because it is difficult to estimate the impact of a change from baseline to efficient equipment for most NEI types. In specific sectors—such as retail, for which the baseline condition often does not include centralized HVAC&R controls—we can research estimates for issues such as food spoilage and equipment repair costs and frequency. For most other sectors, projects fall under a custom baseline approach, which makes NEI estimation nearly impossible.

### 5.2.4 Cooling

With a few exceptions, NEIs from cooling are neutral or negative as one moves from less to more efficient equipment. This is because more efficient equipment generally requires additional maintenance, as there are often more controls, a larger number of moving parts, and the use of water- instead of air-cooled systems, which require additional water, wastewater, and cooling tower maintenance costs. Further, market actors often disagree on customer behavior and equipment reliability, which makes producing accurate estimates more difficult. However, some cooling equipment manufacturers interviewed claimed to have life cycle costing software, which may prove helpful to the Stage 2 study by providing non-energy related cost parameters.

The interviews revealed that where NEIs associated with HVAC/cooling measures were present, they were typically identified by engineering firms during the design phase. For large institutional customers, operational cost differences for various technology options were often analyzed by specialized HVAC staff. For public sector projects, organizations such as the Division of Capital Asset Management and Maintenance (DCAMM) track operational costs

associated with different investments, as institutions are required to pay back investment money through cost savings or revenue increases.

### 5.2.5 Heating

Similar to cooling, NEIs resulting from more efficient equipment are generally negative or neutral, especially with regard to condensing heat exchangers, as the equipment also requires greater maintenance. Transitions from one type of equipment to another are less common than with cooling, except for oil-gas or steam-hydronic transitions, which usually fall under the retrofit program. Estimating NEIs for heating measures is relatively simple from an engineering perspective, but—again like cooling—this depends on accuracy and agreement between market actor responses. One confounding factor is that the most knowledgeable respondents were manufacturers' representatives, most of which had a particular agenda to push. For large institutional customers, operational cost differences for various technology options were often analyzed by specialized HVAC staff. For public sector projects, organizations such as DCAMM track operational costs associated with different investments, as institutions are required to pay back investment money through cost savings or revenue increases.

### 5.2.6 Industrial process

Industrial process measures fall in a different category from an NEI perspective. Because many measures are industry-specific, sometimes even customer-specific, estimating NEIs across the sector is challenging as each project contains a unique set of operational cost changes specific to the facility in which measures were installed. Most large industrial projects are custom, and NEIs should be estimated on a project-by-project basis. Another difference is that industrial respondents seemed quite capable of quantifying NEIs for their plants, since it usually falls in the category of increased manufacturing output. For the two most common industrial process systems, compressed air and steam, NEIs vary dramatically. Very few NEIs exist for compressed air as the efficiency level does not impact operational costs, while respondents reported substantial NEIs for steam measures. Industrial customers were able to identify NEIs for installed measures, as plant engineers frequently had years of experience across multiple facilities and performed detailed analysis of process changes. It may be possible to obtain NEI information from this group through in-depth interviews; however, the relatively small population may limit the ability to provide statistically significant results.

### 5.2.7 Whole building

Designers frequently referenced projects involving whole buildings, while customers did not. Like industrial process measures, whole building NEIs are highly project-specific. However, also like industrial process, they are often quantifiable—at least in some areas. The reason for this is that most whole building projects often seek LEED certification, which requires the designer to submit information about water and wastewater savings. In addition, some studies suggest that workers perform better and stores sell more in LEED buildings due to the better environmental quality in the space.

### 5.2.8 Other

Most discussion about measures not covered by the previous categories related to water savings. Ironically, this makes the NEIs associated with many of the "other" category measures easiest to quantify.

### 5.2.9 Suggested approaches for quantifying NEIs by measure type

Table 5-5 through Table 5-11 provide suggested approaches for quantifying NEIs for each measure type category discussed above. The tables also summarize NEIs suggested by interview respondents, and provide relevant sources and considerations. The different suggested approaches for quantifying NEIs include:

- In-depth interviews: Conduct a round of in-depth interviews with public officials and their representatives and key market actors identified through the Stage 1 interviews to obtain information regarding important project parameters necessary to construct scenarios for estimating NEIs associated with different measure categories.
- Engineering approach: Based on the available New Construction program tracking data, project descriptions from the Dodge Players database, and information provided by existing studies, construct common project descriptions for a range of measure categories/end uses. Using information from the 2102 C&I NEI Retrofit study, TRMs, and in-depth interview results, use DNV-GL engineering staff to estimate facility cost and revenue changes that may result from the installed measures relative to standard efficiency measures.
- Delphi panel review (optional): Use respondents recruited through the Stage 2 in-depth interviews to construct a panel of experts who agree to serve as a respondent pool for a two-round survey effort. Each round of this effort will present respondents with project descriptions and NEI estimates and ask them to provide feedback. Subsequent rounds will use data from previous rounds to refine the estimates.

**Table 5-5. Summary of NEIs Associated with Lighting Measures, Suggested Approaches, and Other Considerations**

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| • Labor-savings come from LEDs and controls reducing bulb replacements, and productivity, and student learning increases.<br>• LEDs show significant O&M savings due to the longer life of LED bulbs. This is especially true of hard-to-reach locations.<br>• LED replacements are more expensive because they require replacement of the entire fixture.<br>• LEDs produce a better light quality, and may lead to increased productivity, sales, and student learning. The lack of infrared and ultraviolet radiation has benefits for food sales and museums.<br>• Some respondents report increased real-estate value for LED-lit buildings. | **Engineering approach:** Results from the 2012 retrofit study contain data about the cost difference for replacing light bulbs. Reducing these costs provides the primary source for lighting NEIs. Studies on productivity and sales numbers can provide NEI estimates for some sectors. Our lighting market analysis for project 27 can provide the baseline. Further research on LED and lighting control measure lives may be warranted.<br>**Survey (alternative approach)**: Customers and contractors seem quite capable of estimating the amount of time it takes to replace light bulbs and can report on their experiences with LEDs and controls in terms of longevity. Survey results could confirm or modify our engineering approach results. | **Sources**: For lighting, anyone who changes light bulbs could answer questions about NEIs for lighting. This includes both contractors and customers. For NEIs associated with real estate values, productivity, sales, and student learning, studies are publicly available.<br>**Considerations**: Labor savings are easy to quantify using labor rates. Sales and productivity can be quantified for select sectors. Other areas are more squishy and difficult to quantify. |

