Lessons Learned from a Decade of Evaluating Customized Commercial and Industrial Efficiency Measures

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ABSTRACT

National Grid has been using the results of detailed impact evaluation studies to improve the reliability of energy studies conducted as part of its demand side management programs since these programs were started in the early 1990s. This paper presents a summary of some of the major lessons that have been learned over the past decade of evaluation work. The paper is intended to help inform implementation staff at other utilities that may be developing quality control policies for new or poorly performing programs. The quality control recommendations are broken down into two major categories. The first group is intended for personnel charged with implementation of rebate programs and is targeted at reducing errors in savings estimation. The second category is intended for program developers who determine program guidelines and measure eligibility criteria. While many of the suggestions may increase program costs, in the long run these improvements are likely to enhance program credibility with customers and regulators.

Introduction

This paper recounts the most significant lessons learned from over ten years of impact evaluation studies of complex energy efficiency measures[1] installed through a customized efficiency program at National Grid, a major electricity distribution company in the Northeast. These customized measures differ from prescriptive measures in that energy savings and demand reduction are determined by an engineer for each specific application. Savings estimates reflect the unique operating characteristics of each installation as well as the skill of the engineer and customer in developing credible calculation methodologies and usage profiles. As the "low hanging fruit" of prescriptive lighting and HVAC become harder to find due to improvements in energy codes and improved common design practices, these more customized measures will likely represent an increasing portion of savings in the large Commercial and Industrial (C&I) customer segment. Support for publicly funded energy efficiency programs may wane if equipment recommended and ultimately installed through these programs routinely fails to perform as expected. In addition, companies like National Grid will lose credibility with their customers if the services delivered do not meet customer expectations.

The evaluation process has been central to the evolution and success of the demand side management programs at National Grid. Evaluations are carried out on a regular basis to verify savings as required by various regulatory agencies. The results serve as the basis of policy change recommendations and help focus the attention of program implementation staff on issues that may adversely affect program success.

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[1] Examples of projects considered are free winter process cooling, transfer of HVAC loads to central chiller plants, snow making equipment, wastewater treatment system improvements, efficient compressed air system components, optimal chilled water plant controls, optimal industrial refrigeration design and controls, and interactive whole building analyses.

The lessons learned and recommendations are divided into two major categories. The first category includes suggestions regarding the manner in which rebate applications are reviewed by program implementation staff. It is assumed that the accuracy of savings estimates will improve if the implementation staff becomes aware of the most common sources of analytical errors. The second category focuses on program guidelines and measure eligibility criteria. It is assumed that improvements to basic program guidelines will minimize the chances that inappropriate efficiency measures will be accepted and that measures are properly implemented in the field.

National Grid Evaluation Process and Results

National Grid has an internal evaluation group that uses stratified sampling to determine the average annual realization rates for four primary indicators: total annual energy savings, the percentage of savings occurring during peak periods, and summer and winter coincident demand reduction values. The evaluations, performed by engineering consultants who specialize in metering and verification, are split into four main end-use groups: lighting; HVAC; process and comprehensive design approach projects. The on-site evaluations involve combinations of: end-use and whole building metering; site inspections; detailed interviews with customers; whole building computer simulations; and detailed engineering analysis. Evaluation studies are based on as-found conditions with the expectation that installation or operational problems encountered on site would have continued indefinitely over the course of the measure life (typically 10 to 15 years).

Overall, evaluated results for Custom installations in National Grid's programs align well with initial savings estimates. Figure 1 below indicates that the average annual energy savings realization rates tend to be within 20% of the ideal target of 100% for the four major types of Custom projects. Much of the deviation from 100% over the past few years is the result of factors currently beyond the control of National Grid or its consultants. These factors include: lower than projected production rates; increased or decreased hours of operation; facilities ceasing operation altogether; and, customers that do not choose to fully implement the recommended measures.

