High Bay Lighting Market Effects Study

FINAL REPORT

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Energy Division

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KEMA

1 Executive Summary

This document presents the results of a market effects study of California's (CA) three largest electric investor-owned utilities' (IOUs) 2006 – 2008 energy efficiency programs on the commercial & industrial (C&I) markets for high bay lighting (HBL) products.[1] This HBL Market Effects Study was commissioned by the California Institute for Energy and Environment (CIEE) through a Request for Proposal (RFP), CP1-006-08 (April 10, 2008) and funded by the California Public Utilities Commission (CPUC).

1.1 Study Objectives

For purposes of this study, HBL products are defined as lighting products designed for use in commercial and industrial spaces with ceiling heights of approximately 15 feet or more. As listed in the RFP, the objectives of the overall market effects study are as follows:

- Understand and quantify the cumulative market effects of California's energy efficiency programs on the retrofit market for HBL between 2006 and 2008.
- Quantify the kWh and kW savings caused by the above market effects, occurring in the years 2006-2008, with particular emphasis on non-participant spillover.
- Support the CPUC's strategic planning efforts by clarifying whether savings from market effects can be quantified with sufficient reliability to be treated as a resource and, potentially, afforded shareholder incentive payments.

Additionally, this approach recognizes that the following study must be performed in a manner that is consistent with the CPUC protocols for market effects evaluations, including the preparation of a Scoping Study prior to conducting this Market Effects Study.

1.2 Sources of Data

The sources of information for this HBL Market Effects Study are summarized as follows:

- Review of previous program evaluation, market research, and market effects studies of California IOUs' programs and other relevant studies outside of California.
- Review of California IOU program data for HBL measures on the Energy Efficiency Groupware Application (EEGA).[2]

[1] They are Pacific Gas and Electric Company (PGE), Southern California Edison Company (SCE), and San Diego Gas and Electric Company (SDGE).

[2] http://eega2006.cpuc.ca.gov/ .

- Review of incremental cost and other HBL measure data in the Database of Energy Efficiency Resources (DEER).
- Interviews with 14 program managers or implementation contractors of the California IOUs' programs claiming savings from HBL measures: eight interviews with key program staff from all three IOUs for mass market programs, five interviews with key program or implementation contractor staff for 3rd Party or partnership programs, and one interview with a CPUC staff person.
- Review of energy efficiency programs across the country to specify an appropriate comparison region to California, which is absent programs supporting accelerated installations of energy efficient HBL technologies.
    - In consultation with the study's sponsors and advisors, KEMA originally specified Pennsylvania (excluding Philadelphia), Ohio, and Michigan as the comparison area. KEMA conducted in-depth interviews with representatives of 11 manufacturers (national and California), 15 distributors (seven in the original mid-western comparison area), and 16 installation contractors (seven in the original mid-western comparison area) active in the C&I HBL market.
    - For the market effects assessment, based on further analysis and discussion with the study sponsors and advisors, the study team identified a region comprising the states of Mississippi, Georgia, Alabama, and South Carolina as a more appropriate and tractable comparison area for the market effects study. The study team completed computer assisted telephone interviews (CATI) with the following market actors in California and the southeastern United States comparison area:
        - Lighting Contractors (150 in California and 100 in the comparison area)
        - Lighting Distributors (142 in California and 77 in the comparison area)
        - End-users of HBL technologies (124 in California and 80 in the comparison area)

1.3 Findings

On balance, the study team believes that reasonably strong evidence exists to demonstrate significant energy and demand savings and market effects from the California IOU programs' support of energy-efficient retrofit HBL technologies.

1.3.1 Assessment of Net Energy and Demand Savings

Table 1 shows the calculation of reductions in demand and annual use associated with the more efficient distribution of technology shares in the program versus comparison area. These calculations proceed in the following steps.

