High Bay Lighting Market Effects Study

FINAL REPORT

Prepared by
KEMA, Inc.
Itron, Inc.

For the
California Public Utilities Commission
Energy Division

June 18, 2010

DISCLAIMER

Contents

<u>Appendices</u>

List of Tables

List of Figures

Acknowledgements

The High Bay Lighting Market Effects Team would like to thank a number of additional parties for their input and assistance in preparing the report, including Ed Vine, Ike Turiel, and Ralph Prahl of the California Institute for Energy and Environment, Kay Hardy and Peter Franzese of the California Public Utilities Commission, and Ken Keating of the Master Evaluation Contractor Team.

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.

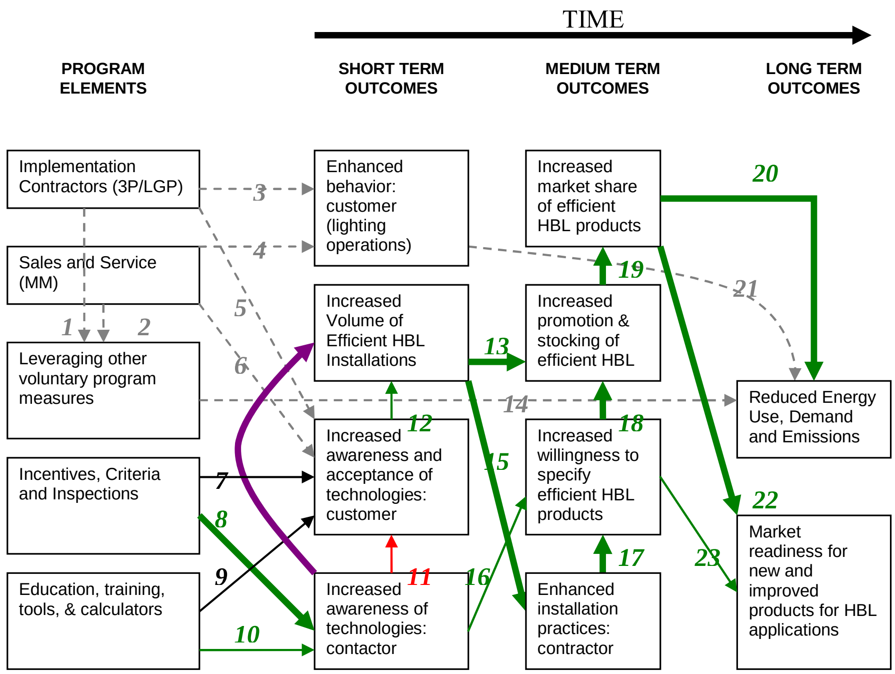
Table 2: Estimates of Net Program Energy Savings

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.

<u>Attributes of T5HO versus competing technologies</u>

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.

2 Introduction

This document presents the results of a market effects study of California's four-largest investor-owned utilities' (IOUs) 2006 – 2008 energy efficiency programs on the commercial & industrial (C&I) markets for high bay lighting (HBL) products.[11] [12] This HBL Market Effects Study was commissioned by the California Institute for Energy and Environment through a Request for Proposal (RFP), CP1-006-08 (April 10, 2008), and funded by the California Public Utilities Commission (CPUC).

2.1 Study Objectives

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 market for HBL.
- 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.

2.2 Methodological Background

The consulting team assembled for this study – KEMA, Inc. supported by Itron, Inc. for survey data collection and program data management – has relied heavily upon the *California Energy Efficiency Evaluation Protocols*[13] for guidance in conducting this market effects study. The *Protocols* define market effects as "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 intervention(s)." It is also useful to consider the definition of market transformation offered by Eto, Prahl, and Schlegel: "a

[11] 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. Table 1 contains descriptions of commonly used HBL technologies.

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

[13] TecMarket Works Team. *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals*. San Francisco: California Public Utilities Commission, April 2006.

reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced, or changed."[14] This study adds the criterion of sustainability implied in the latter definition of market transformation to the Protocol's definition of market effects. Thus, the key research questions to be addressed by the market effects study are as follows:

- What changes occurred in the market for C&I HBL over the period 2006 – 2008?
- To what extent can the observed changes in the market be attributed to the California IOUs' programs?
- What level of energy savings is associated with those changes?
- To what extent are the observed changes in the market likely to be sustained if those programs are changed, reduced in scope, or eliminated?

As pointed out in the RFP, the California protocol for market effects evaluations strongly suggests conducting a scoping study before conducting a market effects study. Components of such a scoping study, when performed at an enhanced level of rigor, are as follows:

> *Define the market by its location, the utilities involved, the equipment, behaviors, sector and the program years of interest. Develop market theory and logic model. Detail indicators. Identify available secondary data and primary data that can be used to track changes in indicators. Outline data collection approach. Recommend hypotheses to test in the market effects study. Recommend the analysis approach most likely to be effective. (p. 150.)*

KEMA prepared a scoping study,[15] which presented the following:

- A summary of secondary sources on past program evaluations and market research reports covering HBL technologies.
- A preliminary characterization of those markets and a market theory based upon secondary research based on in-depth interviews with small samples of lighting manufacturers, distributors and installation contractors.
- A preliminary characterization of the program theory based on program documentation and interviews with program staff.
- A summary of installed HBL measures for the relevant utility programs for the 2006 to 2008 period.

---

[14] Eto, J., R. Prahl, and J. Schlegel. 1996. *A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs.* Berkeley, Calif.: Lawrence Berkeley National Laboratory.

[15] California Public Utilities Commission (Prepared by KEMA, Inc. and Itron, Inc.), *FINAL Scoping Study and Work Plan for a High Bay Lighting Market Effects Study,* June 25, 2009. Hereafter referred to as the *HBL Scoping Study*.

- A summary of indicators to assess theories of the expected market effects, or program outcomes, due to the IOUs' interventions in the market place.
- A detailed plan for this study, including data collection activities and expected outputs such as savings estimates, an assessment of attribution and sustainability.

2.3 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 (see Appendix A).
- Review of California IOU program data for HBL measures on the Energy Efficiency Groupware Application (EEGA).[16]
- 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.
    - In consultation with the study's sponsors and advisors, KEMA originally specified Pennsylvania (excluding Philadelphia), Ohio, and Michigan as the comparison area.[17] 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

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

[17] The Philadelphia area was excluded because as a major metropolitan area bordering New Jersey, the study team anticipated some market influence from New Jersey's energy efficiency programs.

states of Mississippi, Georgia, Alabama, and South Carolina as a more appropriate and tractable comparison area for the market effects study.

    - The Study Team felt that establishing a region with little or no history of HBL program activity was very important to the application of this quasi-experimental design. The in-depth interviews in the Midwestern region revealed that market actors had intermittent experiences with HBL programs which could affect awareness levels of efficiency and specification practices.
    - After conducting a more detailed review of state-level HBL program activity, the Study Team determined that the Mississippi, Alabama, Georgia, and South Carolina region was a potential comparison area with little evidence of program activity.
    - The Study Team compared employee counts in California and the specified comparison area by NAICS code for industries with high likely saturation levels of HBL fixtures to gain some understanding of the comparative industrial structure. While a plot of the employee counts showed the scale of California end users to be larger overall than the comparison area, the profile of employee counts by NAICS code was similar (See Appendix H).
    - In order to assess any systematic differences associated with commercial or cultural differences between California and the comparison area, the Study Team developed a battery of attitudinal questions for the HBL end user market survey to assess any systematic bias in the specified region as a comparison area.

- 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)

2.4 Structure of this Report

This report is structured according to the following subsequent chapters:

- A summary background on HBL technologies describes historical trends and external factors affecting the market such as public policies and regulatory influences.

- The HBL Market in California is characterized along with a description of the market structure and mechanisms.
- The California IOUs' Program Theory and Logic Model for HBL technologies is depicted along with a summary of HBL measure data for 2006 to 2008 IOUs' programs and a presentation of the interrelationships between the program and market theories.
- An analysis of expected outcomes and market effects reviews the data supporting or not supporting any market effects resulting from the California IOU programs in support of HBL measures. Additionally, we present an assessment of net energy and demand savings, program attribution, alternative hypotheses, and sustainability.
- Suggestions for changes to IOU support for HBL technologies, the California Market Effects Protocol, and possible future research activities related to the market for HBL technologies.

Additional data detail and supporting information are provided in a series of Appendices. Appendix A summarizes the key topics from previous studies covering market effects in California and other states. A summary of rebates by HBL measure is presented for each California IOU in Appendix B. The interview guide used for the IOU program managers and other key staff appears in Appendix C. The interview guide used for contractors, distributors, and manufacturers appears in Appendix D. Appendices E, F, and G contain a summary of survey data and the associated CATI protocol used for data collection from lighting contractors, distributors, and end-users, respectively. Appendix H contains the employee sizes for 2002 NAICS Codes of the potential target market for HBL end users in California and in the comparison area for which the states of Mississippi, Alabama, Georgia and South Carolina were selected.[18] A summary of all IOU programs (Mass Market, Third-party and Local Government Partnership programs) claiming savings from HBL measures appears in Appendix I.[19] Appendix J presents a glossary of common technical lighting terminology. Appendix H summarizes Responses to Public Comments from a CPUC-facilitated webinar presentation on May 17, 2010.

[18] Based on the results of the in-depth interviews with contractors and distributors for the scoping study in MI, OH, and PA, the study team concluded that a new comparison area was required with a history that is relatively free of energy efficiency programs supporting HBL technologies. As a result of this second review, the MS, AL, GA, and SC region was specified.

[19] Appendix D summarizes programs that account for 2% of HBL measure savings. The mass market programs from the three IOUs comprise 98% of savings claims from HBL measures and are summarized in detail in the body of the report.

3 Background on HBL Technologies and Historical Trends

This section examines the market evolution of HBL in the commercial and industrial (C&I) sector using information from a variety of industry, professional, government, and academic sources. The most common and emerging lighting technologies appropriate for HBL applications are summarized in the following table (Table 5).