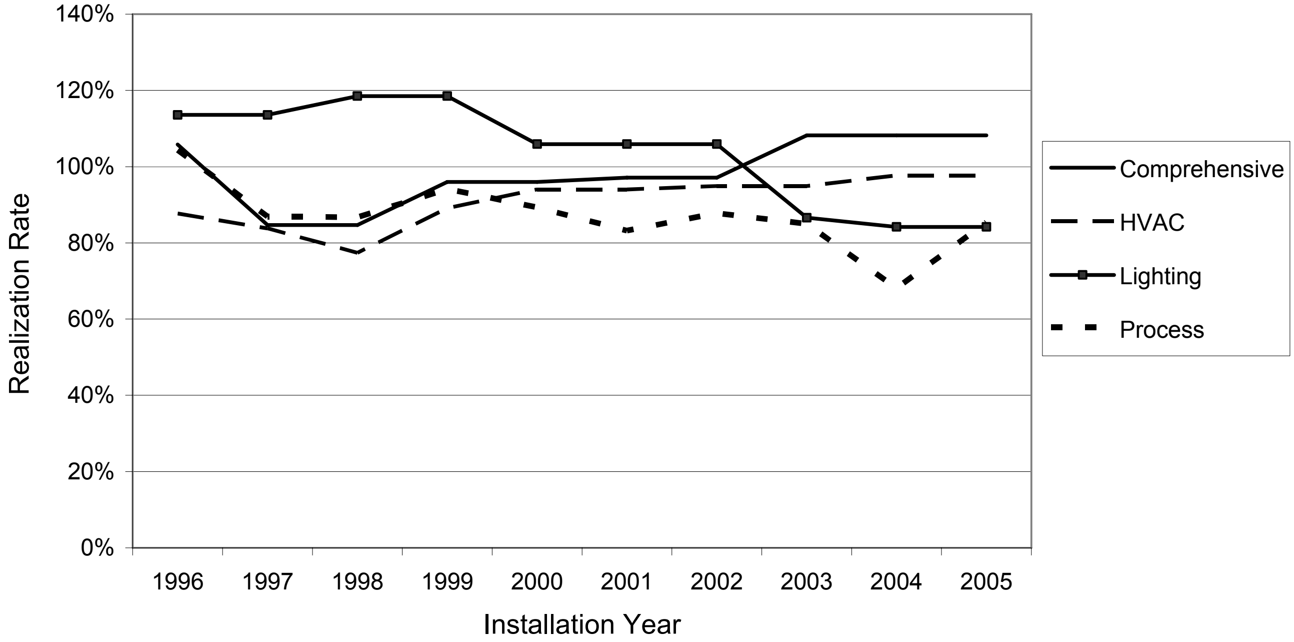

Figure 1. Historical Annual Energy Savings Realization Rates

Program Implementation Recommendations

This section is intended for program implementation staff responsible for reviewing incoming applications for rebates. It is assumed that these personnel are reasonably familiar with the technologies and processes being considered within the applications.

Be Aware Of Potential Conflicts Of Interest Inherent In Energy Savings Estimates from Vendors

Savings estimates prepared by vendors can be inflated since the primary motive behind the analysis is to support the customer's decision to buy a certain product or system. In some cases, vendor analyses do not provide detailed information about assumptions such as base case equipment make/model, the approximate age of equipment, control sequences, or operating schedule.

While equipment vendors do not intentionally want to mislead their customers, their sales effort generally assumes the worst possible alternative that may or may not meet local energy codes or rebate program baseline guidelines. Since vendor profits tend to increase with larger equipment sizes and facility owners typically want to install capacity that can accommodate potential future growth, there is a tendency for equipment to be oversized. Examples include central refrigeration plants, cooling plants, and central pumping systems. In addition, over-sizing can reduce the vendor's liability risks as there are rarely complaints or service calls for oversized equipment while undersized equipment can be a big problem.

When reviewing savings analyses from third parties, the most important factors to consider are: 1) operating hours; 2) equipment capacity; 3) typical equipment loading; and, 4) the difference in equipment performance at the typical load. Estimates from vendors tend to assume the equipment is more fully loaded and operates for more hours per year than would actually be experienced in the field. We recommend that equipment performance curves or a description of how performance varies with load or other external conditions be included with each analysis. It is important for vendors to provide detailed analysis of their load calculation with back-up by independent engineering studies with measured loads of similar existing equipment and/or building simulation or detailed load calculation. Generic rules of thumb regarding load per square foot, etc. should not be accepted.

