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Transforming the Energy Efficiency Market in California: Key Findings, Lessons Learned and Future Directions From California’s Market Effects Studies

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ABSTRACT

In the last three years, the California Institute for Energy and Environment (CIEE), along with the California Public Utilities Commission (CPUC), managed three market effects studies that were funded by the CPUC. This paper summarizes the key findings from these studies that focused on compact fluorescent lamps (CFLs), residential new construction (RNC), and high bay lighting (HBL)¹, with a particular focus on changes to California’s market effects evaluation protocol and lessons learned during the evaluation of market effects. This paper also summarizes the key results from a survey that was conducted by CIEE in February 2011 to determine what additional studies should be conducted in the evaluation of market effects.

Introduction

In an October 2007 decision (D.07-10-032), the CPUC directed its staff to explore (during 2008–2009) the ability to credibly quantify and credit “nonparticipant spillover” market effects, and to report on the ability of current protocols to measure nonparticipant spillover savings for the 2006-2008 program cycle. The Market Effects Evaluation Protocol provides the following definition of market effects (CPUC 2006):

“A change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of energy-efficient products, services, or practices and is causally related to market interventions...” where a “market” is defined as “the commercial activity (manufacturing, distributing, buying and selling) associated with products and services that affect energy usage.”

In the October 2007 decision, the CPUC directed its staff to report its findings following the process evaluation and market impact studies of the 2006–2008 program cycle on the ability of current protocols to measure such “nonparticipant spillover” savings and to propose possible revisions to market effects protocols, utility savings goals, or performance incentive mechanisms for subsequent action by the CPUC. Consequently, the CPUC decided to examine possible market effects in CFLs, RNC, and HBL (referred to as the “Market Effects studies”). Working with the CPUC, CIEE developed study plans for, and assisted in overseeing, each of these market effect studies.²

The Market Effects studies had three primary objectives.³

¹ High bay lighting refers to a diverse group of technologies that are used to light spaces in commercial and industrial facilities with ceiling heights 15 feet and above.

² The CIEE market effects study plans are available at <http://uc-ciee.org/planning-evaluation/7/lbrsearch>.

³ The Residential New Construction Market Effects Study included a fourth objective: Assess the effects of pre-

- Understand the cumulative effects of California’s energy-efficiency programs on the target market.
- Quantify 2006–2008 kilowatt-hour and kilowatt savings (if any) caused by the above potential market effects and not claimed as direct or participant spillover savings.
- Support the CPUC’s strategic planning efforts by clarifying whether savings from potential market effects can be quantified with sufficient reliability to be treated as a resource.⁴

Key Results⁵

As shown in Table 1, each of the studies addressed the above objectives with evaluation methodologies relying on a diverse set of data collection methods and sources of data, including the review of program material and related literature, review of investor-owned utility (IOU) program data, telephone surveys, in-person interviews, in-depth interviews (in person or by phone), in-home audits, onsite visits, and stocking inventories. Most of the analyses relied on descriptive statistics, but multivariate regression modeling was used in one study (CFLs), and compliance modeling and Delphi (expert) panels were used in another study (RNC). Comparison states were used in two studies (CFLs and HBL) to serve as a baseline. While energy savings were calculated for all three studies, two studies (HBL and RNC) claimed that the energy savings could be quantified with sufficient reliability to be claimed as a resource, while the third study (CFLs) could estimate savings but the savings could not be claimed as a resource for the 2006-2008 program cycle.

Due to page limitations⁶, we focus the rest of this paper on the following topics: (1) recommended changes to California’s evaluation protocols; (2) lessons learned in the evaluation of market effects; and (3) future market effects studies.

2006 IOU programs on the adoption of more efficient technologies and practices in the 2005 Title 24 code.

⁴ The market effects studies focused on methodological issues. The authors of the report were neutral going into the studies on whether there were market effects. And the CPUC was not planning on using the results for determining utility performance on meeting their energy savings goals and its impact on shareholder incentives.