Table 5: Common and Emerging Lighting Technologies for High-Bay Lighting Technologies[20]

Lighting Technology	Description
T5 Fluorescent (T5HO)	A linear fluorescent lamp that is 5/8 of an inch in diameter. The "T" in lamp nomenclature represents the tubular shape of the lamp. The number following the "T" represents the lamp diameter in eights of an inch. T5HO lamps are slightly shorter than T8 lamps and therefore cannot be used as replacements for T8 or T12 lamps. Some luminaires, however, can be made to accept either T5HO or T8 lamps by changing the sockets and ballasts.
T8 Fluorescent (T8)	A linear fluorescent lamp that is one inch in diameter.
T12 Fluorescent (T12)	A linear fluorescent lamp that is 12/8 of an inch in diameter.
High Intensity Discharge (HID)	An electric lamp that produces light directly from an arc discharge under high pressure. Metal halide (MH), high pressure sodium (HPS), and mercury vapor (MV) are types of HID lamps.
Metal Halide (MH)	An HID type lamp that uses mercury and several halide additives as light-producing elements. Metal halide lamps have better color properties than other HID lamp types because the different additives produce more visible wavelengths, resulting in a more complete spectrum. Efficacies of metal halide lamps typically range from 75 to 125 lumens per watt (LPW).
High Pressure Sodium (HPS)	An HID lamp type that uses sodium under high pressure as the primary light-producing element. HPS lamps are among the most efficacious light sources, with efficacies as high as 150 LPW.
Mercury Vapor (MV)	An HID lamp type that uses mercury as the primary light-producing element. Mercury vapor lamps are less efficacious than other HID lamp types, typically producing only 30 to 65 LPW, but they have longer lamp lives and lower initial costs than other HID lamp types.
Light-Emitting Diode (LED)	A small electronic device that emits visible light when electricity is passed through it. LEDs are energy-efficient, have long lives, and can be red, green, blue or white in color.
Induction	An electrode-less lamp that use magnetic induction technology to generate light.

[20] Descriptions in Table 1 are either adapted or verbatim descriptions from the Rensselaer Polytechnic Institute National Lighting Product Information Program (NLPIP) Glossary. Retrieved May 19, 2009, from http://www.lrc.rpi.edu/programs/nlpip/glossary.asp

This section characterizes the following major elements of the market:

1. Changes in technology features
2. Changes in saturation and market share over time
3. Changes in efficient technology prices over time in relation to prices for standard technologies
4. Changes in reported values, motivations, and barriers to promotion and adoption reported by distributors, contractors, and customers
5. Public policy, non-market, and other external factors affecting the HBL market.

HBL technology and markets have evolved rapidly over the past ten years. Therefore, we focus our narrative on that period and use that narrative to frame our understanding of changes observed during the evaluation period of 2006 – 2008.

In a nutshell, the technologies used in HBL applications have evolved in a step-wise fashion over time, and each step in the evolution of the HBL market reflects incremental changes in improved lighting efficacy and increases in operational applicability. These changes motivated early adopters among vendors and customers to select technologies that fit their particular HBL needs at lower lifetime costs. These early trends towards more efficient lighting technologies were then accelerated by reductions in incremental costs associated with increased scale and the development of auxiliary controls and fixture designs that further reduced operating costs. The introduction of metal halide (MH) fixtures and fluorescents in HBL applications represented not only increased energy efficiency compared to the competing technologies of the time (incandescent and mercury vapor) but also improved controllability (dimming, sensors, energy management system integration, etc.). At present, the dominant market share and technology are from pulse start metal halide (PSMH) fixtures. Because of their technological properties, T8/T5HO high-bay applications have increasingly emerged into the HBL market because they can offer similar performance properties at lower lifetime costs. Given the strong program support for T8/T5HO HBL fixtures in California, this market will likely continue to expand in retrofit applications.

The rapid advance of fluorescent technologies in the HBL market suggest that vendors and customers are prepared to consider and value product attributes other than first cost in their technology selection decisions. This may bode well for the success of public purpose programs to support LED technology once market-ready products are developed for HBL applications. Such products promise to provide even higher levels of controllability, better directionality down-lighting, and enhanced energy savings compared to fluorescent and PSMH technology.

3.1 Changes in Technology Features

Advances in commercial lighting technology have been the most important factor driving all major changes in technology saturation and share, pricing, customer acceptance of evolving products and vendors' motivations for promoting them. The key performance dimensions on which customers and vendors assess lighting technologies for a given application include the following:

- Initial equipment and installation costs
- Maintenance and lifetime costs
- Expected lifetime
- Lumen maintenance[21]
- Lumen output per watt (efficacy[22]), which is a key component in operating costs
- Color rendering[23]
- Start-up and restrike time
- Dimmability
- Size range
- Focusing power
- Performance capability in low and high ambient temperatures[24].

[21] Lumen maintenance refers to "how well a lamp maintains its light output over time" (Source: Lighting Glossary, http://www.think-energy.net/lighting_glossary.htm).

[22] Efficacy refers to how efficiently electrical power consumed and is converted to light output. (Source: Interlight, https://www.interlight.biz/lighting.int).

[23] CRI, or the Color Rendering Index, is a scale from 1-100 that expresses "how well colors are rendered by different illumination conditions in comparison to a standard (i.e. a thermal radiator or daylight)." The lower the CRI, the more "washed out" colors appear. (Source: Maxwell Render Resource Center, http://think.maxwellrender.com/lighting__ basic_concepts-92.html).

[24] Tri-State. "Lighting Systems: Lamp Types." *Tri-State Generation and Transmission Association, Inc.,* 2009. http://tristate.apogee.net/ (accessed July 8, 2009).

Table 6 summarizes the basic types of lighting technologies used in retrofit HBL applications by expected lifetime, efficacy, CRI, lamp burn orientation, lumen maintenance, and dimmability. [25] [26] [27] [28] [29] [30] [31] [32] [33] [34] [35] [36] Data presented in the table will be referenced throughout this section.

[25] Darragh, Shaun. "Ceramic Metal Halide." *Lighting Design Lab News*, Winter/Spring, 2003. http://www.lightingdesignlab.com/ldlnews/ceramic_metal_halide_sd.pdf (accessed August 5, 2009).

[26] NCDENR. "Energy Efficiency in Industrial Lighting: Fact Sheet." *North Carolina Department of Environment and Natural Resources*, August 2003. http://www.p2pays.org/ref/26/25978.pdf (accessed June 25, 2009).

[27] Advanced Energy. "T-5 Fluorescent, Bright Idea or just another flash in the pan?" *Advanced Energy*, 2005. http://www.advancedenergy.org/progressenergy/T5versusT8.html (accessed July 13, 2009).

[28] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[29] LRC. "Electrodeless Lamps." *Lighting Fixtures: Covering Advances in Lighting Technologies, Techniques, and Trade*, 1998 1 (1). http://www.lrc.rpi.edu/programs/Futures/LF-Electrodeless/index.asp (accessed August 4, 2009).

[30] LRC. "Lighting Answers: T5 Fluorescent Systems." *National Lighting Product Information Program*, June 2002 6 (1). http://www. lrc.rpi.edu/programs/nlpip/lightingAnswers/lat5/pc1a.asp (accessed August 3, 2009).

[31] LRC. "Lighting Answers: Mid-Wattage Metal Halide Lamps." *National Lighting Product Information Program*, March 2005 7 (1). http://www.lrc.rpi.edu/programs/nlpip/lightinganswers/mwmhl/ characteristics.asp *(accessed August 4, 2009).

[32] LRC. "Lighting Answers: T8 Fluorescent Lamps." *National Lighting Product Information Program*, June 2006, 9 (1). http://www.lrc.rpi.edu/programs/NLPIP/lightingAnswers/t8/abstract.asp (accessed July 14, 2009).

[33] E Source. "Lighting: HID Versus Fluorescent for High-Bay Lighting." *E Source Companies LLC*, 2007. http://www.esource.com/BEA/demo/PDF/P_PA_46.pdf (accessed July 8, 2009).

[34] US Lighting Tech. "Lighting 101." *US Lighting Tech*, 2007. http://www.uslightingtech. com/lighting101.html (accessed August 5, 2009).

[35] GGWES. "Electrodeless – Induction." *Global Green Works Energy Solutions*, 2008. http://www. ggwes.com/induction.html (accessed August 4, 2009).

[36] Tri-State, 2009.

Table 6
C&I High Bay Lighting Technology Comparison

Technology	Expected Lifetime (rated hours)	Efficacy (lm/W)	CRI (1 – 100)	Start-Up Time	Restrike Time	Burn Orientation Limitations	Lumen Maintenance	Dimmability
Incandescent	750 - 1,000	15 - 20	100	0	0	No	Poor	Yes
Mercury Vapor	16,000 – 24,000	25 – 50	15 - 25	4 – 8 min	5 – 10 min	No	Poor	Limited
Low Pressurized Sodium	14,000 - 18,000	100 – 185	5	5 – 7 min	0	No	Excellent	Limited
High Pressurized Sodium	20,000 - 24,000	75 - 130	27	3 – 4 min	>1 min	No	Excellent	Limited
Probe-Start Metal Halide	7,500 – 20,000	60 - 85	60-70	2 – 5 min	Up to 10 min	Yes	Poor	Limited
Pulse-Start Metal Halide	20,000	90 - 110	65-90	2 – 5 min	Up to 10 min	Yes	Poor	Limited
Ceramic Metal Halide	20,000	Not Available	80 - 90	2 – 5 min	Up to 10 min	Yes	Poor	Limited
Induction	100,000	70	80 – 88	< .5 sec	0	No	Excellent	Yes
T8 Fluorescent	20,000 – 30,000	86-94	70-90	1 – 5 sec	0	No	Excellent	Yes
T5HO Fluorescent	20,000	90 - 104	75-98	1 – 5 sec	0	No	Excellent	Yes

The following sections describe the two most important areas of technical development in HBL applications: (1) changes in lamp-ballast technology and (2) the integration of auxiliary lighting component technologies.

3.1.1 Lamp-Ballast Technologies

The emergence of various HBL lamp-ballast technologies resulted in incremental increases in energy efficiency, applicability, or both. Generally speaking, the sequence in which lighting technologies with HBL applications were developed is as follows:

1. Incandescent lamps
2. High intensity discharge (HID) lamps including mercury vapor (MV), low and high pressurized sodium (HPS), and metal halides (MH) which currently consist of probe-start, pulse-start, and ceramic arc tubes
3. High intensity fluorescent (HIF) lamps including T5 biaxial configurations, induction, and linear T8 and T5 high output (T5HO) fluorescents
4. Emerging remote-source technologies like light emitting diodes (LEDs)[37] [38] [39].

Incandescent Lamps

Incandescent lamps represent a diminishing share of the HBL market due to the development of better performing lighting technologies. Lighting manufacturers perceived opportunities to create competitive advantages for their products through the development of more energy-efficient technologies. Although incandescent lamps are competitive with later technologies in many of the dimensions mentioned above, they are very inefficient, especially for C&I HBL applications. About 90 percent of the power used by incandescent lamps is dissipated as waste

---

[37] PG&E. "Codes and Standards Enhancement (CASE) Initiative For PY2008: Title 20 Standards Development Title: Analysis of Standards Options for High-Intensity Discharge Lighting Fixtures." *Pacific Gas and Electric Company*, April 3, 2008. http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-04-01_workshop/2008-04-_Pacific_Gas_+_ Electric_HID_Fixtures_CASE_study.pdf (access June 9, 2009).

[38] PG&E. "Codes and Standards Enhancement Initiative For PY2004: Title 20 Standards Development Analysis of Standards Options for Metal Halide Lamps and Fixtures." *Pacific Gas and Electric Company*, August 10, 2004. http://www.energy.ca.gov/appliances/archive/2004rulemaking/documents/case_studies/CASE_Metal_Halide_Lamps.pdf (accessed June 9, 2009).