**Table 5-6. Summary of NEIs Associated with Controls for HVAC&R Measures, Suggested Approaches, and Other Considerations**

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| A wide variety of NEIs accrue to this category, all of which seem justified and significant. They include food spoilage, ease of maintenance, improved equipment life, and occupant comfort.<br>• Remote access to data on refrigerated vaccines, which prevents CDC visits for pharmacies and groceries, and increased comfort.<br>• Accurate monitoring of refrigerated food storage, which prevents spoilage and food poisoning claims.<br>• Technicians can find problems more quickly.<br>• Better air quality can improve sales.<br>• Centralized EMS systems can add security and fire protection with shared wires, saving money.<br>• Better-tuned controls can lead to longer equipment cycle times, which decreases maintenance and increases longevity. Varying airflow (DCV) based on outside air temperature will increase filter changes but reduce wear and tear on the compressor.<br>• For sites where people would otherwise have to walk around shutting units off and turning them on, there is labor savings.<br>• Complex control systems require a higher paid level of contractor. | **Engineering approach**: For some sectors in which centralized controls are not the baseline, we could estimate the NEIs associated with adding these controls based on research and some directed expert interviews.<br>**Supplemental survey (optional)**: Customers who have installed centralized controls could help us understand whether reduced or increased labor is more likely to result from specific controls decisions. | **Sources:** Manufacturers' representatives proved to be the most knowledgeable about NEIs in this area, though they certainly have a bias. Some designers and university operations people were also quite knowledgeable.<br>**Considerations**: Baseline for centralized EMS-style controls is almost impossible to determine.<br><br>For sectors where centralized controls are common, the baseline is nearly impossible to determine except on a project-by-project basis. The differing cultures of different maintenance staffs further confounds this issue. For custom projects, estimating NEIs could become a part of the design package, which customers may appreciate having. |

**Table 5-7. Summary of NEIs Associated with Cooling Measures, Suggested Approaches, and Other Considerations**

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| Most NEIs for cooling are neutral or negative, with a few exceptions. More efficient types of equipment usually take more maintenance. VRF, air-cooled chillers, and GSHPs are the exceptions.<br>• Movement between equipment types happens sometimes. Some PAs avoid trying to persuade people to move from one equipment type to another, but others do this regularly. The most common shifts are from RTU to chiller or from an air-cooled to a water-cooled chiller.<br>• Maintenance rank (most to least): WC chiller, RTU, VRF simultaneous, AC chiller / VRF cool-only, water source HP.<br>• Most said that more complex equipment requires more maintenance and a more expensive maintenance person, though others disagreed with this. However, everyone agreed that water-cooled chillers are high-maintenance, at least in the short term. This also varies by brand.<br>• New technology requires staff training.<br>• A high-end HVAC system can reduce mold.<br>• VFDs extend the life of equipment by reducing cycle times and startup stress.<br>• RTUs: Energy recovery wheels take additional maintenance. Galvanized heat exchangers only last 10-12 years, and controls only 5-6 years before failure. Complex compressors take more maintenance, depending on staging and | **Engineering approach review**: Certain design engineers and manufacturers' representatives have a great deal of knowledge and experience with a wide variety of system types. We using an engineering review to produce estimates. | **Sources:** Designers and manufacturers' representatives were by far the most knowledgeable about cooling measure NEIs. A couple of customers also seemed to have sufficient experience to contribute useful information.<br>**Considerations**: NEIs related to heating and cooling are mostly simple to quantify, though getting agreement between market actors on the magnitude of NEIs is difficult. |

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| whether they have alternating lead-lag (share the load).<br>• Screw chillers (60k hr. maint. cycle) are lower maintenance than centrifugal (15-20k hrs.) or scroll chillers.<br>• More efficient water-cooled chillers can have water savings over less efficient, which leads to less water treatment and staff time. Respondents disagree on the significance of this NEI. | | |

**Table 5-8. Summary of NEIs Associated with Heating Measures, Suggested Approaches, and Other Considerations**

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| Most NEIs for NC heating measures are neutral or negative. Condensing heat exchangers cause increased maintenance and a shorter life in most cases. Some other features can decrease maintenance, but when it is required, maintenance is more difficult due to their proprietary nature. On large steam and CHP systems, NEIs can be significant in both the positive and negative direction, depending.<br>• Maintenance rank (highest to lowest): Steam boiler, RTU, condensing boiler, heat pump, non-condensing boiler.<br>• High efficiency equipment generally takes more maintenance and higher-paid maintenance (some disagreed with this).<br>• Serviceability is important. Those designed to use few parts and standard off-the-shelf parts are easier to maintain. O2 sensors and condensing heat exchangers are usually proprietary, thus harder to maintain.<br>• A number of manufacturers claim features specific to their products that reduce maintenance or make maintenance easier to perform.<br>• Some respondents claim that most customers run their systems until they break, and do not do maintenance (especially schools). Others suggested that most customers are now performing annual or seasonal maintenance.<br>• According to one respondent, a high efficiency condensing boiler will see a flameout and require emergency maintenance at 2-3 years, where a non-condensing boiler could go 4-5 | **Engineering approach**: Certain design engineers and manufacturers' representatives have a great deal of knowledge and experience with a wide variety of system types. We suggest using an engineering review to produce estimates. | **Sources:** Designers and manufacturers' representatives were by far the most knowledgeable about cooling measure NEIs. A couple of customers also seemed to have sufficient experience to contribute useful information.<br>**Considerations**: NEIs related to heating and cooling are mostly simple to quantify, though getting agreement between market actors on the magnitude of NEIs is difficult. |

