Increasing the Value of Field Demonstrations

Researchers in California are developing a standard methodology for conducting field demonstrations to better inform energy codes and standards

BY CORI JACKSON, KONSTANTINOS PAPAMICHAEL AND MICHAEL SIMINOVITCH

Stakeholders invest millions annually in research and development (R&D) aimed at improving the energy efficiency and peak demand reduction of lighting and other electricity consuming building systems. Field demonstrations vet the market readiness of products resulting from these investments. Demonstrations also allow for measurement and verification of new technologies' energy and cost savings potential under real-world conditions. For these reasons, research, development and demonstration (RD&D) has become the standard means by which new lighting technologies reach the broader market. While an evidence-based strategy is often utilized, the methods used to measure and record demonstration results often vary from project to project, making comparisons and aggregation of results difficult, if not impossible.

These issues are further compounded when demonstration results are referenced as evidence in support of enhancing building codes and appliance standards. There is a wealth of information on energy monitoring and evaluation protocols from which to draw, but this quantity and variety of options also presents drawbacks. Monitoring and verification (M&V) procedures exist for all types of systems, each with different objectives and associated procedures.

In California, demonstrations play a critical role in identifying which technologies have the most potential to realize the energy efficiency goals of state agencies and the Investor Owned Utilities. Many groups have addressed the topic and offer guidelines for conducting specific types of M&V projects, yet no single source has been put forth or endorsed by the California agencies looking to these studies to inform their codes and standards processes. The California Lighting Technology Center (CLTC) at the University of California, Davis, is addressing this need by developing a standard M&V methodology for the California Energy Commission that can be used by any team conducting an emerging technology field demonstration.

DEVELOPING A STANDARD METHODOLOGY

The methodology under development at CLTC is intended for use with all forthcoming technology demonstration projects conducted through the California Energy Commission with public funds. As the need for an accepted methodology extends nationwide, the results of this process will be applicable to projects conducted outside of California.

The M&V methodology development is one critical piece of a larger research effort called the Codes and Standards Enhancement—Quality Demonstration Program (CASE-Q DP), conducted by CLTC and funded by the California Energy Commission. CASE-Q DP supports demonstration of energy-efficient building technologies to usefully inform California codes and standards (C&S) activities. The CASE-Q DP bridges the gap between small, pilot-scale technology demonstrations and large-scale market transformation programs currently supported by the Energy Commission and others. Assessments conducted under this program produce complete and detailed technology reports that may be used by the Energy Commission, utilities and other stakeholders as part of their Codes and Standards Enhancement (CASE) initiatives.

The principal document, the CASE-Q DP Program Manual, will contain the requirements and processes for future state-funded field demonstrations. It will be useful to any team wishing to conduct a sound, thorough and well-documented technology demonstration. In addition, the CASE-Q DP directly supports identification, selection, installation and performance assessments of energy-efficient building technologies ready for current or near-term inclusion in California C&S initiatives. Field projects conducted through CASE-Q DP adhere to the procedures and guidelines contained in this Program Manual. This uniform, consistent approach will allow for more transparent assessment of publicly funded demonstrations while improving the reliability and relevance of project results (**Figure 1**).

A TECHNOLOGY-NEUTRAL APPROACH

A guiding objective of CASE-Q DP research is technology neutrality. The M&V methodology is intended to be technology agnostic, technically feasible to implement on both large and small scale projects, and not cost-prohibitive.

To begin the methodology development process, CLTC performed a gap analysis of past Codes and Standards Enhancement reports conducted in support of building code and appliance standards updates in California. Researchers analyzed the common features and information in both successful and unsuccessful CASE measures, thereby identifying the components necessary for demonstration projects to effectively inform C&S measures.