[39] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

heat.[40] The average efficacy of an incandescent lamp is 20 lm/W, compared to mercury vapor between 25 and 50 lm/w, pressurized sodium between 75 and 185 lm/w, metal halide between 60 and 110 lm/w, and high output fluorescents between 90 and 104 lm/W.[41 42 43] Although incandescent lamps do not require a ballast, lamp lifetime is especially sensitive to power quality fluctuations.[44] Furthermore incandescent lamps are sensitive to movement and vibration and produce glare requiring supplemental shielding applications that increase high-bay installation costs.[45 46]

Mercury Vapor (MV)

Invented in 1901, MV lamps were commercially introduced in the US in 1934.[47] The least efficient of all HIDs, MV lamps were, over time, primarily developed to surmount shortcomings in fluorescent lighting technologies for outdoor applications, such as lumen output sensitivity to high and low ambient temperatures.[48] While they are nearly three times more energy efficient than incandescent lamps, they are generally less energy efficient than more contemporary lighting technologies for HBL applications.[49 50] MV lamps do, however, have a relatively longer life expectancy than incandescent lamps and other lighting technologies, ranging from 16,000 to 24,000 hours or 24 times that of incandescent lamps.[51] MV lamps also provide a range of colors, sizes, and shapes, and have low initial and replacement costs.[52 53] On the other hand, next to

---

[40] Tri-State. "Lighting Systems: Lamp Types." *Tri-State Generation and Transmission Association, Inc.,* 2009. http://tristate.apogee.net/ (accessed July 8, 2009).

[41] Tri-State, 2009.

[42] LRC. "Lighting Answers: T5 Fluorescent Systems." *National Lighting Product Information Program*, June 2002 6 (1). http://www. lrc.rpi.edu/programs/nlpip/lightingAnswers/lat5/pc1a.asp (accessed August 3, 2009).

[43] NCDENR. "Energy Efficiency in Industrial Lighting: Fact Sheet." *North Carolina Department of Environment and Natural Resources*, August 2003. http://www.p2pays.org/ref/26/25978.pdf (accessed June 25, 2009).

[44] Tri-State, 2009.

[45] NCDENR, 2003.

[46] Tri-State, 2009.

[47] Lamptech. "The Museum of Electric Lamp Technology: The Low Pressure Sodium Lamp." *Lamptech*, 2003. http://www.lamptech.co.uk/Documents/SO1%20Introduction.htm (accessed August 14, 2009).

[48] Tri-State. "Lighting Systems: Lamp Types." *Tri-State Generation and Transmission Association, Inc.,* 2009. http://tristate.apogee.net/ (accessed July 8, 2009).

[49] NCDENR. "Energy Efficiency in Industrial Lighting: Fact Sheet." *North Carolina Department of Environment and Natural Resources*, August 2003. http://www.p2pays.org/ref/26/25978.pdf (accessed June 25, 2009).

[50] Tri-State, 2009.

[51] Ibid.

[52] NCDENR, 2003.

incandescent lamps they are the most inefficient source of light commercially available, have poor lumen maintenance, require a ballast for dimming, are sensitive to power quality fluctuations, and require a start-up time of about seven minutes and an additional cool and restrike time of about five minutes.[54] [55] MV lamps also radiate a significant amount of their light as ultraviolet resulting in lower quality color rendering.[56] As shown in Table 6, MV lamps have a CRI rating between 15 and 25. Like most HBL designed for outdoor operation, the mercury content in MV lamps requires costly toxic waste disposal.[57]

Pressurized Sodium

Pressurized sodium lighting technologies are a type of HID technology and are generally classified into either low-pressure sodium (LPS) or high-pressure sodium (HPS) lights. LPS technologies were first introduced to the market in 1932.[58] This type of fixture still has the highest average efficacy among competing HBL technologies (up to 185 lm/w).[59] LPS technologies offer other advantages over competing technologies, including:

- Enhanced light uniformity
- Optimal lumen maintenance
- A relatively long effective useful life (14,000 to 18,000 hours)
- Relatively insensitive to ambient temperature changes
- Immediate restart capabilities
- Low cost non-toxic waste disposal[60] [61] [62].

---

[53] Tri-State, 2009.

[54] NCDENR, 2003.

[55] Tri-State, 2009.

[56] NCDENR, 2003.

[57] Lamptech, 2003.

[58] Ibid.

[59] Ibid.

[60] Ibid.

[61] Ibid.

[62] Tri-State, 2009.

On the other hand, standard LPS lamps have the following competitive disadvantages:

- Poorest color rendering capabilities among all HBL technologies, producing an unfavorable yellow-orange glow at a CRI rating of only 5
- Highest HID fixture installation costs
- Longest delay to full light output - between seven and fifteen minutes
- Steep reduction in lamp efficiency over time as wattage is increased over time to preserve optimal lumen maintenance[63] [64] [65] [66].

Commercially available in the early 1970s, HPS lamps offer improved color rendering (CRI rating of 27) and color options (although less preferred than incandescent lamps) while maintaining a relatively high lamp energy efficiency compared to incandescent lamps (7 times more energy efficient) and MV lamps (2 times more efficient).[67] [68] HPS lamps also have a wide wattage operating range between 35 and 1000 Watts, a reduced start-up time of three to four minutes, a lifetime of up to 24,000 hours, optimal lumen maintenance, and both horizontal and vertical operation capabilities.[69] [70] [71] Disadvantages of HPS technologies include:

- Long warm-up periods to achieve designed light output (five to ten minutes)
- A one minute restrike cool down delay
- Ballast designs that are subject to "on-off-on" end-of-life cycling damage

---

[63] NCDENR. "Energy Efficiency in Industrial Lighting: Fact Sheet." *North Carolina Department of Environment and Natural Resources*, August 2003. http://www.p2pays.org/ref/26/25978.pdf (accessed June 25, 2009).

[64] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[65] NCDENR, 2003.

[66] Tri-State. "Lighting Systems: Lamp Types." *Tri-State Generation and Transmission Association, Inc.,* 2009. http://tristate.apogee.net/ (accessed July 8, 2009).

[67] NCDENR, 2003.

[68] Tri-State, 2009.

[69] Horizontal and vertical operating positions refer to the position the lamp is able to effectively and efficiently burn. Certain lamp-ballast systems require that the system be installed in a specific position, which may limit its applicability depending on the fixture space available and the desired application.

[70] NCDENR, 2003.

[71] Tri-State, 2009.

- Mercury content requires costly toxic waste disposal[72] [73].

Furthermore, while color options are improved compared to LPS lamps, the tradeoffs for HPS are reductions in lifetime and efficacy.[74]

Metal Halides (MH)

Commercially introduced in the 1960s, MH lamp technology evolved from MV technologies.[75] [76] The addition of MH elements enhanced both the color rendering capabilities and efficacy of the technology.[77] Average lamp life is between 7,500 and 20,000 hours, and efficacy is between 60 and 110 lm/w, with an average efficacy of 90 lm/w.[78] MHs do require a start-up time between two and five minutes and a cool down before restrike that can take as long as 10 minutes.[79] [80] [81]

There are three types of MHs each of which have high-bay applications: (1) probe-start, (2) pulse-start (PSMH), and (3) ceramic. *Probe-start* MHs are considered "standard" metal halides. Probe-start MHs send a high-voltage discharge between a starting probe electrode (located in the lamp itself) and an operating electrode across a small quartz arc tube.[82] *Pulse-start* technology eliminates the starter electrode by introducing a high-voltage igniter pulse with the starter in the

[72] NCDENR, 2003.

[73] Tri-State, 2009.

[74] Ibid.

[75] Lamptech. "The Museum of Electric Lamp Technology: The Low Pressure Sodium Lamp." *Lamptech*, 2003. http://www.lamptech.co.uk/Documents/SO1%20Introduction.htm (accessed August 14, 2009).

[76] NCDENR, 2003.

[77] Ibid.

[78] Advanced Energy. "T-5 Fluorescent, Bright Idea or just another flash in the pan?" *Advanced Energy*, 2005. http://www.advancedenergy.org/progressenergy/T5versusT8.html (accessed July 13, 2009).

[79] Metal halides also have a technical limitation related to burn orientation. Certain base-up, base-down, and horizontal configurations, depending on the lamp involved, can affect color performance and lifecycle duration. This limitation is unlikely to have an impact on the retrofit HBL market because it is largely an installation issue. Unless manufacturing installation standards do not exist or are not enforced, this would not seem to have an affect on the HBL retrofit market.

[80] Tri-State. "Lighting Systems: Lamp Types." *Tri-State Generation and Transmission Association, Inc.,* 2009. http://tristate.apogee.net/ (accessed July 8, 2009).

[81] CLS. "What is the difference in Metal Halide arc tube bodies?" *Commercial Lighting Sales*, 2009. http://www.comlighting.com/glossary/MetalHalide.pdf (accessed August 5, 2009).

[82] PG&E. "Codes and Standards Enhancement (CASE) Initiative For PY2008: Title 20 Standards Development Title: Analysis of Standards Options for High-Intensity Discharge Lighting Fixtures." *Pacific Gas and Electric Company*, April 3, 2008. http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-04-01_workshop/2008-04-_Pacific_Gas_+_Electric_HID_Fixtures_CASE_study.pdf (accessed June 9, 2009).

ballast (as opposed to the lamp).[83] This modification increases the life of the lamp and reduces the size of the arc tube seal, which in turn reduces unwanted heat loss.[84] Given that MHs require both a high pressure and high temperature arc tube to vaporize halide compounds and, therefore, emit light, luminaire[85] efficacy increases with these technical changes.[86] Light output is also enhanced in the long term compared to standard MH lamps by reducing unwanted tungsten build-up that typically blackens the surrounding tube.[87] [88]

The *2004 Pacific Gas & Electric Company (PG&E) Codes and Standards Enhancement (CASE) Initiative Project* examined options for improved standards for MH lamps and fixtures and provides a comparison between probe-start and pulse-start MH (PSMH) that operate in the mid- to high-wattage range – the ranges most applicable to HBL.[89] PG&E reported the following benefits of PSMH over probe-start which in turn reflects how the technology has progressed:

- Higher efficacy
- Superior lumen maintenance
- Extended lamp life
- Reduced warm-up and restrike times
- Increased color consistency and reduced color shift
- Dimmability [90]
- Enhanced color rendering[91].

---

[83] Ibid.

[84] Ibid.

[85] Luminaire refers to the entire lighting system: lamp, ballast, fixture, etc.

[86] Ibid.

[87] Ibid.

[88] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[89] PG&E. "Codes and Standards Enhancement Initiative For PY2004: Title 20 Standards Development Analysis of Standards Options for Metal Halide Lamps and Fixtures." *Pacific Gas and Electric Company*, August 10, 2004. http://www.energy.ca.gov/appliances/archive/2004rulemaking/documents/case_studies/CASE_Metal_Halide_Lamps.pdf (accessed June 9, 2009).