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| years.<br>• VFDs and O2 sensors could theoretically reduce maintenance frequency but this is not verified by experience.<br>• The primary cause of increased or decreased maintenance is the suitability of the equipment to the existing system, plumbing, and mechanical room. Features are secondary concerns.<br>• On steam plants, energy efficient technology can save on chemicals, pumping costs, and water usage.<br>• External labor cost on CHP projects is high, as there are increased maintenance costs. One respondent reported needing to have a firefighter on site 24/7. | | |

**Table 5-9. Summary of NEIs Associated with Industrial Measures, Suggested Approaches, and Other Considerations**

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| • Compressed air systems have very few and very small amounts of NEIs. Steam system and boiler improvements can have significant NEIs. VFDs can reduce motor maintenance. Most other industrial improvements are so project-specific as to be difficult to generalize.<br>• Steam trap repair can prevent problems with equipment going down, which can save a lot of time and money. This is also true for hospitals. Steam trap maintenance can save condensate (which saves on water treatment) and prevent steam leaks from causing damage and distracting workers.<br>• Compressed air storage tanks and flow controllers are motivated by the program, and can save upfront cost. These are the only compressor system NEIs, other than pressure reduction, which could theoretically cause less stress on the compressor.<br>• Boilers with higher-efficiency burners can produce more reliable steam pressures, which can make high-tolerance processes have less waste. They also often run better at the low end, which prevents thermal stress. Boiler cycling is reduced through proper sizing, which the program can motivate.<br>• Dry back fire tube boilers will need less refractory repair (5 yrs. vs 3).<br>• A VFD can prevent pump start/stop, helping the life of the pump. | **Engineering approach**: For compressed air and steam systems, we could estimate the NEIs associated with adding these controls based on research and some directed expert interviews.<br>**Supplemental survey (optional)**: If the program chose to require NEI analysis as part of custom industrial projects, a follow-up survey and analysis effort could attempt to take these results and make templates for similar projects in the future, lessening the ongoing burden of project-specific NEI estimating. | **Sources:** For industrial measures, customers were usually able to quantify NEIs for their measure installations. This surprised us when compared to every other measure category. For specific measure types, manufacturers' representatives often had additional useful information.<br>**Considerations**: NEIs for compressed air and steam systems, and motors would be highly variable but perhaps quantifiable in general terms. Custom process improvements would be impossible to generalize about, though customers may be able to do so for specific projects.<br>For custom projects, estimating NEIs could become a part of the design package, which customers may appreciate having. |

**Table 5-10. Summary of NEIs Associated with Whole Building and Other Measures, Suggested Approaches, and Other Considerations**

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| • Whole building NEIs in some sense add up to the combination of NEIs for other measures. However, there is some evidence for improved productivity, sales, and student learning in LEED buildings.<br>• Water and sewer savings are the easiest to quantify.<br>• $CO_2$ and chemical-usage reductions are sometimes quantified.<br>• Increased occupancy comfort and improved lighting quality are well known LEED benefits.<br>• Some buildings may be "over engineered," adding components such as flow monitoring stations that can fall out of calibration and require maintenance.<br>• Displacement ventilation has many fewer working parts and so reduces maintenance cost.<br>• Life cycle costing analysis always includes maintenance impacts. These tend to be highly customer-specific and depend on staff culture.<br>• The benefit of being perceived as a green company always comes up.<br>• Maintenance savings often comes from placing equipment so they can access it.<br>• LEED buildings often include green roof projects, which can either increase or decrease maintenance depending on how it is used. Other green roof benefits also exist, but are harder to quantify. | **Engineering approach**: Engineers with experience doing life cycle costing analyses could potentially produce per-square-foot estimates for certain building sectors. | **Sources:** For whole buildings, designers who deal with LEED and life cycle costing projects are the most likely to be able to quantify NEIs.<br>**Considerations**: There are firms that specialize in life cycle costing for LEED buildings, which could provide whole-building NEIs in some areas. This would be highly project-specific, though some items could be generalized. |

**Table 5-11. Summary of NEIs associated with other measures, suggested approaches, and other considerations**

| Suggested NEIs | Suggested Approaches | Sources and Considerations |
|---|---|---|
| As it happens, most "other" measures involve water savings from spray valves and hotel/Laundromat improvements:<br>• Water savings for pre-rinse spray valves.<br>• Water savings. This is a talking point, primarily for gas customers.<br>• Water savings and reduced detergent use for Laundromats. Systems can do more loads per hour and increase production.<br>• Hotels like the "green" reputation, which their guests appreciate. There may be studies to indicate how much income this generates. | **Engineering approach**: For the water-saving measures mentioned by respondents, engineers could easily produce NEI estimates. | **Sources:** For the water savings measures identified by the survey, information is publicly available and not much could be added by market actors. For other measures that come up during the study, we will have to treat them individually.<br>**Considerations**: Water savings from these measures are easy to quantify. |

## 5.3 STAGE 1 CONCLUSIONS

The Stage 1 research provided the following conclusions.

**The analysis of NEIs associated with new construction measures should focus on true new construction only.** While the PAs currently classify true new construction (i.e., major renovation and new buildings), replace on failure, and 100 percent of upstream measures as new construction, the Evaluation Team concluded that the Stage 2 research should focus on true NC at this time. DNV GL will employ the technique outlined in Section 6 to isolate true NC measures from the 2013 program tracking information.

**Self-reports by end users would not provide an effective means for estimating NEIs associated with most new construction measures.** Facility managers reported that if NEIs were assessed on new construction projects, they were typically determined by design engineers during the project or facility design phase. This was particularly true of heating and cooling measures.