1. **Estimate installed capacity of actual 2006 – 2008 high bay lighting purchases in the program area, 2006 – 2008.** We multiplied the area affected by high bay lighting purchases in the program area (Line 1) by the average lighting power density derived from California contractor-reported technology shares (Line 2) to arrive at an estimated installed capacity for those purchases of 293.7 MW (Line 4).
2. **Estimate installed capacity of 2006 – 2008 high bay lighting purchases at baseline efficacy levels.** We multiplied the area affected by high bay lighting purchases (Line 1) by the average lighting power density derived from comparison area contractor-reported technology shares (Line 3) to arrive at a "baseline" installed capacity of 326.3 MW (Line 5).
3. **Estimate the difference between baseline and actual installed capacity high bay lighting purchased in California 2006 – 2008.** This is the difference between Lines 5 and Line 4, as shown in Line 6.
4. **Estimate the difference between baseline and actual annual energy consumption for high bay lighting purchased in California in 2006 – 2008.** To estimate the reduction in annual energy usage associated with higher efficacy in California, we multiplied the estimate of the difference in installed capacity by hours of operation for high bay lighting (2,975 hours per year) as estimated through a lighting logger study conducted as part of the impact evaluation of the 2006 – 2008 Small Commercial Program. The results of this calculation appear on Line 7. We estimate the difference between actual and baseline annual usage for HBL purchased and installed in existing California buildings during the period 2006 – 2008 at 97.2 GWh per year.

Table 1: Demand and Annual Energy Use Reductions

	Item	Input Value/ **Calculated Values**	Notes/Sources
1	Total square feet served by 2006 – 2008 HBL Purchases	458 mil.	Estimated from CA end-user survey
2	Average watts per square foot (lighting power density): Program Area Efficacy	0.62	Estimated based on technology share results from the CA contractor survey
3	Average watts per square foot (lighting power density): Baseline Efficacy	0.71	Estimated based on technology share results from the Comparison Area contractor survey
4	**Total MW of high bay lighting purchased: Program Area**	**293.7 MW**	Row 2 * Row 1
5	**Total MW of high bay lighting purchased: Baseline Efficacy**	**326.3 MW**	Row 3 * Row 1
6	**Difference in MW installed: Program Area v. Baseline**	**32.7 MW**	Row 5 – Row 4
7	**Difference in GWh/Year Usage**	**97.2 GWh/YR**	Row 6 * average annual operating hours per lighting logger study conducted for Impact Evaluation of 2006 – 2008 Small Commercial Program[3]

The Small Commercial Express incentive programs accounted for 95 percent of the total installations of high bay lighting supported by the IOU programs during the study period – as measured by *ex ante* savings, that is: savings estimated on the basis of unit volumes of measures rebated and planning assumptions concerning unit savings. Virtually all (93%) of the fixtures that received incentives through the program during the 2006 to 2008 period used T5HO tube fluorescent technology. A review of the results of the impact evaluation of these programs illustrates a number of relevant points of comparison for this study:

- The net-to-gross ratio of 69 percent (for energy savings) indicates a free ridership rate of over 30 percent, that is: participants report that they would have purchased 30 percent of the efficient units for which they received rebates in the absence of the program. Customers were classified as free riders using a rigorous sequence of questions that closely qualified responses concerning prior product knowledge and purchase intentions.

[3] Itron, Inc. et al. *Small Commercial Contract Group Direct Impact Evaluation Report.* San Francisco: California Public Utilities Commission. December 11, 2009. p. 4-6. Results based on logger data from 45 sites and 161 fixtures.

- The large difference between the *ex ante* and *ex post* demand reduction reflects the results of monitoring and verification that yielded lower-than-anticipated coincidence factors.[4]
- Net energy savings for the HBL component of the Small Commercial program totaled 63.0 GWh per year. Other IOU and third party programs contributed an additional 4.0 GWh per year in estimated net energy savings. Thus, net energy savings from HBL measures supported by IOU programs totaled 67.0 GWh per year.

To summarize the preceding two sections, the Study Team found that:

- The net difference in energy savings due to the higher efficiency of HBL lighting purchased in California from 2006 to 2008 versus the baseline, as represented by technology shares in the comparison area, was 97.2 GWh per year.
- Net energy savings – defined as adjusted gross savings less free ridership – generated by energy efficiency programs that promoted efficient HBL lighting during the period 2006 – 2008 totaled 67.0 GWh per year.
- The difference in the estimate of net energy consumption reductions generated by the two methods is 30.2 GWh. In the next section, we explore the extent to which these additional energy use reductions can be attributed to the effects of the 2006 – 2008 IOU programs versus other potential influences.

1.3.2 Assessment of Outcomes, Attribution and Alternate Hypotheses

The major hypotheses in regard to factors that contributed to energy use reductions due to adoptions of efficient high bay lighting "outside the program" are as follows.