[90] Probe-start MHs require a magnetic ballast. Because magnetic ballasts require additional and costly switches and controls to modify the ballast input voltage, probe-start MH lamps are generally configured in zones on the same circuit. Not only are these additional ballast controls costly to install but connecting multiple lamps to the same circuit limits flexibility of the layout and each individual lamp. (Source: Inter.Light. "Light Guide: Fluorescent Ballasts." Light Guides, 2009. http://www.lightsearch.com/resources/lightguides/ballasts.html (accessed September 1, 2009).

Ceramic MH lamps, commercially available in 1994, offer additional advantages over probe- and pulse-start technologies for certain applications.[92] The substitution of ceramic for quartz arc tubes enables ceramic MH lamps to withstand higher temperatures than both probe and pulse-start models.[93] Depending on the application, ceramic MHs can achieve slightly better color rendering (CRI rating between 80 and 90), color temperature, and efficacy than other MH technologies.[94] Lighting expert Stan Walerczyk argues that "ceramic MH may be the future of metal halide" for these reasons, particularly in markets where customers place a high value on color rendition.[95] Ceramic MHs do not compromise color rendition (as fluorescents do), and maintain comparable efficacy to PSMHs.[96]

Fluorescents

There are three types of fluorescent lighting technologies suitable for HBL applications: (1) T8s, (2) T5HO, and (3) induction technologies. Fluorescents have long dominated the C&I market for low-bay applications.[97] Until relatively recently, they were seldom used in HBL applications because their light output was too diffuse and their ability to operate in low ambient temperatures was limited.[98] [99] For instance, early T8 and T5 lamps could not activate below 50^{o}F.[100] Some newer models, however, are capable of operating at 0^{o}F, and improvements are increasingly being made to reduce the operating temperature even lower.[101] [102] Most biaxial configurations

---

[91] Ibid.

[92] Lamptech. "The Museum of Electric Lamp Technology: The Low Pressure Sodium Lamp." *Lamptech*, 2003. http://www.lamptech.co.uk/Documents/SO1%20Introduction.htm (accessed August 14, 2009).

[93] PG&E. "Codes and Standards Enhancement (CASE) Initiative For PY2008: Title 20 Standards Development Title: Analysis of Standards Options for High-Intensity Discharge Lighting Fixtures." *Pacific Gas and Electric Company*, April 3, 2008. http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-04-01_workshop/2008-04-_Pacific_Gas_+_Electric_HID_Fixtures_CASE_study.pdf (accessed June 9, 2009).

[94] Ibid.

[95] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005, p 10. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[96] Ibid.

[97] E Source. "Lighting: HID Versus Fluorescent for High-Bay Lighting." *E Source Companies LLC*, 2007. http://www.esource.com/BEA/demo/PDF/P_PA_46.pdf (accessed July 8, 2009).

[98] Fetter, David and Jay Barnett. "Fluorescent Solutions for Industrial Lighting." *Energy User News*, July 7, 2000. http://www.esilighting.com/Assets/PDF/ESISolutions.pdf .

[99] E Source, 2007.

[100] Ibid.

[101] Ibid.

[102] Walerczyk, 2005.

achieve optimal operation at 30°F and otherwise experience lumen depreciation above or below that.[103] [104] Most likely, biaxial lamps in HBL applications will be increasingly rare because linear fluorescents provide greater fixture flexibility and efficacy. Only after recent developments over the last 10 - 15 years in linear high intensity fluorescent (HIF) technologies (T8/T5HOs) did HIFs emerge as a viable competitor to HIDs in HBL applications—especially for applications requiring CRI ranges greater than 70.

Ballast technology effective useful life is similar for T8s and T5HOs. Commercialized in the early 1990s, current T8s with program-start ballasts[105] on a 3-hour cycle operate effectively between 20,000 and 30,000 hours with efficacy ratings as high as 94 lm/w. [106] [107] [108] More widely available around the year 2000, T5HOs with program-start ballasts on a 3-hour cycle could operate at 20,000 hours with efficacy ratings as high as 104 lm/w.[109] [110]

T8s are generally the most versatile fluorescent tube fixture for HBL applications. Not only are T8s cheaper than T5HOs but also high ballast case temperatures pose less of a problem for T8s, whereas the reduced size of the T5 in a high output application leads to increased ballast temperatures.[111] This implies that T5HO lamps tend to have a higher heat density over a smaller area which may cause a damaging level of heat build up.[112] Furthermore, T8s have a slightly higher efficacy, can have a longer lifetime when on the same 3 hour cycle, and require less wattage than T5HOs with similar lumen output over the same floor area.[113]

---

[103] Ibid.

[104] A biaxial lamp is a form of non-linear fluorescent lamp that doubles back on itself creating a tight "U" shape bend. The biaxial lamp has a common 2' X 2' configuration designed to save space.

[105] A program start ballast "(r)efers to a type of rapid start ballast that optimizes the starting process by waiting until the lamp's electrodes have been heated to apply the starting voltage, thus easing the load to the electrode and extending lamp life. Standard rapid start ballasts heat the electrodes during the starting process to allow quicker starting without flicker" (Source: LRC. "Lighting Answers: T5 Fluorescent Systems." *National Lighting Product Information Program*, June 2002 6 (1). http://www.lrc.rpi.edu/programs/nlpip/lightingAnswers/lat5/pc1a.asp (accessed August 3, 2009)).

[106] The 3-hour cycle is a standard operating cycle used for comparison between lamps.

[107] LRC. "Lighting Answers: T8 Fluorescent Lamps." *National Lighting Product Information Program*, June 2006, 9 (1). http://www.lrc.rpi.edu/programs/NLPIP/lightingAnswers/t8/abstract.asp (accessed July 14, 2009).

[108] Advanced Energy. "T-5 Fluorescent, Bright Idea or just another flash in the pan?" *Advanced Energy*, 2005. http://www.advancedenergy.org/progressenergy/T5versusT8.html (accessed July 10, 2009).

[109] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[110] Advanced Energy, 2005.

[111] Walerczyk, 2005.

[112] Ibid.

[113] Ibid.

Compared to MHs, T8/T5HOs have several distinct technical advantages and features. These include:

- Higher efficacy
- Increased energy savings potential – a 48 percent savings with a 400 W HIF compared to a 400 W MH, with an average energy savings potential of 20 – 40 percent across all fixtures
- Better lumen maintenance
- Instant-on and restrike capabilities
- The ability to provide emergency ballasting options[114]
- Diminished color shift
- Greater color rendering on average
- Lamp color consistency
- Range of color options
- Quieter operation
- Extended lifetime
- Naturally uniform, diffuse lighting
- Reduced shadows and glare
- Increased controllability (dimming, sensors, photocell switches, daylight harvesting, energy management and scheduling systems, etc)[115] [116] [117] [118] [119] [120] [121].

---

114 Lighting expert Craig DiLouie defines a fluorescent emergency ballast as "a ballast with a built-in battery that senses when power is cut to the unit, resulting in relays inside the ballast switching to battery power to operate the lamp(s) and produce code-compliant illumination during an emergency." (Source: DiLouie, January 2009).

115 DiLouie, Craig. "Fluorescent Emergency Ballasts." *Lightnow: News and Opinion for Lighting People*, January 27, 2009. http://www.lightnowblog.com/2009/01/fluorescent-emergency-ballasts/ (accessed September 1, 2009).

116 DiLouie,Craig. "High/Low-Bay Applications: Fluorescent or Metal Halide?" *Lighting Controls Association, May 2009.* http://www.aboutlightingcontrols.org/education/papers/high-low-bay.shtml (accessed June 20, 2009).

117 Marbek. "BC Hydro Conservation Potential Review 2002 Commercial Sector Report (Base Year: Fiscal 2000/01)." *Marbek Resource Consultants*, June 2003. http://www.cee1.org/eval/db_pdf/426.pdf (accessed July 2, 2009).

118 DiLouie, 2009.

119 Itron. "National Energy Efficiency Best Practices Study – Energy Efficiency Best Practices: What's New?" *California Best Practices Project Advisory Committee*, July 2008. http://www.eebestpractices.com/pdf/whatsnew.pdf (accessed June 19, 2009).

T8/T5HOs also have a few disadvantages compared to MH technologies. For instance, fluorescents project a diffuse light rather than the point source MH light that is typically reflected by a parabolic reflector, and operating temperatures can affect lumens output and the operability of certain controls.[122] Lower lumen output generally requires more fixtures over the same space—depending on the temperature and ceiling height—compared to the number of MH lamps, thereby increasing installation and replacement costs.[123] As noted earlier, MHs are also much better than fluorescents at operating in a range of temperatures. Fluorescent electronic ballasts remain more sensitive to extreme cold and hot starting temperatures and to fluctuations from extreme temperature changes, with an optimal operating temperature of 77°F.[124] [125]

Another member of the HIF family that has made inroads into the HBL market is induction lighting. *Induction lighting* is an electrode-less application of fluorescent lighting that is characterized by a very long effective useful life (around 100,000 hours) and instant-on restrike capabilities in especially cold operating conditions (-40°F).[126] These features make induction lighting a particularly viable option for applications with difficult access conditions or low ambient temperatures.[127] The performance tradeoffs for induction lighting when compared to MHs and T8/T5HOs, however, include lower efficacy and a high lumen depreciation of around 40 percent.[128]

---

[120] Efficiency Maine. "Lighting Guide – Efficient Lighting Technologies: High Intensity Fluorescent Lighting." *Efficiency Maine,* November 2008. http://www.efficiencymaine.com/pdfs/HIFLighting.pdf (accessed July 8, 2009).

[121] NRCAN. "High-Bay Lighting." *Natural Resources Canada*, February 4, 2009. http://oee.nrcan.gc.ca /industrial/equipment/high-bay/index.cfm?attr=24 (accessed July 13, 2009).

[122] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[123] DiLouie,Craig. "High/Low-Bay Applications: Fluorescent or Metal Halide?" *Lighting Controls Association, May 2009.* http://www.aboutlightingcontrols.org/education/papers/high-low-bay.shtml (accessed June 20, 2009).

[124] Ibid.

[125] Walerczyk, 2005.

[126] E Source. "Lighting: HID Versus Fluorescent for High-Bay Lighting." *E Source Companies LLC*, 2007. http://www.esource.com/BEA/demo/PDF/P_PA_46.pdf (accessed July 8, 2009).

[127] Walerczyk, 2005.

[128] BC Hydro. "HID Vs. Fluorescent For High-Bay Lighting." *BC Hydro*, May 9, 2009. http://www.bchydro.com/ powersmart/technology_tips/buying_guides/lighting/hid_versus_fluorescent.html (accessed June 30, 2009).