**Self-reports by engineering firms will provide valuable insights to estimating NEIs across the range of projects for which they perform engineering services.** Engineering firms responsible for the design process often make recommendations concerning the operational cost and production impacts resulting from various equipment options. These firms can provide valuable information concerning the existence and magnitude of NEIs. However, the 2012 C&I Retrofit NEI study demonstrated that obtaining NEIs directly from self-reported interview responses required conducting a lengthy and intricate in-depth interview. Attempting such an interview with engineering firms is likely to result in incomplete interview responses, as such firms represent a challenging group with which to maintain lengthy phone interviews. Further, respondents' ability to recall decisions on individual projects may be limited. Given engineering firms' breadth of knowledge across multiple projects, however, we believe it will be valuable to conduct in-depth interviews with this group to gather information regarding key parameters to consider, and scenarios for which those factors may vary when estimating NEIs.

**An engineering-based approach is warranted to estimate NEIs**. The data mining results suggest that we may be able to utilize the standardized formulas developed through the 2012 C&I NEI Retrofit study as a basis for many NEI computations. DNV GL's engineers can use measure descriptions, TRMs, and data provided by existing C&I market characterization studies to construct sets of scenarios for examining operational cost and revenue changes that may result from energy efficient equipment relative to standard efficiency measures. Engineers can then use their expertise in conjunction with the available data to construct estimates of these cost and revenue changes for each measure category.

**(Optional) Various individuals may be able to serve on a Delphi panel to provide valuable information regarding NEI estimates, and to ensure their soundness.** The approach outlined in this document does not recommend the added expense of a Delphi panel to verify estimates from the Engineering review; however, if additional validation of engineering based estimates is required, the Delphi panel approach outlined this document would allow estimates to be reviewed and refined by a panel of experts will help validate assumptions made during the estimation process and provide stakeholders with added confidence that NEI results are consistent with observed values. Once engineering-based

NEIs estimates were derived, DNV GL could construct research instruments that clearly define the scenarios, and the cost and revenue parameters used to construct them. This would provide respondents with a frame of reference for assessing whether the estimates were reasonable or should be adjusted. Panel participants could include national and local engineering firms, representatives of public agencies who oversee capital investments in public buildings, and large institutional customers. DNV GL identified this as an optional research task that is not essential for providing estimates, but the proposed scope of work does not include the Delphi panel.

**A limited survey effort may be suitable to select measures**. The approach outlined in this document does not recommend using self-reports to estimate NEIs for new construction measures, because such an approach would not yield reliable estimates for most measures. However, an approach similar to the 2012 C&I NEI Retrofit study could be used for the following measures, with the noted limitations:

- Natural replacement – Facility managers are able to estimate NEIs associated with natural replacement measures, making these measures a suitable candidate for a self-report approach. However, only one of the PAs distinguishes natural replacement measures in its tracking data. Because NEIs associated with some natural replacement measures were included in the 2012 C&I NEI Retrofit study, including these measures in the current study would require re-visiting estimates from the previous study.
- Industrial process measures – Measures installed at industrial facilities are most suitable for a self-report/in-depth interview approach. These investments are typically custom measures. Facility managers have intimate knowledge of their operations and the impact various technologies have on them. However, self-reported results are unlikely to result in improved benefits over the engineering-based approach outlined above, as the sample size is likely to be small.

Consequently, DNV GL does not recommend a separate survey estimate for these two groups of measures.

# 6. STAGE 2 RESEARCH PLAN

Based on the findings of Stage 1, we have developed the following proposed methodology for Stage 2 of the C&I New Construction NEI study. Section 6.1 provides an overview of the recommended approach. Section 6.2 presents detailed plans for each task, and Section 6.3 discusses the project budget and timeline.

## 6.1 OVERVIEW OF RESEARCH PLAN

The proposed methodology consists of the following research tasks. Each of these tasks is discussed in detail in the sections that follow:

1. Project management and working group
2. In-depth interview sample selection
3. In-depth interview guide development
4. In-depth interview administration
5. Analysis of existing data and scenario analysis
6. Engineering review – detailed methodology
7. Estimation of NEIs
8. Reporting.

## 6.2 DETAILED PLANS

### 6.2.1 Task 1: Project Management and Working Group

The Evaluation Team will work closely with the PAs and EEAC staff to develop a final work plan for estimating gross NEIs. The Evaluation Team's NEI evaluation project will also hold regular meetings with the lead representatives from each of the PAs, the EEAC, and the Evaluation Team to review the following:

- Completed and upcoming research activities
- Key decisions or variations from the research plan
- Upcoming deliverables and review periods
- Budgetary and scheduling updates and concerns
- Methodological issues, including determining how to calculate the "baseline" for NC measures.

We will provide biweekly status updates detailing the project progress, deliverables completed, and upcoming activities.

### 6.2.2 Task 2: In-Depth Interview Sample Selection

The Stage 1 in-depth interviews identified a number of key players who are knowledgeable about the NEIs associated with NC measures. Below we identify the types of individuals identified through Stage 1, and discuss our proposed plan for interviewing these individuals.

1. National Engineering Firms – The Stage 1 in-depth interviews identified a number of large national engineering firms that provide specialized services to new construction projects. In addition to facility design work, these firms assist property owners and developers in making decisions concerning the relative tradeoffs among options for energy-consuming equipment such as operational cost savings and increased revenues. We will interview representatives from national engineering firms who specialize in large construction projects to obtain information concerning the necessary parameters for estimating NEIs. (5 interviews)

2. Local Engineering Firms – Stage 1 interviews with facility managers of institutional customers revealed that operational cost and production tradeoffs for alternative equipment choices are often reviewed by engineers during the project development stage. We will interview a select group of design engineers who have extensive involvement with measures installed through the New Construction program to obtain information concerning the necessary parameters for estimating NEIs. (10 interviews)

3. Facility Manager for Large Institutional Customers – Many of the facility managers interviewed during Stage 1 were able to provide valuable information regarding the cost and revenue changes resulting from the energy efficiency measures installed. While the Stage 1 interviews showed that even this group of highly knowledgeable property owners would have difficulty estimating NEIs for the range of new construction measures, they are knowledgeable of the types of changes that may result and factors that are important for estimating those changes. Therefore, we will conduct Stage 2 interviews with facility managers to obtain information concerning the necessary parameters for estimating NEIs. (10 interviews)

4. Public Officials and Representatives – Our interviews with colleges, universities, and other public-sector facilities identified a number of key organizations that oversee costs and benefits associated with publicly funded projects. For example, the Division of Capital Asset Management and Maintenance is responsible for overseeing all projects that receive public funding. Further, community colleges in the state retain a single firm who is responsible for benchmarking operational costs for all represented institutions in the state and contrasting costs resulting from various facility investments. Therefore, we will conduct Stage 2 interviews with representatives from public agencies and their affiliates to obtain information concerning the necessary parameters for estimating NEIs. (5 interviews)

Task 2 Deliverables – DNV GL will provide a draft and final sample section memo. The draft memo will outline the proposed types of individuals that DNV GL will target for the interviews and the types of new information we are looking to obtain. We will request that the PAs provide any contact information they may have in this effort. The final memo will document the groups of individuals we targeted after receiving input from the PAs and EEAC consultants.

