

Memo

To: **EEAC Council**
From: **Consultant Team**
Date: **February 15, 2016**
Subject: **Improving Savings Estimates for C&I Custom Projects - DRAFT**

RECOMMENDED PRACTICES FOR ESTABLISHING BASELINES IN CUSTOMER ENERGY EFFICIENCY PROJECTS

The purpose of this memo is to outline considerations and recommended actions that the PAs can take to improve savings estimates in commercial/industrial (C&I) custom energy efficiency projects. Several recent impact evaluation studies of custom measures have identified the potential for the PAs to improve their *ex ante* savings estimates (savings estimates presented to a customer as part of their decision making process, prior to evaluation) to better match actual savings.¹ Improving *ex ante* savings estimates (“savings estimates” for the remainder of this memo) is important for several reasons.

- Savings estimates are used as a basis for customer investment. If estimates are inaccurate (high or low), customers may lose confidence in EE program estimates and could be less likely to invest in projects the future.
- Savings estimates are used as a basis for PA investment. Inaccurate estimates could result in under- or over-investment on the part of the PAs (and therefore ratepayers) to advance measure implementation.
- Inaccurate savings estimates can result in higher projected savings variances between projects, which would require increasing the necessary sample size for EM&V studies to generate accurate realization rates and potentially larger deviations between evaluated and reported gross savings at the measure level.

Improving project level savings estimates will better serve C&I customers and ratepayers while increasing realization rates for custom measures.

Opportunities for improving savings estimates identified in recent impact evaluations² include:

- Improve documentation of baselines and energy savings calculations³
- Verify measure operation through commissioning⁴
- Increase the use of metering during retrofit project development and implementation⁵

¹ While these studies identified program level realization rates within the expected bounds, there was significant variance in savings between reported and evaluated at the project level.

² In progress custom evaluation studies appear to indicate that these trends found in earlier studies may be continuing.

³ 2013 & 2011 Custom Gas Studies, 2012 Custom HVAC Study, 2011 Custom Refrigeration, Motor and Other Installation Study

⁴ 2011 Custom Refrigeration, Motor and Other Installation Study

The custom evaluation findings indicate that there may be actions the PAs can take to help increase the efficiency and consistency of evaluation and to improve savings estimates for customers. Below we describe four areas for consideration, including evaluation findings relating to those areas and recommendations for potential changes based on those evaluation findings. Adoption or enhancement of practices along the lines described below can be expected to decrease savings variances, increase customer benefits, and improve realization rates over time.

PROVIDE SUFFICIENT DOCUMENTATION

When projects are not adequately documented it increases the risk that savings will be counted differently during evaluation for two reasons. First, when analysis method and tools are not provided, the evaluators need to develop the analysis from scratch. The evaluation calculation method may be different than the program method used and may not capture the same conditions used in the undocumented program analysis. Second, when the baseline is not thoroughly documented, the evaluators may not have key information available that was readily at hand when the project was undertaken. Errors in baseline identification can either reduce or increase savings.

- In one recently evaluated retrofit project, evaluators determined that older equipment appeared to be failing and therefore assumed a new construction baseline, which would reduce evaluated savings. After significant follow up effort with Program Implementers, the evaluators were able to verify the retrofit baseline. Better documentation in the project files would have reduced costs for evaluation (including time by evaluators, EEAC consultants, PAs and the customer) and would have decreased the risk of a baseline change in evaluation.
- In another case, a ventilation control measure was found to produce little savings upon evaluation, because baseline ventilation levels were found to be very low, in contrast to a the program assumption of full ventilation. In this case the customer and PAs invested in a measure that did not deliver the expected savings because the pre-installation baseline was not verified.

Detailed project documents increase the consistency of project assumptions from development through evaluation. It also helps ensure that customers and PAs fully understand the project scope, which in turn increases the likelihood that the planned level of efficiency will be obtained.

Recommendation

The PAs should consider adopting a protocol to to enhance and standardize project documentation. This would help ensure consistent and thorough documentation of custom projects statewide.⁶ This protocol should include:

- A project categorization checklist to help ensure that projects are properly categorized as retrofit or new construction from the start
- Documentation of the key parameters that affect the project savings such as actual operating hours, production levels, loads, temperature and humidity, etc.

A project categorization checklist helps protect both the customer and the program from project and baseline mischaracterization. Efficiency Vermont incorporated such a checklist into their screening tool; this resulted in increased realization rates. A common project categorization and baseline establishment checklist for all Massachusetts PAs could help increase net savings from custom projects. Appendix A details the basis for characterizing baselines.

Identifying the key parameters that impact energy savings helps focus the data collection and analysis on the variables with the most impact. Using pre-installation metering to verify and document pre-existing conditions for projects with savings above a threshold value or with highly variable results (e.g., ventilation control measures) will promote accurate characterization of the baseline condition and improved estimates of post installation energy savings.