Light Emitting Diodes

LEDs are an emerging form of solid-state lighting in which semiconductors convert electricity into light.[129] LEDs are particularly promising HBL applications because of their technological features. Unlike other HBL lamp types that naturally generate uplighting, LEDs project most of their output light down. Additional benefits include: compact size, increased resistance to damage or vibration, resistance to rapid cycling, instant-on, and dimmability and color controls.[130] LEDs also have a relatively long effective useful life (50,000 hours).[131] The long life span of LEDs portends well for applications in which maintenance costs are high or require risky working conditions, such as tunnels or parking garages. LED efficacy shows significant potential to one day rival its current competition in high-bay applications.[132] LED research continues to focus on increasing the range of applications, improving the level of light output, and improving chip heat dissipation through heat sinking approaches.[133]

Ballast Technology: Magnetic vs. Electric

The general evolution of lighting ballasts from magnetic to electronic has enabled many of the technological improvements discussed above. In addition to greater energy efficiency, electronic ballasts have the following advantages over magnetic ballasts:

- Reduced size and weight
- Reduced internal heat loss and therefore an increase in energy efficiency
- No flicker or audible noise
- Higher lumen maintenance
- Enhanced color consistency
- Extended lamp life
- The ability to power an increased number of lamps with a single ballast
- Greater design options

---

[129] DOE. "LED Basics." *US Department of Energy, Building Technologies Program*, January 2008. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led_basics.pdf (accessed July 8, 2009).

[130] Ibid.

[131] Ibid.

[132] Ibid.

[133] Itron. "National Energy Efficiency Best Practices Study – Energy Efficiency Best Practices: What's New?" *California Best Practices Project Advisory Committee,* July 2008. http://www.eebestpractices.com/pdf/whatsnew.pdf (accessed June 19, 2009).

- Greater controllable range and lower cost of dimmability[134] [135] [136].

3.1.2 Technology Integration

The previous subsection focused on the evolution of basic light production technologies for HBL applications and its effect on the HBL market. Below, we focus on the integration of auxiliary technologies (such as controls) and elements of fixture design, and the role that these technical developments have played in shaping the HBL market. Integration of auxiliary technologies prolongs the market presence of technologies that might otherwise cease to be competitive. The integration of auxiliary lighting components influences the range of applications, lifetime, energy efficiency, and/or usage of currently available HBL technologies. In some cases, these auxiliary technologies even make traditionally less energy-efficient options more cost effective than higher efficiency options depending on the application and operating environment.[137] [138] The following represent the predominant auxiliary technologies that have been integrated with HBL:

- Domes and reflectors
- Temperature modifying applications (fluorescents)
- Controls
- Lighting-daylighting integration[139].

---

[134] Magnetic ballasts require additional controls and switches that must "condition the power delivered to the ballasts." For both new construction and retrofit opportunities that desire controllability, magnetic ballasts have a number of disadvantages including: controlled ballasts must be on the same circuit creating controllable "zones" limiting how light is distributed; creating multiple zones which require a unique circuit is costly; and zones are "inflexible and are unable to accommodate changes in usage patterns;" retrofit-replacement costs are high; and opportunities for optimizing energy savings is low. (Source: Inter.Light. "Light Guide: Fluorescent Ballasts." Light Guides, 2009. http://www.lightsearch.com/resources/lightguides/ballasts.html (accessed September 1, 2009).

[135] AEL Group. "Advantages of Using Electronic Ballasts." *Asian Electronics Ltd*. http://www.aelgroup.com/benefits%20of%20electronic%20ballasts.pdf (accessed July 14, 2009).

[136] PG&E. "Codes and Standards Enhancement Initiative For PY2004: Title 20 Standards Development Analysis of Standards Options for Metal Halide Lamps and Fixtures." *Pacific Gas and Electric Company*, August 10, 2004. http://www.energy.ca.gov/appliances/archive/2004rulemaking/documents/case_studies/CASE_Metal_Halide_Lamps.pdf (accessed June 9, 2009).

[137] Operating environment refers to the commercial or industrial space the lamp-ballast system, or luminaire, operates in.

[138] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lightingwizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[139] Ibid

Each of these technologies provides operational flexibility to the end-user by enabling standard lighting technologies to fit unique environmental conditions, operational schedules, performance criteria, and enhanced luminaire energy efficiency.

Domes and Reflectors

Domes and reflectors enhance luminaire energy efficiency by improving the transmission of light from the lamp. There are three types of domes: metal, faceted metal, and glass lined.[140] Metal or spun metal domes achieve roughly 70 – 80 percent luminaire energy efficiency with the light directed downward.[141] In some applications, slants are also added to achieve desired uplighting.[142] Faceted metal domes can achieve luminaire energy efficiency between 80 and 94 percent and can incorporate an inner dome reflector.[143] For reflectors, two primary types are most common: prismatic and metal linear. Glass and acrylic prismatic reflectors provide higher luminaire energy efficiency than domes, in some cases in excess of 93 percent when using supplemental metal reflectors.[144] Prismatic reflectors, however, cost more than domes.[145] Manufactured with a 95 percent reflective aluminum, metal reflectors tested with T5HO and T8 HBL applications have yielded luminaire energy efficiencies as high as 93 percent.[146] In fact, the *2000 California Statewide Commercial Energy Efficiency Potential Savings Study* identified the potential for significant energy savings opportunities when combining reflectors with energy-efficient fluorescent HBLs – a configuration that has a short payback in the case of retrofit applications that involve delamping.[147]

Temperature modifying applications for fluorescents

Because optimal fluorescent light output is related to a specific ambient temperature range, the development of specific auxiliary technologies has helped to mitigate less-than-optimal operating requirements related to normal-to-cold and hot-to-normal temperature fluctuations.[148] For instance, in especially cold applications (-18^{o}C), tube guards, lenses, and fixture enclosures

---

[140] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[141] Ibid.

[142] Ibid.

[143] Ibid.

[144] Ibid.

[145] Ibid.

[146] Ibid.

[147] Xenergy. "California Statewide Commercial Sector Energy Efficiency Potential Study Final Report Volume 1 of 2." *Pacific Gas and Electric Company*, July 9, 2002. http://calmac.org/publications/CA_EEPotV1_rev.pdf (accessed June 9, 2009).

[148] Walerczyk, 2005.

retain heat exhaust and create a thermal blanket around the lamp.[149] In contrast, uplight vents, heat sinking metals like aluminum, and ballast vents help to reduce the temperature in applications where heat buildup is detrimental to the system.[150]

Auxiliary Controls

Occupancy sensors and dimming switches are the most popular types of controls for use in HBL applications. The significant saturation of magnetic-ballasted HIDs in the marketplace, however, inhibits penetration of these controls. The *2000 California Statewide Commercial Sector Energy Efficiency Potential Study* indicated that significant potential exists for dimming and occupancy sensor controls in the commercial marketplace, suggesting that as of 2001, only 10 percent of the market was captured.[151] Given the high level of program support for lighting controls in California, it is reasonable to assume that the national market share is lower. Furthermore, the 2008 study of *National Energy Efficiency Best Practices* found that functioning controls can reduce lighting energy consumption by 51 percent.[152] As previously noted, however, this same study found that challenges associated with control applications persist.[153] For instance, in a recent study of 123 commercial buildings, more than 50 percent of the facilities had non-functioning controls.[154] Clearly, significant potential exists for applications of improved lighting controls for HBL fixtures, among other commercial lighting technologies.

Incorporation of Daylighting

Daylighting strategies are possible for use in both HID and HIF technologies. The instant-on capability of fluorescents, however, best supports daylighting applications.[155] Photoswitches, occupancy sensors, and controls can be used with technologies, resulting in reduced load and energy use.[156] Despite the potential advantages in daylight harvesting, research does suggest some hesitancy in the marketplace to implement the strategy as a retrofit measure due to high

---

[149] Ibid.

[150] Ibid.

[151] Xenergy. "California Statewide Commercial Sector Energy Efficiency Potential Study Final Report Volume 1 of 2." *Pacific Gas and Electric Company*, July 9, 2002. http://calmac.org/publications/CA_EEPotV1_rev.pdf (accessed July 8, 2009).

[152] Itron. "National Energy Efficiency Best Practices Study – Energy Efficiency Best Practices: What's New?" *California Best Practices Project Advisory Committee,* July 2008. http://www.eebestpractices.com/pdf/whatsnew.pdf (accessed June 19, 2009).

[153] Ibid.

[154] Ibid.

[155] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[156] Ibid.

implementation costs.[157] A study completed in 2000 of commercial lighting practices in the Pacific Northwest identified additional market barriers, including lack of design integration awareness among contractors, lack of general knowledge of dimming and light harvesting by contractors, lack of significant end-user demand for daylighting applications, and generally low market penetration levels of available daylighting technologies.[158]

3.2 Changes in Saturation and Market Share over Time

This section presents general changes in market saturation and share that have been observed over time with regards to HBL technology. Clearly the technological advantages of MH fixtures have created greater market opportunities when compared to HPS and MV lighting systems. Estimates by the US Department of Energy (DOE) suggested that in 2002 there were nearly 35 million MH lamps in operation in C&I and outdoor applications nationally and about 3 million in California alone.[159] In 2001 – the last year of available reported HID fixture sales data by the US Census Bureau – HID fixtures sales were approximately 12 million.[160] PG&E's 2004 code enhancement study estimated that roughly 90 percent of these unit sales are installed in HBL applications.[161] Furthermore, PG&E reported that in C&I spaces, MH lamps respectively represent 63 and 71 percent of all HID luminaires installed, with probe-start and magnetic ballasts the predominant technologies in use.[162] Furthermore, several lighting manufacturers have reported to PG&E that the majority of their HID MH shipments remain probe-start MHs.[163] In 2004, one lighting manufacturer cited by PG&E reported that "overall 80 percent of their shipments of MH lamps over 150W are probe-start, the remaining 20 percent are pulse-start."[164] Based on results of the Wisconsin *Business Program: Channel Study* and other more recent work, fluorescent technologies have begun to reduce the market share of MH for indoor HBL

---

[157] Xenergy. "Market Research Report: Commercial and Industrial Lighting Study, Volume 1." *Northwest Energy Efficiency Alliance*, December 2000. http://www.cee1.org/eval/db_pdf/242.pdf (accessed July 7, 2009).

[158] Ibid.

[159] KEMA, Inc. 2009. *Scoping Study and Work Plan for a High Bay Lighting Market Effects Study.* San Francisco: California Public Utilities Commission, Energy Division.

[160] Ibid.

[161] PG&E. "Codes and Standards Enhancement Initiative For PY2004: Title 20 Standards Development Analysis of Standards Options for Metal Halide Lamps and Fixtures." *Pacific Gas and Electric Company*, August 10, 2004. http://www.energy.ca.gov/appliances/archive/2004rulemaking/documents/case_studies/CASE_Metal_Halide_Lamps.pdf (accessed July 9, 2009).