### 6.2.3 Task 3: In-Depth Interview Guide Development

We will develop separate in-depth interview guides for each of the groups mentioned in Task 2. These interviews will seek to obtain the following information:

- What benefits or costs do they see from energy efficient equipment on new construction projects?
- How do these differ depending upon whether the project is natural replacement, a new building, or a major renovation?
- What are the important technical, structural, and other parameters for determining whether these benefits are present?
- What sources of information can be used to provide estimates for these parameters?

Task 3 Deliverables – DNV GL will provide draft and final interview guides for each interview group.

### 6.2.4 Task 4: In-Depth Interview Administration

DNV GL will use senior level staff and/or engineering experts to conduct 60 interviews with key players.

Task 4 Deliverables – DNV GL will report on interview progress during monthly working group calls. The results of these interviews will be documented in subsequent task deliverables.

### 6.2.5 Task 5: Analysis of Existing Data and Scenario Analysis

This task consists of two subtasks. Through Task 5.1, we will distinguish “true NC” measures from replace on failure measures. Then, through Task 5.2, we will construct scenarios for developing engineering-based NEI estimates for up to 20 measure categories. Each of these subtasks is discussed in detail below.

*A. Task 5.1. – Identify True New Construction Measures*

To identify true new construction measures, DNV GL will merge the 2013 NC program tracking data for all downstream measures with the following two sets of information:

- **The 2013 Massachusetts Tax Assessors Data** – This dataset contains data reporting the “year build” for all parcels within the Commonwealth. This data is already available through the C&I Customer Profile Database project, which is being conducted under the existing C&I evaluation contract. We will use this information to provide a first pass at identifying new structures.
- **The Dodge Players Database** – PAs have access to the 2013 Dodge Players database through work being performed on the New Construction Customer Profile project, which is being conducted under the existing C&I evaluation contract. This database contains information on all known new construction and major renovation projects in the Commonwealth. DNV GL will merge these data to the 2013 NC program tracking data by address to identify any additional projects that can be classified as true new construction.

- We will assume that tracking records are true new construction if they appear in either the 2013 tax assessors dataset with a year build of 2012-2013, or if they appear in the Dodge Players database. All other records will be coded as replace on failure.

### *B. Task 5.2. – Scenario Analysis*

The second subtask involves reviewing existing data sources (presented below) to construct scenarios for NEI estimates by measure category or end use. DNV GL reviewed the savings reported in the downstream NC program tracking data to identify 20 measure categories/end uses and their corresponding savings. We excluded measures identified as replace on failure from this analysis. These results are shown in Table 6-1.

**Table 6-1. 2013 New Construction Measure Categories/End Uses and Reported Savings**

| End Use/Measure Category | 2013 Gross Annual Gas Savings (Therms) | 2013 Gross Annual Gas Savings (Therms) |
|---|---|---|
| 1. Compressed Air (Contains some Chiller | 8,561,957 | |
| Custom Measures | | |
| 2. Comprehensive Design | 7,341,514 | 2,092,627 |
| 3. Compressed | 1,631,434 | - |
| 4. HVAC | 7,255,992 | 6,697 |
| 5. Lighting | 13,804,990 | |
| 6. Motors | 55,625 | |
| 7. Other (Hot Water, Process, Motors) | 15,678 | |
| 8. Process | 7,683,762 | 9,407 |
| 9. Refrigeration | 2,176,423 | |
| 10. Food Service | 46,834 | 113,606 |
| 11. Hot Water | 821 | 154,086 |
| HVAC | | |
| 12. Boilers/Heaters/Furnaces | - | 618,566 |
| 13. Chillers | 1,947,805 | |
| 14. Packaged, split systems, economizers | 1,651,032 | |
| 15. EMS/Controls | 1,394,229 | |
| 16. Other HVAC | 3,106,067 | 77 |
| 17. Lighting | 12,074,008 | |
| 18. Motors/Drives | 6,048,649 | |
| 19. Other | 453,625 | 4,480 |
| 20. Refrigeration | 3,602,766 | |
| **Grand Total** | **78,853,211** | **2,999,546** |

DNV GL will select a sample of measures from the 2013 tracking data as a starting point for this analysis. Measures will be selected by measure category or end use proportional to the amount of savings each contributes to overall savings of the respective category. Table 6-2 provides an example of the sample of measures we will use to construct scenarios for the engineering review. Measures will also be stratified by prescriptive and custom, electric and gas measures. The sample of measures will be further defined in Task 5.