Recommend the Use of Production Records and Historical Demand Data

The accuracy of equipment operating hours plays a significant role in the estimation of energy savings. Production records, site EMS data, and whole-building power demand profiles can be used to determine typical and maximum hours of equipment operation when equipment specific metered data or run hour data are not available.

The most easily obtained source of operating data is historical trend logs gathered from central controls computers. All energy efficiency projects should maximize the use of this resource rather than relying solely upon assumptions based on interviews with site personnel or design engineers. Many customers do not know how to extract this data from their own systems, and the engineers that are hired to perform the energy studies need to be able to help them do this. Establishing effective access to trend data early in the study process will not only improve the accuracy of energy studies but will also facilitate the commissioning and evaluation processes.

National Grid provides a service called the Energy Profiler Online on its website that allows customers to review the power demand of their facility in tabular format at 15-minute intervals over several years. This data can be used for both estimating savings before the installation as well as during the commissioning and evaluation processes. The data can also confirm verbal descriptions of typical operation patterns of the facility, how power demand varies over the course of the most recent year, and the presence of plant-wide shutdowns. In some situations, the equipment being studied represents the largest power demand at the facility (e.g. rock crushing and grading equipment at a quarry). Interval demand data for the whole facility can reliably be used to estimate the actual operating hours of the equipment.

While most energy conservation measures only pertain to a portion of the total facility power demand, 15-minute power demand data for the entire facility can be used in many cases to provide an upper bound for equipment operating hours. For example, food production equipment cannot operate for 4,000 hours per year if there are only 2,500 hours per year that workers are at the plant as indicated by the background load for lights and HVAC equipment. Overestimates of production hours are found to be one of the most common sources of error during the evaluation process and use of this often readily available data can make the original savings estimates more accurate.

Check the Reliability of Equipment Loading Estimates

Overestimates of equipment loading are one of the most common sources of error in Custom evaluation studies since lower loads generally reduce measure savings. While there are several types of equipment that can be assumed to be fully loaded at selection[2], it is rare that an off-the-shelf machine or a component of a larger system will operate fully loaded given design safety factors. Loading factors should be included for all pumps and blowers, most HVAC and process fans, and most process equipment including air compressors to assist in the application review process. Thermal loads for all water chillers and unitary HVAC cooling and heating systems should be less than the design capacity of the system.

Cooling and refrigeration applications are particularly vulnerable to overestimates of equipment loading. It is not uncommon for cooling loads to be estimated using scaling factors and the system capacity (i.e. the average evaporator load is 75% of its design capacity). The derivation of scaling factors should be clearly described if they are employed in an analysis since they not only scale the load but also the measure savings. A better approach is to calculate the loads using a bin model or an hourly simulation package at non-design conditions. This kind of approach requires a higher level of knowledge of the entire installation on the part of the energy analyst, but this extra effort typically pays off with more realistic load estimates. The assumptions supporting the load calculations can later be reviewed during the evaluation process for reasonableness.

The quantification of energy use should be estimated separately for different use patterns. A central cooling system serving a food processing plant will have significantly lower loads during non-production periods than during production periods. Typical HVAC loads vary by season, day of the week, and hour of the day.

In the case of new construction of manufacturing facilities, it is often difficult for plant designers and owners to estimate the number of production hours for use in the original energy study. If project cost effectiveness is very sensitive to future loading assumptions, the project should be screened with conservative loading assumptions to assure cost effectiveness.

The issue of site startup and slow growth is particularly a problem if production hours are driven by product sales, or the manufacturer is entering a new market, or if the production process is in the process of being optimized. These new plants may require several years to reach production levels that served as the basis of equipment sizing and the operating hours assumed in the original energy study.

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[2] Equipment that typically operates at (near) full load includes some food processing equipment (blast freezers) and fans that do not operate against a discharge pressure (evaporator fans, condenser fans, draw-through cooling tower fans, etc.).

Evaluation work occurring within the first year or two of operation may not accurately quantify the average energy savings that may be experienced over the course of the measure life.

Historical facility power demand data and production records can be used in conjunction with information from plant managers to determine likely future growth trends. Depending upon evaluation program policies, it may be necessary to adjust as-found results to more accurately predict future energy savings if facilities are still in the start-up phase of operation.