[162] Ibid.

[163] PG&E. "Codes and Standards Enhancement Initiative For PY2004: Title 20 Standards Development Analysis of Standards Options for Metal Halide Lamps and Fixtures." *Pacific Gas and Electric Company*, August 10, 2004. http://www.energy.ca.gov/appliances/archive/2004rulemaking/documents/case_studies/CASE_Metal_Halide_Lamps.pdf (accessed July 9, 2009).

[164] Ibid, 7.

applications.[165] In outdoor stationary HBL applications (e.g., tunnels, gas station canopies, and parking garages), a recent PG&E study reports that currently the market consists of 67 percent HPS, 24 percent MV, and 9 percent MH fixtures.[166]

The literature that was reviewed for this study shows that recent changes to federal standards should give PSMH and HIF technologies an edge in the retrofit market. For instance, between 2006 and 2008, federal standards governing probe-start technology have made significant shifts in manufacturing requirements.[167] Starting in January 2006, MH vertical, base-up lamps between 150W and 500W can no longer be manufactured with probe-start magnetic ballasts.[168] Although banned in California, starting January 2008, probe-start MH magnetic ballasts must sustain a 94 percent minimum energy efficiency level, regardless of operating position.[169] As of 2008, there were no probe-start magnetic ballasts manufactured capable of meeting these requirements.[170] These changes in standards will likely accelerate the increase in market share for PSMHs and HIFs in the replacement and new construction markets, although the retrofit market may lag due to higher costs of replacing operating equipment.[171]

Lighting manufacturers continue to report that the technological competitiveness of HIFs and LEDs are a leading reason for further retrofit market expansion of these technologies.[172] Especially with instant-on capabilities, both of these technologies have increased levels of controllability, and readily interface with sensors and controls in ways that HID start-up and restrike delays cannot.[173] Manufacturers report that they are finding building owners interested in retrofitting their HBL fixtures, opting for removal of their HID technology altogether and replacing it with an HIF option.[174]

---

[165] KEMA, Inc. 2009. *Business Programs: Channel Studies – Fiscal Year 2008*. Madison, WI: Wisconsin Public Service Commission.

[166] PG&E. "Codes and Standards Enhancement (CASE) Initiative For PY2008: Title 20 Standards Development Title: Analysis of Standards Options for High-Intensity Discharge Lighting Fixtures." *Pacific Gas and Electric Company*, April 3, 2008. http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-04-01_workshop/2008-04-_Pacific_Gas_+_Electric_HID_Fixtures_CASE_study.pdf (accessed July 9, 2009).

[167] Ibid.

[168] Ibid.

[169] Ibid.

[170] Appleton. "New Federal Standards Eliminate Lower Efficacy Fixtures and Lamps." *EGS Electrical Group, LLC*, 2008. http://www.appletonelec.com/PDF/WhitePaper/MMetalHalide_TopicBrief.pdf (accessed August 5, 2009).

[171] Ibid.

[172] PG&E, 2004.

[173] Ibid.

[174] Ibid.

As will be described later, the market for LEDs is currently limited by both its price and technological limitations for broader use. James Brodrick, the lighting program manager of the U.S. Department of Energy's Building Technology Program (a program dedicated to advancements in solid-state lighting), predicts however that LED market emergence will very likely follow a similar trend as observed in the more recent emergence of HIFs.[175] Namely, that costs and technological application will be the initial market drivers and barriers, but that a shortened payback, better lumen maintenance, reduced lumen depreciation, improved efficacy, enhanced color rendering, and enhanced controllability will make LEDs increasingly more capable of competing in the market.[176] These incremental technological improvements that LEDs will provide for HBL applications increase performance and market demand and will eventually drive costs down and retrofit market penetration up. In other words, Brodrick suggests that there will not be a unique "tipping point" where prices and consumer interest in technology converge into a rush on the LED market.[177] Rather, he foresees a gradual increase in the market share of LEDs as their cost and performance attributes continue to improve in comparison to MH and fluorescent technologies.

3.3 Changes in Efficient Technology Prices over Time in Relation to Prices for Standard Technologies

The following section presents information on relative material cost data for common HBL technologies in relation to prices for standard technologies where data were available.

Cost Comparison of HID and Fluorescent Fixtures

Historically, installation costs (including materials) for fluorescent fixtures in HBL applications have exceeded HIDs. Based on Goodmart.com's 2004 lighting sales data for Sylvania lamps and ballasts, Advanced Energy published average first costs associated with T8s and T5HOs in 2004 on its web site ranging from \$11 to \$15 per kilolumen.[178] In contrast, MH fixtures averaged about \$9 per kilolumen.[179] According to these data, in 2004 MHs had lower initial costs than fluorescents, and may have also had an advantage in lifetime costs due to the smaller number of fixtures needed to light a given amount of floor space. If these costs persisted, lighting experts maintain that despite the high cost of PSMH electronic ballasts, the widespread use of MH luminaires in the HBL market could favor adoption of electronic ballast retrofits over costly HIF

---

[175] Brodrick, James. "LED Watch: The Cost Factor." *US Department of Energy*, June 2009. http://apps1. eere.energy.gov/buildings/publications/pdfs/ssl/lda-cost_06-09.pdf (accessed July 9, 2009).

[176] Ibid.

[177] Ibid, 16.

[178] Advanced Energy. "T-5 Fluorescent, Bright Idea or just another flash in the pan?" *Advanced Energy*, 2005. http://www.advancedenergy.org/progressenergy/T5versusT8.html (accessed July 13, 2009).

[179] Ibid.

change-outs.[180] This would in turn help drive the costs of those ballasts down and make PSMH and ceramic MH retrofits more cost competitive. Industry resources suggest that when comparing MHs to T8s with properly implemented controls, however, the declining first costs and 20 to 40 percent annual cost savings of T8 technology creates a cost competitive alternative to MHs over the life of a system.[181] [182]

Cited from the *2008 DEER Measure Cost Documentation*, Table 7 below reflects 2008 DEER lighting measure cost data based on wattage and lumen output ranges typical of HBL applications.[183] Lumen output is a particularly important characteristic of a luminaire for HBL applications because it determines what lamp-ballast combination will best suit a desired application and, furthermore, the energy efficiency and first costs involved. For instance, industry literature suggests that typical mean lumen output suitable for HBL applications, in general, range between 14,500 and 50,000 lumens.[184] [185] Table 7 was generated from DEER's lighting measure cost dataset based on these parameters; measures were selected based on common HBL lumen outputs and wattages.

Besides lamp-ballast type, wattage, and lumens output, the reported DEER cost data are also determined according to a specific program delivery strategy. The strategies selected from DEER's 2008 dataset used for comparison here include:

- Downstream prescriptive replacement rebates/incentives
- Downstream prescriptive retrofit rebates/incentives
- Downstream prescriptive rebates/incentives
- Rebates.

For the latter two, because neither replacement nor retrofit is specified in DEER's dataset for these strategies, measures with these strategies are presumably new installations with a rebate or

---

[180] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[181] Ibid.

[182] NRCAN. "Lighting Reference Guide." *Natural Resources Canada*, 2005. http://oee.nrcan.gc.ca/publications/ equipment/lighting/doc/LightningReferenceGuide-NRCAN-E.pdf (accessed June 19, 2009).

[183] Keneipp, Floyd and Mike Yim. "2008 DEER Measure Cost Documentation." Revision 3. *Summit Blue Consulting, LLC*, June 2, 2008. http://www.deeresources.com/index.php?option=com_content&view=article&id=65&Itemid=57 (accessed January 22, 2010)

[184] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[185] INFORM. "High-Bay Lighting: Opportunities for Mercury Reduction and Energy Efficiency." *INFORM, Inc.*, December 2003. http://www.lightcorp.com/PDFs/industrial/learn/InformHgReduction_DD1A4.pdf (accessed January 23, 2010).

incentive. Because lighting measure cost data are not available for each of these four strategies equally across all reported technologies in the DEER dataset, comparisons between lighting measure costs on the basis of lumen output are not necessarily always apples-to-apples comparisons in Table 7.

Comparable data in DEER from 2005 are not available.

Table 7
2008 DEER Lighting Measure Cost Data: Applicable HBL Technologies Based on Wattage and Lumen Output

Technology	Lamp Wattage	Lamp Quantity	Ballast Type	Ballast Quantity	Lumen Output	Watts per Fixture	Program Delivery Strategies	Material Cost	Cost per Kilolumen
Incandescent	1000	1	NA	NA	23,740	1000	Downstream Prescriptive Rebates/Incentives - Replacement	Not Available	Not Available
Mercury Vapor	400	1	Unspecified	1	18,700	455	Downstream Prescriptive Rebates/Incentives - Replacement	Not Available	Not Available
Mercury Vapor	700	1	Unspecified	1	33,000	780	Downstream Prescriptive Rebates/Incentives - Replacement	Not Available	Not Available
Mercury Vapor	1000	1	Unspecified	1	44,000	1075	Downstream Prescriptive Rebates/Incentives - Replacement	Not Available	Not Available
High Pressure Sodium	200	1	Unspecified	1	19,260	250	Downstream Prescriptive Rebates/Incentives - Retrofit	$144.11	$7.48
High Pressure Sodium	360	1	Unspecified	1	41,450	414	Downstream Prescriptive Rebates/Incentives – Replacement	$180.55	$4.36
High Pressure Sodium	400	1	Unspecified	1	45,000	465	Downstream Prescriptive Rebates/Incentives – Retrofit	$189.66	$4.21
Probe-Start Metal Halide	250	1	Unspecified Magnetic	1	14,500	295	Downstream Prescriptive Rebates/Incentives - Replacement	$152.84	$10.54

Technology	Lamp Wattage	Lamp Quantity	Ballast Type	Ballast Quantity	Lumen Output	Watts per Fixture	Program Delivery Strategies	Material Cost	Cost per Kilolumen
Probe-Start Metal Halide	400	1	Unspecified Magnetic	1	22,000	458	Downstream Prescriptive Rebates/Incentives - Replacement	$164.40	$7.47
Pulse-Start Metal Halide	250	1	Pulse Start CWA (Magnetic)	1	16,625	288	Downstream Prescriptive Rebates/Incentives – Replacement	$148.33	$8.92
Pulse-Start Metal Halide	350	1	Pulse Start CWA (Magnetic)	1	25,200	400	Downstream Prescriptive Rebates/Incentives - Retrofit	$165.64	$6.57
Pulse-Start Metal Halide	400	1	Pulse Start CWA (Magnetic)	1	30,000	456	Downstream Prescriptive Rebates/Incentives – Replacement	$203.54	$6.78
Fluorescent, 46in, T5HO lamp	54	4	Programmed Start Electronic (BF: 1.00)	2	19,000	234	Downstream Prescriptive Rebates/Incentives - Replacement	$206.03	$10.84
Fluorescent, 46in, T5HO lamp	54	6	Programmed Start Electronic (BF: 1.00)	3	28,500	351	Downstream Prescriptive Rebates/Incentives - Replacement	$283.06	$9.93

*NLO, Normal Light Output; RLO, Reduced Light Output; BF, Ballast Factor; CWA, Constant-Wattage Autotransformer

(Source: Keneipp, Floyd and Mike Yim. “2008 DEER Measure Cost Documentation.” Revision 3. *Summit Blue Consulting LLC*, June 2, 2008. http://www.deeresources.com/index.php?option=com_content&view=article&id=65&Itemid=57 (accessed January 22, 2010))

Table 8 below compares the costs per kilolumen for metal halides and T8/T5HO fluorescents for two different periods. On balance, the values below are consistent with the industry and utility program literature as discussed in earlier subsections: that retrofit or replacement first costs for fluorescent fixtures tend to be higher than for HID. This condition of relatively higher incremental costs for T5HO fixtures compared to pulse start metal halide fixtures persists in the comparative data from 2004 and 2008. Corresponding retrofit/replacement data for T8 fixtures in 2008 are not available in DEER, but those costs would likely be lower than those for T5HO fixtures.