⁵ Ibid

⁶ The PAs currently employ a “Minimum Requirements Document” which describes the minimum requirements for the post installation condition.

The PAs should require Technical Assistance (TA) Providers to deliver the fully operational modeling files that were used to develop savings estimates as part of the project documentation. The documentation submitted to the PAs should include input files and any custom spreadsheets so that the TA models can be used as a starting point for evaluation. In addition to aiding evaluation, keeping these expensive-to-develop models on file will help ensure they are available for use in analyzing future opportunities at participant facilities.

COMMISSIONING

Both Eversource and National Grid currently include commissioning as a program component for custom projects to verify that installed equipment is performing as intended. Nevertheless, the Custom HVAC, Boiler, and Refrigeration studies found that opportunities remain for the commissioning process to support more accurate savings estimates and better project outcomes. A key finding is that the commissioning scope of work must address all systems with an impact on energy savings, not just those systems that are actively targeted by the project. For example, a project aimed at saving energy by controlling exhaust air fans, and thereby reducing fresh air supply, was found to have minimal savings. Further investigation revealed that because the supply air fans were not considered as part of the project, their operation was not reviewed. A scope of work that tasked an independent third party commissioning provider with verifying the operation of all parts of the system would identify the key variables that determine energy consumption and provide actionable information about how to reduce consumption within the context of the project. In this example, a more complete commissioning scope would have identified that the uncontrolled supply air fans were preventing the realization of savings from the project to control the exhaust air fans.

Recommendation

The PAs should seek to develop commissioning work scopes that tie commissioning directly to the areas of energy savings, not just to the engineered changes. The scope of work should include commissioning design review for larger projects to help ensure the planned project improvement will deliver the expected energy savings. A commissioning design review provides a separate set of eyes that can identify missed opportunities to ensure savings.

The PAs should provide training for commissioning providers in energy efficiency programs and measures. From our experience, there is a range of proficiency among commissioning providers relative to the importance of and opportunity for energy efficiency through high performance sequences of operation for HVAC systems. Providing training followed by the development of minimum performance requirements for commissioning providers will help improve consistency between commissioning providers increasing PA and customer confidence in the service.

INCREASE THE USE OF METERING

Creating a feedback loop that provides M&V as a component of project delivery will increase realization rates, improve engineering estimates over time, and increase customer confidence in energy efficiency as an investment that pays for itself. Con Edison incorporates measurement and verification into program delivery by hiring independent contractors to undertake pre and post installation metering and data collection. These data are used to improve energy savings estimates by ensuring accurate baselines and by verifying performance after installation. The final reported project savings are those based on the post installation meter data. The meter data is provided to evaluators to reduce the cost and the custom impacts of independent evaluation.

Recommendation

The PAs should incorporate program funded independent M&V in larger projects and those with difficult to estimate savings, such as HVAC controls improvements, as a standard practice. Issue a solicitation for M&V contractors at the state level so that even the small PAs can tap into M&V resources without having to issue separate RFPs. Ensure M&V data is stored as part of the project documentation to support more cost efficient and timely impact evaluation studies.

CLOSE THE CUSTOMER FEEDBACK LOOP

Advanced energy efficiency programs like those in Massachusetts are customer oriented. One clear opportunity for programs to improve their effectiveness is to close the savings feedback loop for customers by demonstrating

the achieved savings after projects are complete. This means providing clear documentation of the pre-installation baseline, the post-installation energy efficient conditions and the resulting savings of the installed measures. By incorporating more rigorous baseline methods and adding post installation assessment of consumption, the PAs will increase customer confidence in the program project analysis as a solid basis for making investments. Benefits of this approach include:

- Higher confidence in efficiency investments based on measured baseline performance
- Increased program credibility through validated savings
- Data and information to support case studies based on robust pre/post measurement

Recommendation

The PAs should increase follow up with customers to demonstrate achievement of expected energy efficiency savings as a result of their investment.

APPENDIX A: RECOMMENDED PRACTICES FOR ESTABLISHING BASELINES IN CUSTOM ENERGY EFFICIENCY PROJECTS

Energy efficiency measure baselines are established during project development and analysis in order to calculate energy savings (the *ex ante* baseline). Baselines are also assessed during evaluation (the *ex post* baseline.)¹ The determination and documentation of *ex ante* baselines affects the ability of evaluators to understand the program baseline determination. Appendix A documents recommended practices for developing and documenting *ex ante* baselines for custom C&I projects to improve realization rates and customer satisfaction.

What is a baseline and why is it important?