Check That All Auxiliary Loads and Impacts Have Been Taken Into Account

Energy studies should quantify the impact of all equipment that is affected by a system improvement. While it is common for some minor factors to be ignored due to the magnitude of their impacts on final energy savings estimates, reviewers should be adequately familiar with the application to determine whether these omissions are reasonable. Examples of loads and sources of power demand that are occasionally excluded from energy studies include the following:

- Increased fan power demand associated with HVAC energy recovery
- Additional heat generation within refrigerated spaces due to increased evaporator fan operation and coil defrost
- Increased exhaust fan operation during enthalpy economizer
- Fan and pump heat in HVAC hydronic systems
- Power demand of variable speed drive electronics
- Pumps included in HVAC hydronic systems and chilled water plants
- Changes in HVAC load due to the installation of efficient lighting and controls
- Reduction in cooling loads due to installation of more efficient process equipment

While the amount of money allotted to the engineering study typically impacts the degree of detail included in the energy analysis, some of the items listed above do not require significant additional effort to address. For more complex issues, such as the impacts of equipment selection on HVAC loads, program managers will need to decide whether this degree of analytical detail and improved accuracy is worth the additional engineering costs.

Check That Correct Equipment Performance Data Have Been Used

Energy studies should be based on the most reliable sources of equipment performance data. There are two different sources of error that fall under this topic: use of generic performance curves and incorrect interpretation of performance information.

In the case of HVAC projects, default curves included in hourly simulation software packages do not necessarily represent the base case or proposed case for pumps and fans under consideration for a project. While hourly simulation packages can provide reliable estimates of HVAC loads, use of default performance curves reduces the value of this accuracy. The default option allows the modeling engineer to avoid the task of obtaining the curves for the base and proposed case units and the potentially difficult task of accurately entering this information into the model. Evaluation studies use the actual curves for the listed base case unit and metered power demand, and it is not uncommon to find significant deviation between the evaluated and originally estimated savings. Program managers should be wary of modeling that is based on generic performance curves. For measures where existing loads can be measured or estimated within a reasonable degree of accuracy, it may be better to use a bin model spreadsheet with actual equipment performance data than a simulation model with generic performance curves.

The second type of error under this topic concerns the improper use of EER ratings in studies comparing code-compliant unitary air handling equipment to high-efficiency models. The published EER ratings are based on the total power consumption of the unit at ARI conditions. This rating value includes supply fan power, which can vary considerably between various units depending on fan selection and pressure drops across coils, filters, and other internal components. Annual energy savings associated with an air-cooled RTU relative to a base case air-cooled RTU should not be based on the total annual cooling load and the EER ratings of the equipment. This is a surprisingly common error, and indicates a general misunderstanding of what is included in the EER rating.

Comparisons of air handling equipment should be based on two actual units and the performance information specific to each. The EER rating can be used to select an appropriate base case unit, but it should not play a significant part in the quantification of energy savings. Savings arising from improved cooling section performance for air-cooled equipment are not as great as the savings arising from improved fan performance and reduced internal pressure drop.

Carefully Review Assumed Control Point Setpoints and the Possibility of Operator Overrides

Energy studies that report very high savings estimates that depend upon easily modified control setpoints should be reviewed carefully and should be verified during the commissioning process. Condensing temperature setpoints are the most frequently overstated assumption in HVAC and refrigeration projects. Admittedly, it is difficult for energy efficiency consultants to be able to foresee how a customer will operate their chilled water plant, especially when there are significant benefits to minimizing condensing temperatures. Unless a facility has a history of aggressive condensing temperature controls, it may be prudent for energy studies to assume a warmer condenser water/condensing temperature setpoint in the proposed case than technically possible. For example, most new chiller installations can be operated at a tower water temperature of 60°F or less. Plant operators may be wary of such a low temperature relative to what they are used to and they may increase the minimum temperature setpoint to 70°F.

Additional setpoint overrides that are commonly encountered during commissioning and evaluation work includes the following:

- Elevated differential pressure setpoints on variable-speed pumping applications
- Decreased suction temperature setpoints on supermarket compressor rack systems
- Increased ‘on’ time for lighting control occupancy sensors

Use Evaluation Results as a Means of Training and Selecting Consultants

The quality of the energy savings estimates is dependent upon the quality of the information available at the time of the original energy study. However, a small number of firms tend to consistently overestimate savings regardless of the quality of information available to them. Evaluators should provide feedback to the implementation staff as to which consultants consistently do not achieve the savings projected. Those consultants should be given feedback as to how to improve their performance. If after a reasonable amount of time the accuracy of their work does not improve, they should no longer be used to provide savings estimates. Because jobs are often evaluated long after the original study is submitted, this process can take many years.