1. **Spillover**. Spillover is the influence of the program on HBL purchases made "outside the program." For example, among program participants, spillover may occur if and when they purchase and install energy-efficient products that they learned about and tested through the program, without seeking financial incentives. Among non-participants, spillover may occur if and when they install energy-efficient measures in response to vigorous promotion from contractors who learned about the measures and their technical advantages through the program.
2. **Influence of codes and standards**. The 2008 version of Title 24 contains relatively stringent compliance requirements for lighting power density in high bay spaces compared to IEEE and ASHRAE guidelines, which provide the basis for other state building codes. Energy code enforcement is generally not invoked in replacement

[4] Personal correspondence with the Itron project team.

projects, but does come into play in new construction and renovation projects for which building and occupancy permits are required.

3. **Cumulative effects of previous California energy efficiency and information programs on customers' purchase decision criteria and processes.** California IOUs have been offering incentives to commercial and industrial customers to purchase high efficiency lighting equipment continuously for over two decades. In the past decade, these incentive programs have been supplemented with broad-based information programs such as *Flex Your Power*, as well as by an array of focused education and training offerings. Coming into the 2006 – 2008 program cycle, California customers may have been much more predisposed than their counterparts in the comparison area to select energy-efficient high bay lighting.
4. **Targeting of the California market by manufacturers and large distributors.** Related to Hypothesis 3, it is possible that some portion of efficient high bay lighting sales "outside the program" could be related to manufacturers and distributors focusing their marketing efforts for those products on California, thus taking advantage of incentives and other public benefit promotions.

The Study Team reviewed data and results from all of the activities to assess the relative strength of the four hypotheses stated above. We found strong evidence in support of Hypothesis 1, which posits a causal relation between observed differences in technology shares and the activities of the IOUs in support of efficient HBL technologies—particularly for T5HO technologies. We also found evidence to support Hypothesis 2 concerning the influence of Title 24. However, that evidence suggests that the influence of Title 24 is not as strong as that of the programs in regard to differences in the share of various technologies sold for application in existing buildings. Finally, we found no convincing evidence in support of Hypotheses 3 and 4 regarding the influence of previous energy efficiency programs and independent manufacturer or distributor initiatives.

1.3.3 Computation of Net Program Savings

Based on the evidence reviewed above, the Study Team believes that the IOU programs are responsible for most of the difference between actual and baseline adoption of efficient high-bay lighting technologies in California during the period 2006 – 2008. Compliance with Title 24 lighting power density requirements by contractors and the designers with whom they work also accounted for some of the difference, but we believe that channel of influence on projects in existing facilities (as opposed to new facilities) was relatively weak compared to the programs. The research that we conducted does not enable us to apportion quantitatively the percentage of net adoptions attributable to the programs versus Title 24. However, it is useful to assess the scale of program-induced benefits estimated using the methods described above versus those

derived by the 2006 – 2008 evaluations that used methods prescribed by the *Evaluators' Protocols.* The following points outline that comparison.

- The evaluations of the 2006 – 2008 programs estimated 67.0 GWh per year in "Installed *Ex Post* Net Energy Savings" for components that promoted efficient high bay lighting during that period. This quantity represents only net savings realized through transactions supported by the programs.
- Using the methods outlined above, we estimated energy savings of 97.2 GWh per year in energy savings, net of baseline levels of efficient HBL technology adoption. (See Table 31 for details.) Conceptually, this quantity includes the Installed *Ex Post* Net Energy Savings mentioned above plus savings associated with purchases of efficient high bay lighting made outside the program that exceed baseline levels. The purchases outside the program provided 97.2 – 67.0 = 30.2 GWh per year of energy use reduction when compared to levels associated with baseline efficiency.

Based on the assessment of alternative hypotheses, we are confident that at least 50 percent of those adoptions were attributable to the effect of the program. We also believe that 90 percent is a plausible estimate for the top end of the range, given the relative weakness of the other potential influences in regard to the replacement (as opposed to new construction) market. Applying these percentages to the estimate of 30.2 GWh per year in savings from net out-of-program adoptions developed above, we arrive at a range of 15.1 to 27.2 GWh per year in savings attributable to net out-of-program adoptions.

Table 2 combines the results of the above analysis with the estimate of net energy savings from the 2006 – 2008 impact evaluations to generate estimates of net program savings that include out-of-program adoptions. These estimates range from 72.1 to 94.2 GWh per year.