**Table 6-2. Preliminary Sample of Measures for Scenario Development of Engineering Review**

| Category | Relative Precisions (Proportion/ Ratio Estimation) | | | Total Sample Accounts | POP Accounts | Pop BTU Savings | Percent Pop kWh |
|---|---|---|---|---|---|---|---|
| Compressed Air | 24% | / | 35% | 25 | 344 | 29,497,819,649 | 3% |
| Custom Measures | 31% | / | 44% | 26 | 570 | 542,987,845,520 | 54% |
| Food Service | 21% | / | 30% | 28 | 198 | 11,583,510,344 | 1% |
| HVAC | 41% | / | 58% | 27 | 1,758 | 135,291,455,563 | 13% |
| Hot Water | 26% | / | 37% | 27 | 414 | 8,503,795,579 | 1% |
| Lighting | 29% | / | 42% | 40 | 2,722 | 221,535,405,563 | 22% |
| Motors/Drives | 21% | | 30% | 25 | 233 | 26,828,705,860 | 3% |
| Other | 3% | / | 5% | 18 | 25 | 24,751,050,120 | 2% |
| Refrigeration | 12% | | 17% | 20 | 50 | 13,800,761,552 | 1% |
| Total | 18% | / | 26% | 236 | 6,314 | 1,014,780,349,751 | 100% |

Once we select the sample of measures, we will use information in this sample to identify specific measures installed and project descriptions. Next, we will link projects to data provided by the 2013 Dodge Players database, which DNV GL obtained through work being conducted under the C&I contract. The Dodge Players database will provide project-specific information that may facilitate NEI estimation. In addition, we will leverage the following existing C&I market characterization research to obtain information important for estimating NEIs:

- Commercial New Construction Customer Quantitative Profile Market Characterization (June 2011)
- Customer Profile Project (June 2013)
- New Construction Market Characterization (ongoing)
- 2013 C&I Customer Profile (final report forthcoming)
- Dodge Players database
- Massachusetts Existing Building Market Characterization (October 2014)
- Massachusetts Existing Building Market Characterization On-Site Study (final report forthcoming)
- US Census County Business Patterns data
- Massachusetts Tax Assessors data.

Based on this information, we will construct a series of scenarios for engineers to construct estimates of NEIs. These scenarios will provide engineers with a range of measure types to construct NEIs for a particular measure category or end use. They will also provide engineers with important parameters for determining the operational and other cost savings that may result from the energy efficient measure relative to standard efficiency, such as building type/industry and wage information. For example, parameters could include:

- Lighting measures:

- Interior installations of LEDs or T-8 fixtures in high bay (auditorium) settings versus standard ceiling heights that do not require equipment
- Exterior installations
- Union versus non-union labor.

- Cooling equipment
  - Replacement of air cooled systems with water-cooled systems
  - Replacement of standard efficiency water-cooled systems with energy efficient water-cooled systems
  - Number of square feet cooled
  - Industry (grocery, office, other).

Task 5 Deliverables – DNV GL will summarize the scenarios for each measure category or end use in a draft and final memo.

### 6.2.6 Task 6: Engineering Review – Detailed Methodology

DNV GL will review the available data to construct NEI estimates for the scenarios developed through Task 5. We will review measure descriptions, TRMs, in-depth interview results, and the available data to construct estimates for each measure category or end use required. This task will include a thorough review of alternative equipment and their potential impact on operations and maintenance costs and production changes under the scenarios defined in Task 5. This task will consist of the following steps:

- Identify the necessary cost and revenue metrics from the available data based on the standard formulas provided by the 2012 C&I NEI Retrofit study and other research for each respective measure category or end use
- Obtain estimates of these parameters from the available data discussed in Task 5
- Assume technical parameters for installed measures and standard efficiency measures based on the sample of NC measures
- Apply metrics to standard formulas identified through the 2012 C&I NEI Retrofit study and other identified sources such as TRMs and in-depth interviews and scenarios defined in Task 5
- Estimate range of NEI estimates for each measure category or end use
- Compute weighted estimates based on the proportion of savings in the measure category represented by the specific measures represented by each scenario.

Task 6 Deliverables – DNV GL will prepare an Excel file that computes NEIs for each measure category or end use under the different scenarios identified in Task 5.

### 6.2.7 Task 7: Estimation of Final NEIs

DNV GL will refine NEI estimates based on review by the PAs and EEAC Consultants. This task will consist of summarizing the approach and the NEI estimates to meet the PAs'

reporting deadlines prior to the final report that will provide a more comprehensive review of the project.

Task 7 Deliverables – This task will produce draft and final memos that summarize the engineering approach and present the NEI estimates.

### 6.2.8 Task 8: Reporting – Detailed Methodology

This task consists of documenting the methodology and findings from the Stage 2 research to the PAs and EEAC consultants.

Task 8 Deliverables – DNV GL will provide a draft and final report documenting our objectives, approach, and findings.

### 6.2.9 Optional scope expansion

*Delphi Panel Option*

DNV GL could conduct a Delphi panel to review estimates provides by the engineering review. However, we do not recommend this added expense at this time. The Delphi method is a widely accepted technique for achieving convergence of opinion from experts within certain topic areas, developed by the Rand Corporation in the 1950s. The literature on this method identifies several objectives for which the Delphi technique may be used. Two of these objectives are important to this study:[9]

- Seek out information that may generate a consensus on the part of the respondent group
- Explore or expose underlying assumptions or information leading to different judgments.

In order to validate the findings, we could include conducting a Delphi panel as an optional task to verify and adjust the engineering-based estimates. If the PAs and EEAC consultants chose to employ this optional task, we would engage a panel of experts to estimate sources and levels of NEIs associated with the different types of NC measures. This engagement would occur in two rounds:

- Round 1 – Provide experts with an open-ended questionnaire, soliciting specific information regarding sources of NEIs and levels associated with different measure types and project types (new building vs. major renovation or natural replacement). Create a structured questionnaire based on the responses to send back out the expert panel in round 2.
- Round 2 – A questionnaire developed in round 1 is sent to the panelists. Each panelist will be asked to agree or disagree with the opinions of the other panelists and provide reasoning for their agreement/disagreement as to the sources and levels

[9] Hsu, C.-C., & Sandford, B. A. (2007). The Delphi Technique: Making Sense of Consensus. *Practical Assessment, Research & Evaluation*, 1-8.

of new construction NEIs. A final set of consensus and minority opinions will be distributed for comment.

Completion of the Delphi process will require approximately eight weeks, assuming a 4-week period to recruit the participants and design the open-ended questionnaire, 2 weeks for panelist responses during each round, and 1 week for data aggregation following each round.