Results of this analysis led to development of a basic field demonstration M&V framework. Projects follow a general approach, beginning with identification of demonstration technologies and sites and ending with the reporting of demonstration outcomes. There are six major components of a CASE-Q DP demonstration project, in addition to technology installation at the host site. These major components are detailed in **Figure 2.**

APPLYING THE METHODOLOGY

A majority of technology field demonstration projects proceed as retrofits or alterations of existing spaces that are selected to accommodate and demonstrate

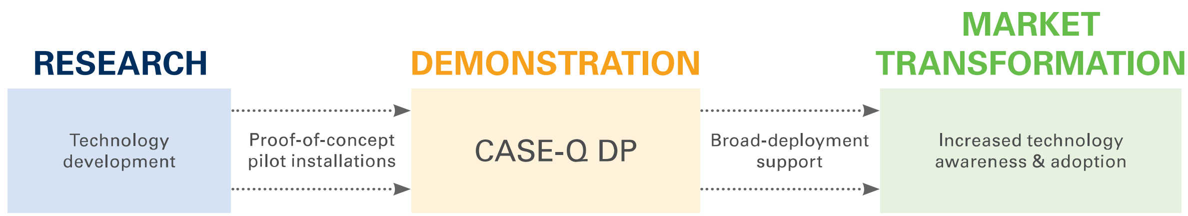
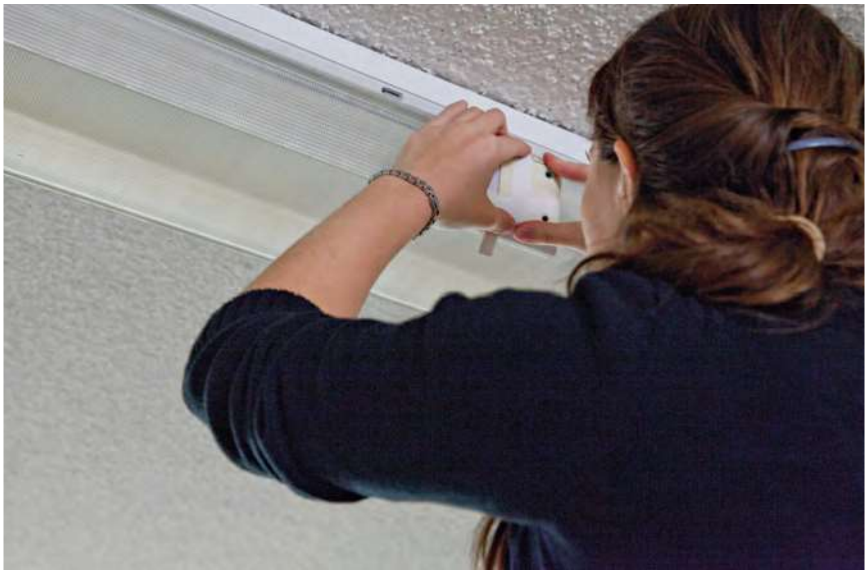


Figure 1. Commercialization process for new lighting technologies.

Figure 2. General approach for CASE Q demonstation projects.



Comparing baseline data to post-retrofit data is part of the CASE-Q DP M&V procedure.

a new product or practice. The general approach for this type of demonstration project, therefore, is based on in situ measurement and verification of the baseline conditions and systems, followed by post-retrofit evaluations of the demonstration technology. Baseline performance data are then mapped to post-retrofit conditions, which provide a true comparison of the pre-retrofit and post-retrofit technologies. Outcomes from this mapping are used to calculate resource savings and document other performance attributes. This process follows, in many ways, a process called the "retrofit isolation approach" to document energy savings, developed by ASHRAE.

The CASE-Q DP M&V procedure:

1. Select and document baseline conditions.
2. Select independent variables and develop a baseline, energy-use model.
3. Select duration and frequency of monitoring period for baseline and post-retrofit scenarios.
4. Collect baseline data.
5. Document post-retrofit conditions.
6. Collect post-retrofit data.
7. Map baseline usage to post-retrofit conditions.
8. Determine savings: Mapped Baseline Use – Post-retrofit Use = Savings.

A key outcome of the initial gap analysis was the development of the field demonstration data mapping procedure. This procedure standardizes energy-related data collection and analysis. CLTC found that while past demonstration projects often include energy savings calculations based on a comparison of energy use before and after retrofits, the operating and physical site characteristics between the two systems often proved to be significantly different. This makes attribution of energy savings to the demonstration technology difficult, because savings are often the result of factors unrelated to the technology itself.