Baseline refers to the amount of energy (electric and/or gas) and electric demand that would have been consumed absent the measure installed under the energy efficiency program. There are two important components to correctly characterizing baseline energy consumption:

- Equipment - what equipment would exist on the site but for the measure or upgrade.
- Baseline operating characteristics – how would that equipment operate

Accurate savings estimates are important because customers often use the expected return on investment for energy efficiency upgrades as a basis for investment decisions.² The determination of ratepayer expenditures for a project is similarly made based in part on the estimated project savings.

BASELINE EQUIPMENT

The guidelines for determining baseline equipment vary depending on project type. There are two primary categories or projects with different baseline methods:

- New construction/end of life – in this case the determination of baseline equipment is generally guided by energy code or federal regulation. For measures that are not regulated, there are two possible approaches to establishing baseline equipment: least cost available alternative or industry standard practice.
- Retrofit – for retrofit projects the baseline equipment is the equipment in place at the time of the project.

Code Baseline Considerations

In general, the energy code serves as an accepted standard for determining baseline³. One potential exception to this is when standard practice exceeds code efficiency. While this is typically not the case, trends in lighting indicate that the code may be lagging standard practice. If sufficient evidence were obtained documenting this phenomenon, it could warrant a change from use of the code's minimum lighting efficiency requirements to a baseline determined through rigorous research. In the absence of such research, the code remains the best available information for a new construction baseline determination.

In the case of lighting, current code is not specified in terms of equipment efficiency but rather on total lighting energy power as measured by installed watts per square foot (i.e., lighting power density or LPD). This presents challenges for prescriptive and upstream lighting measures for which savings are typically

¹ The Evaluation Management Committee is currently in the process of developing a protocol for the review of *ex-ante* baseline assumptions and establishing *ex-post* baselines for C&I measures during EM&V.

² In some cases the customer may consider the baseline to be retrofit while the PAs consider the baseline to be end of life equipment replacement. This issue is discussed under the “Customer vs PA Baselines” section.

³ In towns that have adopted stretch codes, the baseline for energy efficiency programs remains the lower efficiency levels mandated in the statewide code.

determined based on a comparison of baseline and efficient technology efficiency. Energy efficiency programs should adopt a mechanism for using LPD to determine savings for prescriptive and upstream lighting projects that are governed by the energy code. This will also benefit customers because lighting projects realized through upstream or prescriptive programs are often vendor-driven and vendors have an incentive to maximize product sales. Tying incentives to system LPD, rather than to each lighting fixture or lamp, will reduce the common practice of one-for-one fixture replacement which can result in over-illumination.⁴ In addition, the documentation requirements for these projects should include evidence of minimum compliance with code lighting controls standards.

New Construction/End of Life – Not Covered by Code

In cases where an energy code does not apply and no regulation governs the efficiency levels of available alternatives, the two options for determining baseline are:

- Industry standard practice⁵
- Least cost available equipment that can meet the same need

Although there are challenges associated with determining industry standard practice, particularly for custom measures, using the equipment that is typically or commonly installed in similar applications as the baseline for energy efficiency calculations will usually provide a highly defensible savings estimate.⁶

Using the least cost available alternative equipment method is simpler to implement, but can result in mischaracterization of project savings. In some cases, the least cost available alternative may be more energy efficient than the industry standard practice. For example, the price of variable speed drives is lower than that of motor starters for small motors, but the industry still has not adopted drives as standard practice in this application. Alternatively, in some cases the lowest cost alternative is a legacy technology that no longer offers the features desired by customers and may consume considerably more energy than the equipment that is typically or commonly installed in similar applications. The least cost available alternative can be a useful approach to establishing measure baselines and can help reduce the potential for double counting of free-ridership.⁷ On the other hand, it is not consistent with the requirements of ISO New England for the bidding demand reductions into the Forward Capacity Market and therefore not recommended for Massachusetts programs.

An effort should be made by the PAs to continue assessing industry standard practice for custom measures on an ongoing basis. Prioritization of these efforts should be driven by the volume of measures and savings associated with a particular application as well as the “age” of the baseline data. An example of this would be updating the baseline for new injection molding machines (IMM). Vermont has been using a blended baseline of hydraulic and electric IMM for several years; Southern California Edison recently updated their baseline assumptions for IMM to reflect a preponderance of electric baseline equipment. Failure to proactively update equipment baselines as part of program development and implementation puts savings at risk during evaluation and may result in ratepayer funded incentives being provided for standard practice equipment. Planning for updated net-to-gross ratios should also be part of the evaluation cycle to ensure that free-ridership is determined relative to the industry standard practice baseline.

Retrofit Equipment

The baseline for retrofit projects is the existing equipment, except in cases where the equipment is

⁴ Over-illumination describes the situation in which too many fixtures or too many lamps per fixture are installed in a space or building, resulting in more light intensity than required for the purpose of the space type.