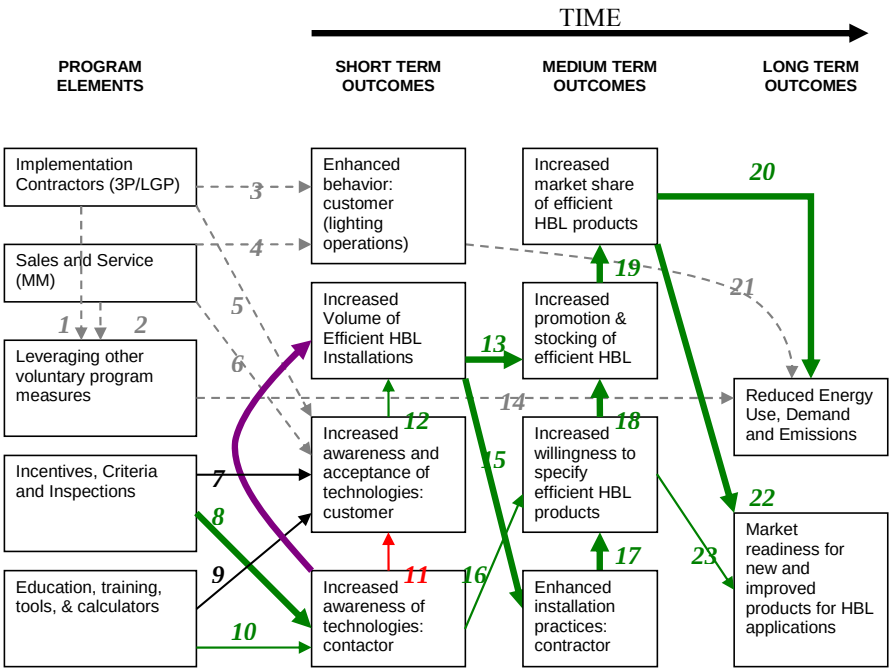
Table 2: Estimates of Net Program Energy Savings

Row #	Calculation Step	Quantity/Outcome
1	Energy savings associated with adoption of efficient HBL technologies, net of baseline adoptions. Conceptually this quantity includes net savings estimated through *Protocol* methods (adjusted gross savings * (1-free ridership rate))	97.2 GWh/Year
2	Net savings estimated via 2006 - 2008 impact evaluations (program transactions only)	67.0 GWh/Year
3	Savings from out-of-program adoptions, net of baseline adoptions: Row 1 – Row 2	30.2 GWh/Year
4	Low estimate of savings from out-of-program adoptions, net of baseline, that are attributable to the program: 0.5 * Row 3	15.1 GWh/year
5	High estimate of savings from out-of-program adoptions, net of baseline, that are attributable to the program: 0.9 * Row 3	27.2 GWh/year
6	Low estimate of net program energy savings: Row 2 + Row 4	72.1 GWh/year
7	High estimate of net program energy savings: Row 2 + Row 5	94.2 GWh/year

The following Figure (Figure 1) shows a modified program logic model that reflects the study team's findings, and the extent to which the hypothetical program chain (Hypothesis 1) is supported by the data. The color coding of the figure represents the following:

- Gray dashed lines represent links that were specified in the program logic but not specifically researched because they were assumed to be inconsequential to the market effects assessment.
- Green lines represent intended program links that are clearly supported by findings from one or more of the research elements.
- Black lines represent links for which insufficient data exist to make an assessment.
- Red lines represent links for which the data do not provide support or for which the data more strongly support alternative hypotheses.
- Purple lines represent unintended market effect linkages which developed in spite of the articulated program theories for HBL market development.
- Where the linkages appear in **bold,** we believe the evidence is particularly strong.

Figure 1: Modified Program Logic Model with Support for Market Effects



The basic argument for linking the observed high market share of T5HO technologies to activities of the California IOU programs runs as follows.