Program Policy Recommendations

This section offers suggestions to program design teams. It is assumed that the rebate granting entity requires that a consistent set of guidelines are applied to all applications for incentives.

Use Commissioning Information to Finalize Reported Savings Values

For installations with complex controls or incentives greater than $100,000, National Grid requires commissioning of the measures before the full incentive is paid. The commissioning process often requires customers to demonstrate data trending capabilities. In order to compel customers to complete the commissioning, the Company withholds 20% of the incentive until the commissioning process is substantially completed.

It is common for installations to vary slightly from the assumed system parameters that served as the basis of the original energy study, and these variations can dramatically affect the savings results. The impact of most changes to setpoints and control sequences on final energy savings can be estimated fairly easily by adjusting the original energy models. Arrangements can be made at the time of the original study to have the engineer who developed the savings calculation plant to re-run savings calculations based on commissioning findings. In cases where the specific model of proposed equipment was not actually installed, more detailed effort may be required. Typical issues that arise from commissioning that may impact savings include the following:

- Changes in motor sizes
- Different setpoints than were originally assumed (e.g. higher minimum condensing temperature)
- Hours of operation different than expected
- Loads different than expected
- Optimal HVAC control sequences that were not implemented as intended
- Defrost heating periods that are shorter and less frequent
- Faster minimum VSD speeds
- Changes in typical space temperature control setpoints

The incremental effort to revise energy savings estimates based on commissioning information typically does not require much additional cost on the part of the original energy analyst. Implementation of a policy that requires recalculating savings and adjusting final claims for large projects will generally improve realization rates and overall rebate program performance.

In addition to the re-estimation of savings, we recommend that a rule be established that no part of project savings can be claimed until the commissioning process is also completed. Since measures are often installed during the time of year they are not required to run (i.e. chillers installed in the winter), commissioning often takes place several months to up to a year after the measure is installed. Implementation staff eager to make their installation goals take credit for the job after the measure is installed assuming the commissioning process will likely confirm the savings estimates. Often credit for the savings is taken in one year and the results from the commissioning are not available until the next year. Thus, even if the savings are re-estimated, the revised savings estimates cannot be used in the tracking system. This can lead to lower realization rates when these installations are evaluated based on the original savings that were claimed for the job.

Utilize Minimum Requirements Documentation Standards

A major challenge to rebate programs is ensuring that the intended energy efficiency measures are properly installed. Minimum requirements documentation can help ensure that critical aspects of the design that lead to energy efficiency are implemented in the field. The document should contain four distinct sections: equipment description, sequences of operation, documentation, and other requirements. National Grid relies heavily on these documents to record the Owner's intent, serve as a checklist for post-installation inspections, and also as the basis for commissioning efforts and subsequent evaluation work.

The equipment description section should include specific parameters such as number of installed units, capacity of each unit, and minimum performance at specific conditions. This should match the assumptions that were used in the energy study. It may be desirable to mention the specific make and model of equipment that served as the basis for savings calculations, although the intention is not to force the customer to select a particular manufacturer. This description will ultimately help post-inspection personnel ensure that the equipment meets project requirements prior to issuing an incentive. It is also helpful to state other assumptions that can be verified during post-inspection or commissioning, such as expected production rates, hours of operation, etc.

The descriptions of sequences of operation should be developed in adequate detail to provide specific direction to controls contractors. As projects become more dependent upon complex controls strategies, clear guidance is critical. We recommend that the controls contractor review these documents before the final energy study is completed to ensure that the intent of the sequences is understood.

These documents represent the starting point for the evaluation contractor's determination of whether variations in savings are due to installation problems or changes in site conditions.