Table 8
Technology Cost per Kilolumen Comparison: HIDs versus HFLs

Technology	Cost per Kilolumen	Source	Date of Data
Metal Halide	$9	Goodmart.com/Advanced Energy	2004
Probe Start Metal Halide (22,000)	$7.47	DEER 2008	2008
Pulse Start Metal Halide (25,200)	$6.57	DEER 2008	2008
Pulse Start Metal Halide (30,000)	$6.78	DEER 2008	2008
T8/T5HO	$11 - $15	Goodmart.com/Advanced Energy	2004
T5HO (19,000 lumens)	$10.84	DEER 2008	2008
T5HO (28,500 lumens)	$9.93	DEER 2008	2008

These data also show a slight decrease in costs for all fixtures during that period, especially for T5HO retrofit/replacement fixtures relative to pulse start metal halides. In particular, for a comparable lumens output range (between 19,000 and 22,000 lumens), the cost of probe start metal halides in 2008 ($7.47) fell below the composite value in 2004 for metal halides ($9). For T8/T5HO fixtures at a comparable lumens output levels, the cost range is similar from $11 to $15 in 2004 compared to the 2008 value in DEER ($10.84)—but T5HO fixtures were likely on the high end of that 2004 range. At higher lumens output levels (25,000 to 30,000), a cost comparison between PSMH and T5HO fixtures for 2008 shows similar reductions, with relatively higher reductions for T5s.

The comparison in Table 8 raises some questions with regard to the validity of the data for comparison, however. The comparison would be better supported if DEER had corresponding values from 2005, but such values are unavailable. That the incremental cost differences persist is fairly well supported in the literature and through the study team's primary data collection efforts. The rate of relative decreases between the technologies, however, is less supported. Alternative explanations might include the following:

- The cost reductions are valid and represent a slightly higher relative reduction for T5s in California compared to the country. Goodmart.com's data are national manufacturer pricing data, while DEER data are specific to California. California's history of IOU program support for energy efficiency may explain why the more energy-efficient fluorescents seem to be gaining traction in cost reduction in a retrofit market rich with MHs.
- The cost reductions are valid but represent national trends only with slightly greater relative reductions for T5s.
- The estimates are imprecise using two different methodologies, and no real change has taken place during the 2004 to 2008 period either nationally or in California specifically.

LED Cost Comparisons

Comparing costs from (Table 8) of MH and T8/T5HO fixtures to LEDs, the price differential is considerable at an estimated $30 per kilolumen for white LEDs.[186] Roughly three years ago, red LED pricing averaged $500 per kilolumen.[187] In 2008, the US Department of Energy reported that red LED pricing decreased, averaging around $200 per kilolumen moving toward comparable price signatures with competitive technology around 2020 or 2025.[188] Likewise, in 2001, white LEDs cost $200 per kilolumen, and, in 2007, dropped to approximately $30 per kilolumen.[189] Brodrick states that Haitz's Law, which governs LED price signals over time, has proven to be an applicable guide.[190] The Law, using data collected for the last 40 years, contends that for every ten years the output of red LED light will increase 20 times while the price will decrease by a factor of 10 resulting in an overall retail cost reduction of 20 percent per year.[191] Brodrick notes that currently the observed cost reduction for red LED's is slightly ahead of Haitz's estimations – at roughly 25 percent.[192] With Federal lighting research dedicated to funding further advancements in LEDs, the technology may emerge in the manner that DOE

[186] DOE. "LED Basics." *US Department of Energy, Building Technologies Program*, January 2008. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led_basics.pdf (accessed July 8, 2009).

[187] Brodrick, James. "LED Watch: The Cost Factor." *US Department of Energy*, June 2009. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/lda-cost_06-09.pdf (accessed July 9, 2009).

[188] Ibid.

[189] DOE. "LED Basics." *US Department of Energy, Building Technologies Program*, January 2008. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led_basics.pdf (accessed July 8, 2009).

[190] Brodrick, 2009.

[191] Ibid.

[192] Ibid.

predicts.[193] Furthermore, while LEDs have the highest lumen per watt cost, these costs may be offset by lower operating costs associated with reduced maintenance and lumen depreciation rates.

3.4 Changes in Reported Values, Motivations, and Barriers to Promotion and Adoption of HBL Technologies as Reported by Distributors, Contractors, and Customers

Below we present general changes in values, motivations, and barriers to promotion and adoption of HBL technologies as reported in available literature.

Reported Barriers

The following list reflects the barriers that have persisted over time and will likely continue to present challenges in the short- to medium-term:

- **General technical barriers**. The general technical barriers associated with lamps and ballasts that have naturally limited market penetration include: ambient temperature operability, restrike and warm-up times, dimmability, the environmental operating space and height of the application, lifetime and lifetime costs, lumen output and maintenance, luminaire depreciation, heat dissipation, color consistency and shift, and retrofit and maintenance costs.[194] [195]
- **Recent purchases of sub-optimal technologies.** The large portion of customers who have upgraded their HBL lighting to PSMH using ratepayer funded programs may be unwilling to invest in the replacement of these systems with more efficient fluorescent equipment.[196]
- **Control and sensor performance and implementation issues.** Utility studies consistently report that customers and contractors demonstrate reluctance to use controls and occupancy sensors due to distrust in performance and/or lack of technical and implementation knowledge.[197]

---

[193] Itron. "National Energy Efficiency Best Practices Study – Energy Efficiency Best Practices: What's New?". *California Best Practices Project Advisory Committee*, July 2008. http://www.eebestpractices.com/pdf/whatsnew.pdf (accessed June 19, 2009).

[194] Marbek. "BC Hydro Conservation Potential Review 2002 Commercial Sector Report (Base Year: Fiscal 2000/01)." *Marbek Resource Consultants*, June 2003. http://www.cee1.org/eval/db_pdf/426.pdf (accessed July 2, 2009).

[195] Walerczyk, Stan. "HIBAYS It's All About The Details." *Lighting Wizards*, September 19, 2005. http://www.lighting wizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf (accessed June 19, 2009).

[196] Xenergy. "Market Research Report: Commercial and Industrial Lighting Study, Volume 1." *Northwest Energy Efficiency Alliance*, December 2000. http://www.cee1.org/eval/db_pdf/242.pdf (accessed July 7, 2009).

[197] Ibid.

- **The lack of standardized controls.** Some market observers believe that the lack of effective and standardized industry-wide lighting controls has led to a significant incidence of controls that do not work at all or in the intended manner. This lowers the energy efficiency of the intended system, limits the application of the intended system, and discourages future use.[198]

- **HBL-daylight harvesting integration.** The following barriers are associated with HBL-daylight harvesting integration: prohibitively high installation costs, poor control capabilities, low technical awareness amongst contractors and customers, low demand related to low awareness, and limited contractor retrofit expertise to capture daylighting opportunities in the lighting layout and design.[199]

- **PSMH electronic ballast.** The availability of electronic ballasts for PSMH applications remains limited, and they remain costly compared to magnetic ballasts. Thus only 2 percent of PSMHs in the market have electronic ballasts.[200] This trend has limited realization of the full potential of PSMH technologies in terms of controllability and energy savings.[201]

- **T5HO market share and cost.** The predominant barrier to increased market share for T5HOs is cost, primarily due to manufacturing rates and because retrofits require completely new fixtures.[202]

- **LED cost and performance barriers.** LEDs are still too expensive, and their performance in HBL applications is not sufficiently advanced to support immediate gains in market share. As discussed above, however, the development of this technology has been rapid and will continue to receive public support.[203]

---

198 Itron. "National Energy Efficiency Best Practices Study – Energy Efficiency Best Practices: What's New?" *California Best Practices Project Advisory Committee*, July 2008. http://www.eebestpractices.com/pdf/whatsnew.pdf (accessed June 19, 2009).

199 Xenergy, 2000.

200 PG&E. "Codes and Standards Enhancement Initiative For PY2004: Title 20 Standards Development Analysis of Standards Options for Metal Halide Lamps and Fixtures." *Pacific Gas and Electric Company*, August 10, 2004. http://www.energy.ca.gov/appliances/archive/2004rulemaking/documents/case_studies/CASE_Metal_Halide_Lamps.pdf (accessed July 9, 2009).

201 Ibid.

202 Bisbee, David A. "Customer Advanced Technologies Program Technology Evaluation Report: T5 Fluorescent High-Bay Lighting Systems." *Sacramento Municipal Utility District*, May 15, 2002. http://www.cee1.org/eval/ db_pdf/422.pdf (accessed July 11, 2009).

203 Itron, 2008.

Observed Customer Values and Reported Motivations

The drivers for customer adoption and vendor promotion of successive HBL technologies have remained fairly constant over time. These are:

- First cost, which includes the material cost of lamps, fixtures and controls, and installation costs
- Lifetime cost, which is shaped by efficacy, component life, rates of lumen depreciation, and ongoing maintenance requirements
- Lighting performance, as characterized by controllability, technical limitations for key applications, warm-up and restrike intervals, and color rendition.

Public policies and programs targeted to the HBL market have worked over the past five years to alter the relative weight that customers and vendors apply to these sets of motivations. Specifically, changes in Federal and California state product standards will effectively limit the use of incandescent, mercury vapor, and probe-start metal halides in HBL applications. Aside from these general motivations, however, the HBL market has only recently become a focus for detailed analysis by the energy efficiency industry. We are aware of only one study that explores levels of customer awareness, knowledge, and value accorded to energy efficiency in HBL: KEMA's *Business Programs: Channel Studies – Fiscal Year 2008*, conducted for the Wisconsin Public Service Commission.[204] This study uses the results of surveys with lighting installation contractors in Wisconsin and a non-program area (Illinois) to compare progress in the development of the market in the two states for energy-efficient HBL.[205] In this survey, the contractors were asked to estimate the percent of recent relevant projects in which they had recommended efficient forms of HBL, as well as the percent in which such equipment was actually installed. They were also asked to assess the value that their customers placed on various attributes of lighting equipment, including initial costs, total cost of ownership, and quality of lighting.