1. Throughout the study period, T5HO technology commanded a steep price premium compared to other "efficient" high bay lighting (HBL) technologies: 22 to 65 percent higher prices compared to equivalent pulse start metal halide (PSMH) technologies and 300 to 400 percent higher prices compared to T-8 fluorescents.
2. Compared to PSMH technologies, T5HOs had much lower operating costs, which offered simple paybacks in the range of 2 – 3 years for their selection versus PSMH. Other advantages included higher compatibility with controls and superior lumen maintenance. Compared to T-8 technologies, T5HOs offer a superior quality of light in many high bay applications.
3. The IOU programs focused heavily on supporting T5HOs, which accounted for 93 percent of all fixtures rebated and incentives paid.
4. The program accounted for a large portion of the total market: over 50 percent of all HBL purchasers received incentives through the program. Fixtures that received incentives from the program accounted for 22 percent of all HBL fixtures sold into the program area market. Roughly two-thirds of contractors in the program area reported receiving rebates

for HBL from an IOU. Half of those firms reported receiving rebates for more than 25 projects. Moreover, expenditure data reported by the IOUs for the relevant mass market programs show that rebate funding was generally available for the entire 2006 to 2008 period.[5]

5. Despite their high incremental costs, sales of T5HO fixtures outside the program exceeded in-program sales by over 3:1. Out-of-program sales of T5HOs alone accounted for 51 percent of total HBL sales. The market share of T5HOs in the comparison area, as reported by contractors, was only 29 percent.
6. The high level of out-of-program sales strongly suggests that program area contractors took a much more aggressive approach to promoting and selling T5HOs than did their counterparts in the comparison areas. This finding is supported by other contractor survey results. Virtually all contractors in California consider T5HOs to be energy-efficient, versus 62 percent in the comparison area. Only 21 percent of California contractors consider PSMH to be energy-efficient, versus 70 percent in the comparison area. Seventy-two percent of program area contractors say that they recommend energy efficient HBL for *all* of their projects.
7. Seventy-nine percent of program area contractors rated the importance of IOU programs in their decisions to promote efficient HBL at 8 or above on a scale of 10. Seventy-three percent rated IOU program influence on the market share of efficient HBL technologies at 8 or above on a scale of 10.

The following paragraphs provide additional detail on these findings.

Attributes of T5HO versus competing technologies

Throughout the study period, T5HO linear fluorescents were considerably more expensive than other efficient HBL technologies that were supported by the IOU programs – at least as they were designed. According to the 2008 Database on Energy Efficiency Resources (DEER), T5HO fixtures were anywhere from 22 percent to 65 percent more expensive than PSMH on a per kilolumen output basis. Moreover T5HOs were listed as 3 to 4 times as expensive as T-8 fixtures on a per kilolumen output basis.[6] These cost relationships do not necessarily indicate costs of alternative approaches for a given project, which will depend on the degree to which

[5] Based on quarterly reports accessed on EEGA (http://eega2006.cpuc.ca.gov/), April 29, 2010., for the four MM programs accounting for 98% of the measures, SDGE had not expended all available budget for all measures (including HBL measures), PGE had expended its budget without exceeding it, and SCE had not yet reported its expenditures.

[6] We note that the lumen output and efficacies that DEER assigns to various HBL technologies are lower than rated initial lumens, but considerably higher than the design lumen ratings we found in the professional and technical literature.

existing fixture layouts and wiring must be changed, as well as a host of application-specific factors. However, they are indicative of general market conditions.

For customers planning retrofit or replacement HBL projects, this incremental cost can be substantial. According to our analysis of market size in Section 6.2, program area customers undertaking such projects in 2006 – 2008 installed an average of 251 fixtures with input capacity of 63.7 kW. These T5HO retrofit projects were undertaken despite the higher average incremental installation cost over PSMH technology, which ranged from $18,800 to $25,200.

- **Advantages relative to PSMH technologies.** As discussed in Section 3, these higher initial costs were offset by a number of key advantages.
    - **Operating Cost.** Operating costs for fluorescent linear fixtures are 35 to 50 percent lower than those for PSMH with similar light output. At 2008 electric rates in California,[7] the payback period for selection of T5HO over PSMH technologies would range from 2 to 3 years, depending on the configuration of the project.
    - **Lumen maintenance.** Lumen degradation for fluorescent systems at 40 percent of rated life is 5 to 10 percent, versus 30 to 35 percent for PSMH. In some situations, this will enable customers to reduce relative capital costs by installing a smaller number of fixtures than would have been needed for high intensity discharge (HID) technologies (e.g., PSMH).
    - **Control applications.** Current linear ballast technologies offer more or less instantaneous restart and some dimming capabilities. PSMH require a 10 minute cycle between starts and stops and much more limited dimming capabilities than current linear fluorescent technologies. Thus, the opportunities for gaining energy savings through controls are more limited with HID than with fluorescent technologies.
- **Advantages relative to T-8 fluorescent technologies.** Operating costs and maintenance considerations are roughly equivalent for T-8 and T5HO technologies. T5HO lamps may need to be changed somewhat more frequently due to their relatively higher operating temperatures. The principal advantage of T5HOs over T-8s is the quality of light provided. Their narrower diameter provides more intense, focused light than T-8s are capable of producing. That quality is valued in manufacturing and retail spaces. However, this advantage is purchased at considerable cost since the total operating costs of T-8s are slightly lower than those associated with T5HOs.