With lighting projects, combinations of measures are often demonstrated through one project, at one site. For example, the savings attributed to the addition of daylight harvesting controls could be masked by changes in weather conditions during the post-retrofit monitoring period. Reported results often did not document the pre-retrofit and post-retrofit weather conditions, making it impossible to compare the baseline lighting system's energy use to the use with the daylight harvesting control system. With the CASE-Q DP methodology, project teams can now follow a demonstration plan that details how to record critical environmental conditions, such as weather, along with other operating conditions, before and after retrofits. This will allow project teams to map baseline energy use to post-retrofit conditions more accurately and consistently, allowing for a true "apples-to-apples" comparison of the effects of different technologies on energy use.

ANALYZING DATA

CLTC's review of past field demonstration projects also resulted in the development of much-needed procedures to determine appropriate data monitoring periods. Determining appropriate baseline and post-retrofit monitoring periods depends, primarily, on the range of actual and anticipated operating conditions at the site. A monitoring period that allows for data collection under all possible conditions is necessary to reduce uncertainty in energy computations and reported outcomes. CLTC's evaluation of past projects found that data monitoring periods often lacked a rationale to support the duration selected, or the period aligned with building operating conditions or schedules that would produce the most or least savings, which skewed savings when extrapolated to an annual value.

The CASE-Q DP provides project teams

with a procedure to follow when planning and scheduling pre-retrofit and post-retrofit data collection. For baseline monitoring, the period immediately preceding the installation of the demonstration technology is recommended, as this will reduce the probability of conditions changing between the pre-retrofit and post-retrofit monitoring periods. In fact, baseline data collection often only requires spot measurements of system energy use, which will be mapped to conditions occurring in the post-retrofit period. This reduces data collection complexity and cost. When setting a post-retrofit data collection period, the period should be sufficiently long to include the entire range of operating conditions. Examples of possible operational conditions are seasonal business hours and variable climatic and sky conditions.

The newly-developed CASE-Q DP process will also include pre-demonstration market and economic evaluation procedures; procedures for reporting missing or corrupted field data; methods for quantifying measurement uncertainty; and methods for conducting subjective, human-factor studies of newly installed technology. Public comments on the CASE-Q DP M&V methods and program guide are welcome. A copy of the preliminary CASE-Q DP Manual is available at *http://cltc.ucdavis.edu/publication/case-q-dp-program-manual.*

CASE-Q DP IN PRACTICE

As part of the CASE-Q DP M&V field demonstration development process, CLTC is testing its methods and procedures through two lighting demonstration projects. One project is focused on vetting the process in an outdoor, commercial lighting demonstration and the other in an indoor, residential lighting demonstration. The outdoor CASE-Q demonstration involves a new microwave occupancy sensor capable of sensing and differentiating between pedestrians, small vehicles and large vehicles. The technology is appropriate for use in outdoor commercial applications with luminaires mounted at a height of more than 24 ft; this is a market sector not currently required to use occupancy sensors under California's Title 24, Part 6 regulations.

The indoor residential lighting project involves evaluation of LED screw-base replacement lamps that meet the Voluntary California Quality LED Lamp Specification. Multiple LED lamps will be installed throughout homes in a multi-family housing community. CLTC will use this demonstration to evaluate and refine the subjective survey methods and procedures detailed in the CASE-Q DP Manual. Outcomes from both studies will indicate the performance characteristics and energy savings attributable to these new technologies. These study results will also help to vet and refine the CASE-Q DP M&V procedures and related program processes. ■

THE AUTHORS

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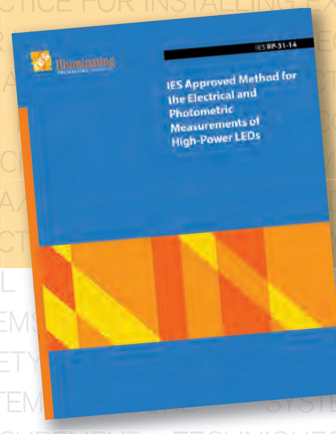

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