⁵ ISO NE requires the use of industry standard practice for baseline determination in the absence of codes and standards in Chapter 6 of the M-MVDR. <http://www.iso-ne.com/participate/rules-procedures/manuals>

⁶ Baseline studies are a common way to determine appropriate baselines, but they take time and money, and must be updated periodically. In addition careful coordination with net-to-gross studies is required to avoid double counting free-ridership.

⁷ Gross is Gross and Net is Net: Simple Right?, Rick Ridge, IEPEC 2013

expected to be replaced during the life of the efficient replacement. This exception is discussed further under the “dual baseline” heading. While this sounds simple, there are several complex aspects of retrofit baseline documentation to which rigorous attention must be paid, described further in the next section.

BASELINE OPERATING CHARACTERISTICS

Determining baseline operating characteristics can be significantly more challenging than identifying the baseline equipment. This aspect of project development requires significant rigor and documentation to help ensure customers receive accurate information and that the estimated savings are reasonable. Again, there are variations in approach depending on the project type.

Operating characteristics are determined through identification and quantification of the hours of operation and load. Hours of operation are relatively easy to measure, but establishing baseline loads for complex systems typically requires the determination of a variety of dependent variables.

True New Construction, Additions, and Major Renovations

For true new construction or major renovations, savings estimates are based on assumptions about the operating characteristics of the baseline and the efficient equipment ranging from building occupancy patterns to room occupancy rates to thermostat set points. It is extremely difficult to estimate the energy consumption of a building or system while it is in design due to the lack of accurate data about these operating characteristics. Therefore, the baseline effort should focus on:

- Ensuring that code-mandated control strategies are included in the baseline model
- Relying on published modeling guidance including ASHRAE Standard 90.1 Chapter 11 and Appendix G
- Ensuring the assumptions for all key parameters are well documented in the analysis.

Equipment Replacement - End of life and Retrofit

In the case of equipment replacement, the baseline can typically be determined from existing operating parameters unless the replacement triggers a code requirement for additional controls, in which case the measure would be treated as new construction. Metering and the use of building automation system trend logs can be used to establish operations and loads for custom projects.

Options for establishing key parameter data` in equipment replacement projects include:

- Trend and/or production logs
- BMS/EMS
- Metering
- Estimation
- Customer self-report

Again, the documentation of key parameter assumptions and data points should be explicit in the project files.

ADDITIONAL CONSIDERATIONS

Projects often affect older working equipment that may be approaching the end of its useful life. In these early retirement cases there are additional issues that should be addressed during project development to accurately estimate and document baseline energy use.

Dual Baselines

The use of dual baselines is increasing and may become the norm for energy efficiency projects within

the next few years. The draft EPA guidelines⁸ for evaluating energy efficiency project impacts under the Clean Power Plan requires the use of a dual baseline. The MA PAs should monitor national trends and ensure they are using best practice in characterizing retrofit projects and establishing the baseline for early retirement projects.

A dual baseline for early retirement projects involves establishing two savings streams for the measure⁹. Savings stream one comes from the efficiency gain from the existing equipment to a code minimum standard and is applied over the remaining life of the existing equipment. Savings stream two comes from the efficiency gain from the code minimum efficiency and the installed level of efficiency and is applied over the full measure life.

Evidence of PA Role in project

Custom retrofit project documentation should include clear evidence of the program administrator's role in driving the equipment upgrade. The higher incentives available for retrofit projects (as compared to those addressing the incremental efficiency increases for end of life replacement projects) could cause planned upgrades of functional equipment to be mischaracterized as an energy efficiency retrofit. Including evidence of the project evolution in the project files supports the validation of savings claims and minimizes second guessing during evaluation. It is also important for evaluators to recognize that as programs evolve and become more market-oriented they are often using non-energy benefits of new equipment such as increased productivity, better comfort, etc. to help sell energy efficiency upgrades. The use of this approach should not be seen as evidence of a planned upgrade. However, it is incumbent on the program administrators to document their role in highlighting other benefits to advance measures as part of the sales process in the project files.

Production Impacts

Where upgrades affect production levels, particular attention should be paid to developing a basis for the production levels on which savings claims are based. The production levels used in the savings claim should not exceed the capacity of the prior existing equipment.

Customer vs PA Baselines

In some cases the customer will perceive their project as a retrofit because 100% of the energy use reduction will be realized in their energy bills, even where the PAs classify the project as end of life, thereby greatly reducing the claimed savings and available incentives. In these cases, the PAs can help the customer understand the costs and benefits of the project based on the bill savings. Approaching these customers from the perspective of the financial benefits they will see from the project (e.g., return on investment) as opposed to the available incentives may increase customer comfort with the project and with the PA's contribution.

⁸ https://www.epa.gov/sites/production/files/2015-08/documents/cpp_emv_guidance_for_demand-side_ee_-_080315.pdf

⁹ This method is used by the residential program in equipment replacement program savings estimates.