[7] $0.1392 per kWh for full service customers in California. http://www.eia.doe.gov/cneaf/electricity/epa/average_price_state.xls

De Facto Objectives of the 2006 – 2008 IOU Programs

The review of the tracking data for California's IOU programs that supported efficient HBL clearly indicates that those programs were operated primarily to support the installation of T5HO lighting technology. As shown in the following table (Table 3), despite the availability of incentives for PSMH, induction technologies, and T-8 linear fluorescent technologies, T5HO technologies accounted for 93 percent of the units for which incentives were paid and 93 percent of total incentives. Only 0.1 percent of units for which incentives were paid were explicitly called out as linear T-8 fixtures. The remainders were linear fluorescent fixtures of unspecified type.

Table 3: HBL Fixtures Rebated and Incentives Paid: 2006 – 2008

Technology	Fixtures Rebated	Percent of Fixtures	Incentives Paid	Percent of Incent.	Average Rebate/Unit
T5HO Technologies	184,601	93.4%	$18,912,836	92.9%	$ 102
T-8 Technologies	105	0.1%	$ 14,187	0.1%	$ 135
Unspecified Linear Fl.	12,915	6.5%	$ 1,423,995	7.0%	$ 110
Total	197,621	100%	$20,351,018	100%	$ 103

Presence of the IOU programs in the market

The sheer scale of HBL program activities compared to our estimated volume of total fixture purchases during the study period serves as an indicator of its influence on market share. The following table (Table 4) displays indices of program scale developed from the IOU's tracking system data and compares those indices to corresponding measures of market size discussed above. According to our market sizing calculations, over 57 percent of program area purchasers of HBL equipment received incentives through the program for some or all of those purchases. Fixtures rebated through the program accounted for nearly 22 percent of total HBL fixture purchases during the study period, and for a similar percentage of total T5HO fixtures installed.

Table 4: Market Size Indices v. Tracked Program Activity

Quantities	All Customers Program Area	HBL Program Participants	Program as % of Market
Number of HBL Purchasers/ Participants: 2006 – 2008	5,203	2,983	57.3%
Total HBL Fixtures Purchased/Rebated: 2006 – 2008	1,221,715	287,110	23.5%
T5HO Fixtures Purchased/Rebated: 2006 – 2008	794,115	184,601	23.2%
Average number of fixtures purchased/rebated	235	96	

The programs also had a large presence among contractors. Roughly two-thirds of contractors in the program area reported receiving rebates for HBL from an IOU. Half of those firms reported receiving rebates for more than 25 projects.

In the program area, contractor promotional support for T5HO fixtures is strong

The high level of out-of-program sales strongly suggests that program area contractors took a much more aggressive approach to promoting and selling T5HOs than did their counterparts in the comparison areas. This finding is supported by the contrast between program and comparison area contractors on key items from the survey.

- **Identification of T5HOs as efficient technology.** Virtually all contractors in the program area consider T5HOs to be energy-efficient, versus 62 percent in the comparison area.
- **PSMH technologies not identified as efficient.** Contractors in the program area do *not* identify the less efficient PSMH technologies as energy efficient, despite their promotion as such by manufacturers and distributors. Only 21 percent of program area contractors consider PSMH to be energy-efficient, versus 70 percent in the comparison area.
- **Consistency in promoting energy efficient technologies.** Seventy-two percent of program area contractors reported that they recommend energy efficient HBL for *all* of their projects, versus 48 percent in the comparison area.

Perceived program influence on contractor behavior

Seventy-nine percent of program area contractors rated the importance of IOU programs in their decisions to promote efficient HBL at 8 or above on a scale of 10. Fifty-four percent of contractors in the program area reported receiving direct marketing support from IOUs, roughly similar to what distributors reported.

Perceived program influence on customer behavior

Seventy-three percent of contractors in the program area rated IOU program influence on the market share of efficient HBL technologies at 8 or above on a scale of 10.