*Survey Option*

DNV GL could conduct a parallel study to obtain self-reported NEI information from industrial customers only. This option would require an additional interview effort similar to the process employed by the 2012 C&I NEI Retrofit study.

## 6.3 BUDGET AND TIMELINE

### 6.3.1 Preliminary budget

Table 6-3 presents the proposed revised budget for this preliminary work plan. This revised budget differs from the previous budget in the following ways:

1. We reduced the number of IDIs and total measure categories for the engineering analysis.
2. We removed the items related to the Delphi panel from all tasks.
3. We added some budget to Task 5 (Analysis of Existing Data and Scenario Analysis) in order to merge the PA tracking and Dodge data and identify true new construction measures.

**Table 6-3. Preliminary budget**

| Task | Milestone | DNV GL | Tetra Tech | Total |
|---|---|---|---|---|
| **Task 1 – Project management and Working Group** | | | | |
| | Finalize work plan | $ 11,329 | $ 2,778 | $ 14,107 |
| | Monthly working group meetings and project management | $ 60,626 | $ 28,735 | $ 89,361 |
| **Task Total** | | **$ 71,955** | **$ 31,514** | **$ 103,469** |
| **Task 2 – In-Depth Interview Sample Selection** | | | | |
| | Compile lists of contacts | $ 9,650 | $ 1,085 | $ 10,735 |
| | Draft sample Memo | $ 4,558 | $ 830 | $ 5,388 |
| | Final Sample Memo | $ 3,346 | $ 769 | $ 4,115 |
| **Task Total** | | **$ 17,554** | **$ 2,684** | **$ 20,238** |
| **Task 3 –In-Depth Interview Guide Development** | | | | |
| | Review NEI and Sample Information | $ 8,521 | $ 1,028 | $ 9,549 |
| | Draft IDI | $ 12,785 | $ 1,241 | $ 14,026 |
| | Final IDI | $ 5,797 | $ 892 | $ 6,689 |
| **Task Total** | | **$ 27,103** | **$ 3,161** | **$ 30,264** |
| **Task 4 – In-Depth Interviews Administration (30 IDIs)** | | | | |
| | Complete 15 IDIs | $ 6,014 | $ 903 | $ 6,917 |
| | Complete 15 IDIs | $ 6,014 | $ 903 | $ 6,917 |
| | Compile IDI Results | $ 6,014 | $ 903 | $ 6,917 |
| **Task Total** | | **$ 18,042** | **$ 2,708** | **$ 20,750** |
| **Task 5 – Analysis of Existing Data and Scenario Analysis** | | | | |
| | Obtain existing tracking, C&I project, Dodge, and other 3rd party data; ID True New Construction | $ 14,673 | $ 1,336 | $ 16,009 |
| | Construct Scenarios for Eng review of NEIs by measure groups | $ 6,977 | $ 951 | $ 7,928 |
| | Construct Excel Template for Eng review with assumption from existing data | $ 7,613 | $ 983 | $ 8,596 |
| **Task Total** | | **$ 29,263** | **$ 3,269** | **$ 32,532** |
| **Task 6 – Engineering Review** | | | | |
| | Construct preliminary estimates for up to 20 measure categories | $ 132,223 | $ 7,213 | $ 139,436 |
| | Construct revised estimates for up to 20 measure categories | $ 27,153 | $ 1,960 | $ 29,113 |
| **Task Total** | | **$ 159,376** | **$ 9,173** | **$ 168,549** |
| **Task 7 – Estimation of Final NEIs** | | | | |
| | Draft results memo | $ 5,761 | $ 890 | $ 6,651 |
| | Final results memo | $ 5,761 | $ 890 | $ 6,651 |
| **Task Total** | | **$ 11,522** | **$ 1,780** | **$ 13,302** |
| **Task 8 – Reporting** | | | | |
| | Draft Report | $ 26,886 | $ 4,144 | $ 31,030 |
| | Final Report | $ 15,814 | $ 3,591 | $ 19,405 |
| **Task Total** | | **$ 42,700** | **$ 7,735** | **$ 50,435** |
| **Total Less Delphi Panel** | | **$ 377,515** | **$ 62,024** | **$ 439,539** |

### 6.3.2 Timeline

Table 6-4 presents the timeline.

**Table 6-4. Timeline**

| Task/Milestone | Jan-14 | Feb-14 | Mar-14 | Apr-14 | May-14 | Jun-14 | Jul-14 | Aug-14 | Sep-14 | Oct-14 |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 |
| **Task 1 – Project management and Working Group** | | | | | | | | | | |
| Finalize work plan | | | D F | | | | | | | |
| Monthly working group meetings and project management | | | | | | | | | | |
| **Task 2 – In-Depth Interview and Delphi-Panel Recruitment Sample Selection** | | | | | | | | | | |
| Compile lists of contacts | | | | | | | | | | |
| Draft sample Memo | | | | | | | | | | |
| Final Sample Memo | | | | | | | | | | |
| **Task 3 –In-Depth Interview and Delphi-Panel Recruitment Guide Development** | | | | | | | | | | |
| Review NEI and Sample Information | | | | | | | | | | |
| Draft IDI | | | | | | | | | | |
| Final IDI | | | | | | | | | | |
| **Task 4 – In-Depth Interviews Administration (30 IDIs)** | | | | | | | | | | |
| Complete 30 IDIs | | | | | | | | | | |
| Compile IDI Results | | | | | | | | | | |
| **Task 5 – Analysis of Existing Data and Scenario Analysis** | | | | | | | | | | |
| Obtain existing tracking, C&I project, and 3rd party data | | | | | | | | | | |
| Construct Scenarios for Eng review of NEIs by measure groups | | | | | | | | | | |
| Construct Excel Template for Eng review with assumption from existing data | | | | | | | | | | |
| **Task 6 – Engineering Review** | | | | | | | | | | |
| Construct preliminary estimates for up to 20 measure categories | | | | | | | | | | |
| Construct revised estimates for up to 20 measure categories | | | | | | | | | | |
| **Task 7 – Estimation of Final NEIs** | | | | | | | | | | |
| Memo with draft results | | | | | | | | D | | |
| Memo with final results | | | | | | | | F | | |
| **Task 8 – Reporting** | | | | | | | | | | |
| Draft Report | | | | | | | | | D | |
| PA and EEAC Consultants Review | | | | | | | | | | |
| Final Report | | | | | | | | | | F |

# APPENDIX A: INTERVIEW GUIDES

All interview guides are included as objects in this document to maintain original formatting. Double-click on each guide to open the full document.