⁵ Each of the studies are listed in the References section at the end of this paper.

⁶ More details can be found in Vine 2011.

Table 1. Summary of Market Effects Evaluations

Data Collection	Data Analysis	Comparison States	Energy Savings	Claim savings as a resource?
CFL				
<ul style="list-style-type: none"> • Review of program material & related literature • Review of IOU program data • Telephone surveys with customers, retailers, manufacturers • In-person interviews with program managers & evaluators • In-home audits • Stocking inventories 	<ul style="list-style-type: none"> • Descriptive Statistics • Multivariate Regression Modeling 	<ul style="list-style-type: none"> • Georgia • Kansas • Pennsylvania 	<ul style="list-style-type: none"> • Total net impacts for 2008 were 23% of IOU's claimed gross savings 	<ul style="list-style-type: none"> • Not for the 2006-2008 program cycle
High Bay Lighting				
<ul style="list-style-type: none"> • Review of program material & related literature • Review of IOU program data • Telephone surveys with program managers, implementation contractors, lighting contractors, lighting distributors, and end users • In-depth interviews with manufacturers, distributors and installation contractors 	<ul style="list-style-type: none"> • Descriptive Statistics 	<ul style="list-style-type: none"> • Mississippi • Georgia • Alabama • South Carolina 	<ul style="list-style-type: none"> • 15.1 to 27.2 GWh per year in savings due to the net out-of-program adoptions of HBL technologies 	<ul style="list-style-type: none"> • Yes for the 2006-2008 program cycle
Residential New Construction				
<ul style="list-style-type: none"> • Review of program material & related literature • Review of IOU program data • Telephone surveys with 	<ul style="list-style-type: none"> • Descriptive Statistics • Compliance modeling • Delphi (expert) 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Average new home built used 7.6% less energy than permitted to use under state building code 	<ul style="list-style-type: none"> • Yes for the 2006-2008 program cycle (and already covered in the Codes &

homebuyers, builders, contractors, Title 24 consultants, HERS raters, window distributors, lighting fixture and control distributors <ul style="list-style-type: none"> • Onsite visits and audits of non-program homes • In-depth interviews with program managers, building code officials/inspectors 	panels			Standards Program evaluation)
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Changes to California’s Market Effects Evaluation Protocol

All three studies recommended changes to California’s Market Effects Evaluation Protocol, including allowing for the estimation of total net effects (includes free ridership, participant spillover and nonparticipant spillover), and the use of Delphi panels as part of the Basic level of rigor.

One of the greatest challenges the CFL Market Effects Team faced in trying to quantify the energy/demand savings from market effects of the 2006-2008 Upstream Lighting Program (ULP) was the lack of earlier market effects data—both to establish a (pre-2006) baseline, and to understand the market effects for the first portion of the program period. While the Market Effects Evaluation Protocol states, “a baseline study must be conducted as early as possible,” they recommended some subtle but important changes to the scoping study section of the Protocol. Specifically, they recommended that through the scoping study the evaluation contractor be required not only to conduct a thorough review of relevant past studies, but also to explicitly delineate the quality and usefulness of any extant baseline market data. They recommended that the CPUC should use this assessment of baseline market data availability to define the timing and scope of the subsequent market effects study. In addition, the CFL Market Effects Team recommended that the scoping study be required to include a description of the market’s evolution over time. Documentation of the market history provides a context for the market effects assessment. An understanding of this context may be of critical importance if, for example, significant program impacts occurred prior to the timeframe under evaluation (as the evaluators believed it did in this evaluation).