1.3.4 Assessment of Sustainability

Based on our review of the evidence developed for this study, we believe that the observed high market share for T5HO and other linear HBL technologies will persist. Key findings that support this assessment include the following:

- **Current high market share and out-of-program sales for T5HO technologies.** According to the results of the contractor survey, T5HOs currently account for 65 percent of all fixtures sold into the HBL market, and T-8s account for an additional 14 percent. Even in the non-program areas, contractors reported the combined market share for energy-efficient T5HOs and T-8s in HBL applications to be 45 percent. Studies of the development of the market for electronic ballasts for linear fluorescent lighting in the commercial sector[8], as well as market effects studies of consumer products such as ENERGY STAR clothes washers[9] and compact fluorescent lamps[10] have found that market share for efficient products generally remains stable and continues to grow once it reaches the levels observed in this study in the program and non-program areas.
- **Availability of an inexpensive linear fluorescent alternative.** The installed costs of linear T-8 technology are considerably lower than those for T5HOs or for PSMH. In many applications, including those with lower ceiling heights, this approach offers a technical solution that is as efficient as T5HOs at a much lower first cost.
- **Widespread adoption and promotion of fluorescent HBL technologies by contractors.** As discussed in Section 6.3, contractors in California clearly identify T5HOs as a technology that offers many consumer advantages. The high market share and level of out-of-program sales are further evidence of strong contractor support. We infer from this evidence, as well as from the continuing price premium for T5HOs, that contractors are making money by promoting and selling this technology and will continue to do so. The results of in-depth interviews with contractors and program implementation

[8] XENERGY, Inc. PG&E and SDG&E Commercial Lighting Market Effects Study. San Francisco: Pacific Gas & Electric Company. July, 1998.

[9] Wilson-Wright, L., S. Feldman, L. Hoefgen, and A. Li. 2005. "Front-load Marketing," *Proceedings of the 2005 International Energy Program Evaluation Conference*, pp. 735-746, National Energy Program Evaluation Conference, Chicago, IL.

[10] The Cadmus Group, Inc. *Compact Fluorescent Lamps Market Effects Final Interim Report.* San Francisco: California Public Utilities Commission. 2009.

staff suggest that contractors may be able to reduce fixture installation costs by using linear fluorescent technologies, which are lighter than HID technologies and require less heavy lifting equipment.

- **Non-energy consumer benefits.** In addition to energy savings, consumers benefit from the use of linear fluorescents in a number of other technical dimensions, including improved lumen maintenance and easier application of control technology. End users in both regions frequently report that they appreciate the improved lighting quality of the new T5HO fixtures, that it was frequently a goal of the lighting retrofit, and that they installed controls in the program area much more frequently than in the comparison area.

The study also identified a number of conditions that may inhibit continued high market share for fluorescent technologies in HBL applications. The most important of these is the persistent price premium for T5HO technologies. T5HO fixtures continue to cost 20 – 60 percent more than PSMH and T-8 technologies for comparable installations. Under current electricity price regimes in California, this incremental cost is paid back in 2 – 3 years. However, the significant decline in economic conditions since the fourth quarter of 2008 may deter customers from selecting equipment with higher first cost, despite the relatively short payback.

Finally, based on the results summarized above, the Study Team recommends the following in regard to program design, changes to the Market Effects Evaluation Protocol, and future research opportunities.

Recommendations Regarding Program Design

- Discontinue financial support for pulse-start metal halide (PSMH) technologies for HBL retrofit and replacement applications.
- Continue financial support for application of T-8 and T-5 fluorescent technologies in high bay applications, but require that they be implemented in conjunction with occupancy or other advanced controls.
- Continue financial support for niche and emerging HBL technologies such as ceramic MH, induction and LED technologies.
- Continue and intensify customer education and support through sales and service teams for fluorescent HBL fixtures and associated control technologies.

Suggested Changes to Market Effects Evaluation Protocol

- The reporting protocol for market effects studies 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.
- Researchers should include the discovery of unanticipated market effects, if any, as another objective of a market effects study.
- The Market Effects 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.

Suggestions for Future HBL Market Effects Evaluation Work

- A reassessment of the need for financially supporting T5HO technologies in 2012 to 2013.
- A white paper on the use of comparison areas in the nonresidential sector.
- A study on HBL controls and changes in hours of use.
- An HBL end user participants' study.
- A new construction HBL market study.