# Program Administrator Interview Guide—C&I NEI New Construction

## Objectives:

This interview guide is written to gather information from PA staff to address the following workplan objectives:

- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses from in-depth interviews (IDI's) from various marker actors;
- Determine whether NEIs from NC measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi-panel, or other techniques;

In light of these objectives, this interview guide sets out to determine:

1. How the NC program is structured and marketed so we can understand who is communicating the non-energy benefits of the EE measures?
2. How the PAs communicate the benefits of the EE measures to customers or vendors they market to?
3. How (and which) manufacturers are marketing non-energy impacts for new construction measures ?
4. Baseline equipment or practice for specific, common measure types and scenarios, both from an energy efficiency and non-energy impact perspective?
5. How much information customers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation? We expect to segment customers by size and market sector.
6. To identify knowledgable vendors who we can interview in the next round of interviews.
7. What to look for, and what questions to follow up on in interviews with other market actors

# Building Designers Interview Guide

# C&I NEI New Construction

## Objectives:

This interview guide is written to gather information from designers to address the following workplan objectives:

- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses from in-depth interviews (IDI's) from various marker actors;
- Determine whether NEIs from NC measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi-panel, or other techniques;

In light of these objectives, this interview guide sets out to determine:

1. How (and which) designers are marketing non-energy impacts for new construction measures ?
2. Baseline equipment or practice for specific, common measure types and scenarios, both from an energy efficiency and non-energy impact perspective?
3. How much information designers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation?
4. How much information customers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation? We expect to segment customers by size and market sector.

## Target Respondent:

Architecture, MEP, and design firms

# Suppliers of Energy Efficient Technologies Interview Guide

# C&I NEI New Construction

## Objectives:

This interview guide is written to gather information from suppliers to address the following workplan objectives:

- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses from in-depth interviews (IDI's) from various marker actors;
- Determine whether NEIs from NC measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi-panel, or other techniques;

In light of these objectives, this interview guide sets out to determine:

1. How (and which) manufacturers are marketing non-energy impacts for new construction measures?
2. How they communicate benefits associated with EE equipment relative to baseline equipment. And how these messages differ between customer types?
3. How much information suppliers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation?
4. How much information customers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation? We expect to segment customers by size and market sector.

# Institutional Customer Interview Guide

# C&I NEI New Construction

## Objectives:

This interview guide is written to gather information from customers to address the following work plan objectives:

- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses from in-depth interviews (IDI's) from various marker actors;
- Determine whether NEIs from NC measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi-panel, or other techniques;

In light of these objectives, this interview guide sets out to determine:

1. How do customers think about non energy considerations when selecting energy using equipment?
2. What is baseline equipment or practice for specific, common measure types and scenarios, both from an energy efficiency and non-energy impact perspective?
3. How much information are customers likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation for a specific project?

## Target Respondent:

Institutional customers, especially those that manage multiple buildings.

# Program Administrator Interview Guide—C&I NEI New Construction

## Objectives:

This interview guide is written to gather information from PA staff to address the following workplan objectives:

- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses from in-depth interviews (IDI's) from various marker actors;
- Determine whether NEIs from NC measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi-panel, or other techniques;

In light of these objectives, this interview guide sets out to determine:

1. How the NC program is structured and marketed so we can understand who is communicating the non-energy benefits of the EE measures?
2. How the PAs communicate the benefits of the EE measures to customers or vendors they market to?
3. How (and which) manufacturers are marketing non-energy impacts for new construction measures ?
4. Baseline equipment or practice for specific, common measure types and scenarios, both from an energy efficiency and non-energy impact perspective?
5. How much information customers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation? We expect to segment customers by size and market sector.
6. To identify knowledgable vendors who we can interview in the next round of interviews.
7. What to look for, and what questions to follow up on in interviews with other market actors

# Building Designers Interview Guide

# C&I NEI New Construction

## Objectives:

This interview guide is written to gather information from designers to address the following workplan objectives:

- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses from in-depth interviews (IDI's) from various marker actors;
- Determine whether NEIs from NC measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi-panel, or other techniques;

In light of these objectives, this interview guide sets out to determine:

1. How (and which) designers are marketing non-energy impacts for new construction measures ?
2. Baseline equipment or practice for specific, common measure types and scenarios, both from an energy efficiency and non-energy impact perspective?
3. How much information designers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation?
4. How much information customers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation? We expect to segment customers by size and market sector.

## Target Respondent:

Architecture, MEP, and design firms

# Suppliers of Energy Efficient Technologies Interview Guide

# C&I NEI New Construction

## Objectives:

This interview guide is written to gather information from suppliers to address the following workplan objectives:

- Assess the effectiveness and most appropriate means of establishing baseline conditions for NEI computations and eliciting self-reported responses from in-depth interviews (IDI's) from various marker actors;
- Determine whether NEIs from NC measures are best estimated from self-reports from participants and/or other market actors, engineering review, Delphi-panel, or other techniques;

In light of these objectives, this interview guide sets out to determine:

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3. How much information suppliers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation?
4. How much information customers are likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation? We expect to segment customers by size and market sector.

# Institutional Customer Interview Guide

# C&I NEI New Construction

## Objectives:

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2. What is baseline equipment or practice for specific, common measure types and scenarios, both from an energy efficiency and non-energy impact perspective?
3. How much information are customers likely to be able to provide about the NEI differences between the standard efficiency installation and the program-rebated installation for a specific project?

## Target Respondent:

Institutional customers, especially those that manage multiple buildings.