Maximize the Use of Pre-retrofit Metering Data

The collection of pre-retrofit power metering data as part of retrofit studies, where possible, can lead to improved reliability of savings estimates and facilitates post-installation evaluation work. This data should be accompanied by descriptions of the operating conditions apparent during the metering period, such as ambient temperatures, production rates, item being produced, setpoint values, etc, that would allow the data to be properly used during potential evaluation work. As a result of evaluation findings, in 2006 National Grid started requiring pre-retrofit metering for some projects under its retrofit programs.

Metering data is particularly important in cases where equipment performance is unlikely to be accurately reflected in manufacturer's data. For example, chiller bundles become fouled over time, and performance can easily be 20% worse than expected. The degree of fouling varies widely depending on the age of the installation and the site's past O&M practices. In such a situation, power metering data should be used in conjunction with a reliable estimate of chiller load to determine the chiller's performance at a variety of condenser conditions and loading.

For all retrofit projects, as much information regarding the as-found equipment should be documented as possible. Evaluation efforts are routinely hampered by inadequate descriptions of pre-retrofit equipment, operating sequences, and loading patterns. Not only is the equipment removed from the site, but most supporting documentation that had been held on file is frequently discarded as well. It should be noted that in some cases the construction schedule does not leave time for pre-metering.

Require the Installation of Trending Capabilities

Many facilities with complex installations have the capability to monitor system operating parameters and log this data for brief periods of time. Installations such as this that receive rebates should all be required to archive long-term trend data of the most important parameters that affect system performance. This data should be compiled in a format that can be incorporated into an independent analysis, not just in the form of hard copies, html-based graphs or other formats that are difficult to import into a spreadsheet. Data should be gathered at a minimum frequency of 60 minutes with integrated values preferred over instantaneous sampling. Ideally, at least one year's worth of data should be maintained in the database. This data can be very useful to facility operators, energy efficiency consultants, commissioning agents, and utility evaluators.

Given the importance that this data has in commissioning and evaluation work, it is recommended that a significant portion of the final incentive payments be withheld until all controls systems have been shown to be operational and capable of supplying trend data. Minimum requirements documentation should explicitly list those points that should be tracked. The engineer who prepared the energy study is the best person to generate this preliminary data request since this person had to identify the key parameters that lead to energy savings.

Develop a Policy for Addressing Interactive Effects between Multiple Measures

Energy savings for individual efficiency measures may be impacted by interactive effects associated with other measures installed at the same time or as part of subsequent projects. Optimized controls measures tend to reduce the savings associated with measures that focus solely upon the installation of energy efficient equipment. For example, the savings associated with a high-performance lighting design will be decreased if occupancy sensors reduce the total number of operating hours per year. Similarly, energy recovery will reduce savings associated with improved cooling performance in HVAC projects. Projects with a high degree of interactivity among measures should be considered as a single project, and rebates should not be awarded on a measure-by-measure basis. Evaluation teams will need to develop clear guidelines regarding the manner in which these kinds of projects should be approached.

Utilize a Peer Review Process

For projects where savings are either very large (>250,000 kWh per year) or involving specialized engineering skills, the use of a more formalized peer review should be considered. The peer reviewer assesses soundness of the basic engineering involved in the measure (i.e. does it make sense to install) and the reasonableness of the savings and cost estimates. The peer review process is most useful in cases where equipment vendors provide the initial savings estimates.

National Grid has implemented this procedure in the last two years and it appears to be providing value to the application review process. A formal analysis of the realization rates of peer reviewed projects versus similar non-peer reviewed projects has not been undertaken at this time. The Company maintains a group of preferred technical assistance vendors that have proven experience working with National Grid rebate programs in a wide range of applications. These consultants are used to check one another's work as well as applications submitted by vendors and customers. The peer reviewer for each project is selected based on the technology being considered and the reviewer's past experience.

Regularly Update Baseline Standards

Baseline standards for the most common types of measures should be routinely updated using information from evaluations. There are two types of baseline information: that which is dictated by State codes and Federal guidelines (e.g. EPACT 1992, IECC 2003), and that which is non-regulated but set by common practice or less formal industry standards. The process of defining what is and what is not common practice in the field for non-regulated systems can be a complex task.

National Grid has developed a baseline document for its New England service territory that summarizes those aspects of local and national codes germane to more common HVAC and lighting energy efficiency measures. The intent of providing this information to technical reviewers and consultants is to eliminate the possibility that regulatory guidelines will not be considered during the energy study process. Evaluations have found that requirements for unitary air conditioner performance are routinely misapplied. The baseline document clarifies reference tables to make code requirements more easily understood.