Once a market effects study has been authorized, the Market Effects Evaluation Protocol recognizes two approaches for estimating causal attribution: preponderance of evidence and modeling. The CFL Market Effects Team tried to assess the markets effects attributable to California’s 2006-2008 ULP using the preponderance of evidence approach for some metrics (e.g., CFL awareness, availability, and the program’s effect on CFL pricing) and modeling for others (e.g., energy and demand savings). They found the preponderance of evidence approach—in this case employing customer surveys, in-home lighting audits, retail shelf stocking surveys, and trade ally surveys—worked well for qualitatively assessing the market effects attributable to California’s ULP. However, modeling the nonparticipant spillover effect of an upstream program on the market as a whole—without the benefit of adequate annual sales data or being able to readily identify end use customer participants—posed unique challenges. In light of the

challenges inherent in modeling the market effects attributable to upstream energy-efficiency programs, the CFL Market Effects Team suggested that the Protocol allow for the estimation of total net effects (i.e., a net-to-gross ratio that is inclusive of free ridership, participant spillover, and nonparticipant spillover – instead of solely focusing on free riders, which is common practice for most net effects analyses) for upstream programs rather than focusing solely on nonparticipant spillover.

The **HBL** Market Effects Team recommended that the Market Effects Evaluation Protocol should include the documentation of unanticipated market effects—or program effects that are not characterized in the program logic model—as a “key aspect” of the report. For example, the study team revealed an unanticipated market effect in the survey data that represented a significant departure from the California IOU’s program theory: many end users probably received a financial incentive without knowing it and without being educated on the technologies. Similarly, they recommended that researchers should include the discovery of unanticipated market effects, if any, as another objective of a market effects study. Finally, they recommended that the Market Effects Evaluation Protocol should be revised to contain guidelines on the appropriate conditions under which to deploy available approaches for quantifying adoptions of targeted measures outside the program and for assessing the attribution of observed market changes to program activities (e.g., hypothesis testing).

The **RNC** Market Effects Team suggested that the Market Effects Evaluation Protocol be modified for estimating the net impacts of RNC programs. In the California RNC market, distinctive and continually changing state building codes, multiple and varied climates, and the prevalence of local market actors preclude a cross-sectional inter-state modeling approach for causation; new construction in California simply is not comparable enough to new construction in any other area—or even a combination of areas—to allow valid comparisons. In addition, the diversity and complexity of the end-uses and practices involved in new construction make a modeling approach problematic. This is in contrast to other types of markets that are relatively similar across areas, with relatively uniform technologies, in which quasi-experimental designs taking into account differences over time and across areas are more feasible.

Hence, the RNC Market Effects Team suggested that the Market Effects Evaluation Protocol be modified to provide the following requirement for estimating the net impacts of new construction programs for the Basic level of rigor:

A Delphi or expert panel approach, in which gross savings and penetration of technologies and practices are estimated and presented to panel members, who are then asked to attribute savings to energy efficiency programs and other factors; it is essential that there be at least two rounds of Delphi surveys, with the first round results summarized and presented in the second round survey so panel members can understand and learn from each other in developing the final attribution estimates.

Lessons Learned

Many lessons were learned in the evaluation of market effects, and some of the most important were the following:

- Market effects need to be estimated throughout a program’s life cycle

- Baseline market data (pre-conditions as well as ongoing current market practice) need to be collected throughout a program's lifecycle – ideally, before program implementation
- Because non-program (comparison areas) are becoming harder to find, timing is crucial and other methods will need to be used (e.g., qualitative hypothesis testing and Delphi (expert) panels).
- Require hypothesis testing as part of the evaluation⁷
- Include elements of market effects evaluation in other program evaluations

In the endeavor to accurately estimate the magnitude of CFL market effects, the CFL Market Effects Team concluded that market effects needed to be estimated throughout a program's life cycle. In other words, a rigorous assessment of program versus estimated baseline sales conducted earlier in the life cycle of the California IOU CFL programs *might* have identified quantifiable market effects that occurred earlier in the program's life. The lack of such baseline market data, coupled with the rapid increase in CFL sales throughout the U.S. during the first part of the 2006-2008 program cycle and the more recent national downturn in sales, makes it extremely difficult for any program state, including California, to now claim or quantify savings from cumulative market effects induced by their programs alone. The CFL Market Effects Team recommended that future market effects studies gather baseline market data before program implementation as well as throughout a program's lifecycle. These studies do not need to be more costly; in fact, they may be less costly by using longitudinal analytic approaches that implement ongoing data collection activities.

In addition to establishing baseline and ongoing, more regular data collection, the CFL Market Effects Team made other methodological recommendations for CFL or other market effects studies, including:

- Use multistate regression analysis, an approach that improves on the simple difference of means (i.e., delta sales) approach by controlling for other factors that impact sales of energy-efficient measures, including income, education, housing characteristics, and utility rates.
- When conducting a multistate approach that requires the collection of good estimates of sales data, develop and implement consistent approaches across states for primary data collection activities (survey questions, time horizons, etc.).
- Continue to conduct shelf-stocking surveys - although shelf-stocking surveys are less useful as a proxy for sales since they cannot fully capture sell-through rates (i.e., lowest cost products may have sold quickly and not be available during the stocking survey), they are valuable for understanding availability and pricing characteristics.
- Develop diffusion of technology curves to understand how efficiency gains in one state (e.g., California) might impact standard practices in other areas of the country.

Finally, the CFL Market Effects Team noted that market effects studies also provided

⁷ For example, in the CFL market effects study, several hypotheses/researchable issues were developed for testing during the evaluation: for example, are consumers able to distinguish program and non-program CFLs, and are new products and specialty CFL products entering the market due to IOU coordination and incentives?

important market characterization findings that could inform both impact evaluations and program planning efforts. For example, the primary data collection activities produced estimates for a number of important parameters, such as sales and prices of CFLs, saturation, penetration, current buying patterns, current offerings (model types, features), stocking patterns, and program pricing effects (e.g., pricing multiplier effects) across all retailer channels and differences by retail channel.

From a methodological point of view, the **HBL** Market Effects Team concluded that it was feasible to conduct a cross-sectional, market-level net savings analysis, including estimation of market size and technology shares, without actual data. However, they warned analysts interested in conducting similar studies of the following potential complications:

- Previous studies relying on cross-sectional methods involving comparison of program areas to non-program areas show that timing is crucial. Once national markets for efficient technologies begin to take off, differences in technology shares between program and non-program areas quickly become insignificant.
- Non-program areas are becoming increasingly difficult to find (e.g., commercial lighting programs are active in nearly every state).
- Comparability of the program and non-program areas will always be an issue. Therefore, the kinds of qualitative hypothesis testing used to isolate spillover effects will be required in these kinds of studies.

The authors provided suggestions for future HBL market effects evaluation work. First, they recommended that a white paper be prepared on using comparison areas in the nonresidential sector. They also recommended three related market effects studies to improve the understanding of the HBL market: one on HBL controls and changes in hours of use, another on end users using HBL technologies, and a third on HBL usage in new construction.

Based on their research, the **RNC** Market Effects Team noted several lessons learned with respect to program evaluation:

- Because market transformation is a program goal, market effects research should occur on a regular basis; otherwise, program planners cannot know if the goal is being achieved.
- Baseline studies (e.g., building practice and code compliance) should continue in the future on a regular basis to allow continued examination of efficiency trends over time.
- As IOU-sponsored training programs were consistently identified as being critical to the observed market effects, coordinate the evaluation of education and training programs to include elements of market effects evaluations to better understand what building techniques and technologies are being applied to non-program homes.
- Because of difficulties in identifying and recruiting building industry experts for Delphi panels, identify and recruit building industry experts who could serve on a similar Delphi panel at the conclusion of the program cycle. Panelists would be asked to follow the programs during the program cycle, paying particular attention to non-participant spillover.