The baseline document also describes typical baseline practice for non-regulated measures including refrigeration, drive power, water treatment, compressed air, plastics thermoforming, and ice rinks. The recent redesign of National Grid's baseline document was instigated to a large extent by one recurring trend observed in annual evaluation results: unreasonably high condensing temperature/ discharge pressure assumptions in projects pertaining to cooling systems. Improvements in head pressure controls over the past 20 years have resulted in more efficient factory-installed default minimum condensing pressure setpoints. For example, National Grid considers a minimum condensing temperature setpoint of 95°F for HCFC-based medium-temperature systems to be reasonable. Use of a minimum setpoint of 110°F could potentially overestimate measure savings by approximately 15%.

Standardize Reporting Formats

Standardization of report formats encourages full descriptions of installations, analysis methodologies, and assumptions, which allows program managers to improve their technical review of incoming applications. The most problematic projects encountered during annual evaluations tend to be those that do not include a full description of the project and/or savings assumptions. Documenting the project in a consistent manner during the energy study can help identify those aspects of the project that have the greatest impact on savings. While creating detailed descriptions of modeling methodology is tedious, it can potentially help the energy analyst uncover calculation errors before studies are delivered. If these descriptions match the actual calculation methodology, the report can be used by the commissioning agent, the utility reviewer, and future evaluators.

As projects often change in the course of installation, it is also important that any changes in the project be documented in the final report. A well formatted report which does not reflect the actual installed measure is of little value.

Develop Guidelines for Addressing Redundant Equipment

Savings and cost estimates should reflect the actual operation of all equipment in systems, including redundant equipment. Utilities need to develop a clear and coherent policy regarding how rebates and savings are to be calculated when more capacity is installed than is required to meet system loads. The claimed energy savings need to correspond to the specific equipment that a rebate was provided for.

As an example, consider a proposal to install a variable speed drive on one of two secondary hot water pumps. The load of the plant only justifies one pump running at a time but the owner plans to automatically rotate the duty of the pumps between lead/standby on a regular basis, and will therefore require that two drives to be installed. In the analysis, the project cost and savings need to consider both drives and both pumps running at reduced hours, not one pump running for the entire year. Since the operating hours that either motor sees is really only half the total annual hours, it would be inappropriate to assume the entire year of operation was being served by one motor and drive. Since the full cost of the drive is only providing half of the savings, the project may not be cost effective under this redundant equipment scenario.

It is very important to determine customer intentions regarding equipment operation. Many customers require redundancy for chillers and air compressors as well as mission critical support systems in hospitals and laboratories. When in doubt, it should be assumed that if a similarly sized piece of equipment is at the site, that each piece of equipment will roughly split the total hours of runtime.

Provide Direction for the Calculation of Demand Reduction

Historically, annual energy savings estimates were deemed to be more important than peak demand reduction. As demand reduction programs becomes a more important objective of energy efficiency programs, a greater emphasis should be placed on proper calculation of demand reduction. Program managers should provide adequate training to technical vendors to ensure that estimates of demand (kW) savings are based on explicit definitions of peak demand time periods. The concepts of peak power demand and the percentage of savings occurring during peak energy periods are not necessarily straight forward and seem to be misunderstood by some technical vendors. To complicate the matter, different utility companies operating in a region may have different definitions of these periods and how the values should be calculated may be applicable at different points in time. Avoiding confusion on this issue is particularly important as utilities come to rely more heavily on data generated during the energy study process.

Conclusions and Lessons Learned

The objective of all demand side management programs is to encourage customers to make informed and financially sound choices regarding energy efficiency improvements. The effectiveness of these programs is dependent upon many factors, some of which can be controlled through the policies that guide implementation and the quality control measures that are employed during the implementation process. We have described a number of specific recommendations that can help to ensure that rebate funds are used to support cost-effective projects. As evaluation professionals, it is essential that we communicate the lessons we have learned over the past decade to program developers, implementation staff, technical reviewers, and other evaluators so that the accuracy, reliability, and reputation of all efficiency programs can be optimized.