Future Market Effects Studies

In order to determine what further research should be done in the future in the area of market effects, CIEE conducted a survey in February 2011. Forty (40) individuals responded to the survey. Most of the respondents were consultants (38%) or from academia (28%), and many of them were professors (23%), evaluators or market researchers (20%), program planners or managers (18%), or evaluation or market research managers (15%). Since we do not know the size of the population of people who are interested in this topic, we were unable to determine a response rate or assess the representativeness of the sample. Nevertheless, we believe that the responses provide some useful information for determining the next steps in the evaluation of market effects.

Many respondents would like to see additional market effects studies. Some had specific studies in mind (see below), while others provided general reasons for more studies. Some respondents thought these studies were very important for assessing market transformation and carrying momentum forward, others were interested in the market penetration of other energy-efficient products and services, and others wanted to quantify savings from market effects and identify the program components that were most responsible for the savings (for program design). They also want to increase their understanding of new technologies and indirect program impacts, and how future market effects studies would compare with the ones recently conducted. Respondents felt that market effects evaluation was practically and conceptually difficult but crucial. Moreover, as California continues to emphasize the importance of market indicators, respondents thought that market effects studies would be important for more measures, and particularly for the statewide programs. However, some respondents only wanted market effects studies if the evaluation results were going to be used by the CPUC. Finally, specific market effects studies were suggested (Table 2).

Table 2. Suggested Market Effects Studies

Residential	Non-Residential	Other
<ul style="list-style-type: none"> • HVAC • Whole house home performance • Audits • Weatherization • Smart meters • Appliances • LEDs • Lighting and HVAC control technologies • Electronic loads • Large screen televisions 	<ul style="list-style-type: none"> • New construction • Retrofit • HVAC • High performance T-8 lighting • LEDs • Lighting and HVAC control technologies • Building commissioning • Smart meters • Energy storage 	<ul style="list-style-type: none"> • Industrial programs • Agricultural programs • Local government programs • Renewables (in buildings)

Conclusions

The three market effects studies were successful in collecting and analyzing a variety of data to understand the cumulative effects of California's energy efficiency programs in three

markets (CFLs, HBLs, and RNC), and they were able to quantify the savings caused by the above potential market effects for the 2006-2008 time period. Two studies (HBL and RNC) claimed that the energy savings could be quantified with sufficient reliability to be claimed as a resource, while the third study (CFLs) could estimate savings but the savings could not be claimed as a resource for the 2006-2008 program cycle.

These studies affirm that measurement of program effects and market transformation is possible even in a market crowded with stimuli. But it is important to note that, as with other evaluation efforts, there is often a great deal of uncertainty when evaluating market effects. This uncertainty reflects the reliance of the evaluator on self-reports (of manufacturers, retailers, participating consumers and nonparticipants) for assessing changes in the marketplace as well as program attribution. In addition, the uncertainty also stems from the increasing “clutter” of other (nationwide, local, regional) campaigns, incentives and messages affecting behavior that makes it very difficult to assign attribution to the effects from one particular program. Nevertheless, the use of multiple methods (surveys, quasi-experimental design, econometric modeling, etc.) and obtaining information from a range of actors leads to relatively robust measurements of market effects. And this approach will become even more robust if the following lessons are incorporated in future studies of market effects:

1. Collect baseline market data as early as possible and throughout a program’s lifecycle
2. Estimate market effects throughout a program’s lifecycle
3. Require hypothesis testing as part of the evaluation
4. Include elements of market effects evaluation in other program evaluations

The CPUC is planning to conduct additional market effects studies, starting in 2012. One study will be on residential HVAC maintenance and installation, and a second study will be on LEDs (there may be additional studies as well). Both studies will be prospective, rather than retrospective: they will develop comprehensive baseline characterizations of each of these technologies and services. The baseline studies will facilitate later estimation of the market effects of current and future IOU programs that promote these technologies and services. For example, after the IOU programs have had time to affect the market, it is expected that a retrospective study will be conducted to assess the market effects of the IOU programs and estimate the energy savings associated with those market effects.

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