The key findings from this study in regard to customer response to efficient HBL lighting were as follows:

- Contractors in Wisconsin reported that fluorescent technologies were actually installed in 72 percent of relevant projects versus 28 percent in Illinois.[206] The observed difference

---

[204] KEMA, Inc. 2009. *Business Programs: Channel Studies – Fiscal Year 2008*. Madison, WI: Wisconsin Public Service Commission.

[205] Ibid.

[206] Ibid.

between the two states in this regard was statistically significant at the 99 percent level.[207] This finding suggests that fluorescents have made strong inroads into the HBL market in general, but that the consistent support of energy efficiency programs in Wisconsin has significantly accelerated this trend.[208]

- Contractors in Wisconsin reported that they had recommended fluorescent fixtures for 69 percent of relevant projects versus 51 percent in Illinois.[209] This observed difference is not statistically significant. From this observation, we can conclude that contractors in states that have not been served by energy efficiency programs have begun to promote fluorescent fixtures for HBL applications, but that customer response has not caught up to that in states that have been served by such programs.
- In most other respects, contractor perceptions of conditions on the customer side of the HBL market did not differ significantly between the two states. Specifically, the percentage of projects in which T5HO systems, high performance T8 systems, and daylighting controls were recommended and installed did not differ significantly.[210] Customers in Wisconsin, however, accorded significantly higher importance ratings to system operating costs, total lifetime costs, and quality of light versus their counterparts in Illinois.[211] This result may reflect the effects of consistent utility promotion and customer education programs.

Customers and vendors nationwide are beginning to select fluorescent fixtures for a significant portion of HBL applications, responding to that technology's relative advantages in life-cycle cost and trends in reduced first cost and increased performance. Based on the results of the *Wisconsin Business Programs Study*, it appears that ratepayer funded programs have accelerated that trend in the markets where they are offered.[212] Again, the Wisconsin findings are consistent with experience in California. The *2003 Statewide Express Efficiency Program Measurement and Evaluation Study* reported that California linear fluorescent HBL system rebates proved the

---

[207] Ibid.

[208] Ibid.

[209] Ibid.

[210] Ibid.

[211] Ibid.

[212] KEMA, Inc. 2009. *Business Programs: Channel Studies – Fiscal Year 2008*. Madison, WI: Wisconsin Public Service Commission.

most desired customer lighting rebate available with continuous vendor support for such rebates.[213]

3.5 Key External Factors Affecting the HBL Market

The literature review, in-depth interviews, and market surveys with market actors conducted for this study identified a number of external factors affecting the HBL market. These factors include public policies, regulatory standards, soft economic conditions nationwide and the level of awareness of environmental and energy issues. Soft economic conditions arguably apply nationally with mixed impacts on regional markets. This section focuses on the following external factors that have influenced the development of the market for energy-efficient HBL: Codes and Standards and Voluntary Programs. Section 4 discusses awareness factors in the context of specification and market shares.

3.5.1 Codes and Standards

State Codes and Standards

The California Energy Commission revised Title 24 to require the use of pulse-start ballasts in new fixtures effective in 2004. Nine other states have taken similar action.[214] There are also new California Title 20 Appliance Standard requirements that push the manufacturers towards metal halide electronic ballasts.

Many of the spaces that use HBL also fall under the skylighting and daylighting control requirements in Title 24. The control requirements would be more easily met with fluorescent sources that do not have the restrike issues associated with metal halide lamps. Also, the warehouse lighting power densities in Title 24 are 40 percent lower than those in ASHRAE 90.1[215] (see sections 131(c), 143(c) and 146 in Title 24). This also helps to push designers toward higher efficiency lighting sources like T5HO or T-8 aisle lighter luminaires.

---

[213] PGE. "2003 Statewide Express Efficiency Program Measurement and Evaluation Study." *Pacific Gas and Electric Company*. March 21, 2005. http://www.calmac.org/publications/!Final_2003_Express_Eval_Report_ and_Appendices.pdf (accessed July 11, 2009).

[214] The other states are Arizona, Connecticut, the District of Columbia, Massachusetts, Maryland, New York, Oregon, Rhode Island, Washington, Vermont. Based on results from http://www.standardsasap.org/documents/StatestandardsstatusgridJanuary2009update.pdf, accessed May 21, 2009.

[215] ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, is a consensus standard developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) to provide minimum requirements for the energy efficient design of buildings. ASHRAE 90.1 has been adopted as state or local energy code in several jurisdictions.

Federal Codes and Standards

In December 2007, the U.S. Congress enacted the Energy Independence and Security Act, setting initial minimum efficiency standards for metal halide lamp fixtures.[216] Effective January 1, 2009, the law requires a minimum ballast efficiency of 88 percent for pulse start ballasts and a minimum ballast efficiency of 94 percent for magnetic probe start ballasts. The U. S. Department of Energy must complete a rulemaking to consider increased standards by January 1, 2012. Any revision would be effective January 1, 2015.

Industry and Professional Standards

Current standards by the American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and the Illuminating Engineering Society of North America (IESNA) contain lighting power density allowances that are sufficiently high to be met by either HID or fluorescent technologies. It is not clear when these standards will be revised.[217] [218]

3.5.2 Voluntary Programs

Voluntary energy efficiency programs operated by utilities and other sponsors nationwide have offered financial incentives and technical support for the installation of PSMHs and high-performance fluorescent products in HBL applications for well over a decade. Distributors and contractors in California and in non-program areas reported being aware of these programs as well. Nearly all of the California vendors believed that the incentive programs had contributed to the observed growth in market share for efficient HBL technologies. Section 3 contains a detailed description of the California programs and their volume of activity in support of HBL.

Past California IOU Programs

Based on a review of recent evaluation efforts from 2004 to 2005 in California,[219] rebates for energy-efficient HBL measures were available; however, the specific HBL measures eligible for

---

[216] http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_public_laws&docid=f:publ140.110

[217] "ASHRAE, founded in 1894, is an international organization of 51,000 persons. ASHRAE fulfills its mission of advancing heating, ventilation, air conditioning and refrigeration to serve humanity and promote a sustainable world through research, standards writing, publishing and continuing education." From http://www.ashrae.org, accessed May 19, 2009.

[218] "The Illuminating Engineering Society of North America (IES) is the recognized technical authority on illumination. For over 100 years; its objective has been to communicate information on all aspects of good lighting practice to its members, to the lighting community, and to consumers, through a variety of programs, publications, and services." From http://www.ies.org, accessed May 19, 2009.

[219] PGE. "2003 Statewide Express Efficiency Program Measurement and Evaluation Study." *Pacific Gas and Electric Company*. March 21, 2005. http://www.calmac.org/publications/!Final_2003_Express_Eval_Report_ and_Appendices.pdf (accessed July 11, 2009); and, Itron, Inc. et al. Small Commercial Contract Group Direct Impact Evaluation Report. San Francisco: California Public Utilities Commission. December 11, 2009.

IOU incentives were unchanged. According to program managers, the incentives were always intended to offset the incremental cost of the higher efficiency measure compared to a standard efficiency measure—usually a probe start metal halide. As discussed in Section 6, IOU support for energy-efficient HBL measures from the 2004 to 2005 period probably had little or no effect on customers during the 2006 to 2008 period, but the effect on the supply side is less clear. Based on a review of available evaluations during that program period, HBL applications were not a focus and we cannot make a determination of the impact of the 2004 to 2005 programs on contractors.

Review of Other Incentive Programs with Potential Market Influence

Other national and regional energy-related programs may interact in the market for HBL within California's IOU service territories. Such programs include the ENERGY STAR program, the U.S. Green Building Council's (USGBC) Leadership in Energy & Environmental Design (LEED) program, and the Sacramento Municipal Utility District (SMUD) incentive programs.

LEED is a third-party certification system for the design, construction, and operation of high performance buildings. This program may have some minor influence on the market for HBL, given that the LEED rating system includes credits relating to energy performance, daylighting, and the controllability of lighting systems, for both new construction and existing buildings. The LEED rating system encourages buildings to achieve increasing levels of energy performance above baseline levels, which may include increasing the efficiency of planned or existing HBL. In addition, the rating system encourages the use of occupant controls for lighting and interior daylighting.

Additionally, SMUD offers several incentives for commercial lighting within its territory. These incentives cover HBL applications and include financing options and rebates for the following:

- Title 24 Interior Lighting ($.06/kWh up to the lesser of 30% or $150,000)
- Non-Title 24 and Exterior Lighting ($.04/kWh up to the lesser of 30% or $100,000)
- T12 Retirement Incentives (50% of project cost up to $150,000 for commercial customers w/ 300kW+)
- Prescriptive Incentives for Small Businesses (for commercial customers <300kW, up to $20,000)
- Express Incentive: Occupancy Sensors Integrated in High Bay Fixtures ($20/sensor).

Review of Program Support for Efficient HBL Technologies by State

Table 9 summarizes support, if any, for HBL technologies across the continental 48 states. Each state is characterized by having active or partial support based on how recently the program was implemented and the extent of geographic program coverage, and a third category of no or unknown support.

The majority (58%) of states maintain some active support for energy-efficient HBL technologies and another 19% of states include some partial (e.g., local) or very recent support.

Table 9
Level of Support for Energy Efficient HBL in the Contiguous US by State

State	Active Support	Partial/Recent Support	No Support
Alabama			√
Arizona	√		
Arkansas			√
California	√		
Colorado	√		
Connecticut	√		
Delaware			√
Florida	√		
Georgia		√	
Idaho	√		
Illinois	√		
Indiana		√	
Iowa	√		
Kansas	√		
Kentucky		√	
Louisiana			√
Maine	√		
Maryland		√	
Massachusetts	√		
Michigan		√	
Minnesota	√		
Mississippi			√
Missouri	√		
Montana	√		
Nebraska	√		
Nevada		√	
New Hampshire	√		
New Jersey	√		
New Mexico	√		

State	Active Support	Partial/Recent Support	No Support
New York	√		
North Carolina			√
North Dakota		√	
Ohio		√	
Oklahoma			√
Oregon	√		
Pennsylvania		√	
Rhode Island	√		
South Carolina			√
South Dakota	√		
Tennessee			√
Texas	√		
Utah	√		
Vermont	√		
Virginia			√
Washington	√		
West Virginia			√
Wisconsin	√		
Wyoming	√		
TOTAL	**28**	**9**	**11**
PERCENTAGE	**58%**	**19%**	**23%**

Source: Database of State Incentives for Renewables & Efficiency (DSIRE), accessed on April 22, 2009. Some of these states may offer residential, non-profit, or government lighting incentives.

4 The HBL Market in California

In this section, we identify the key groups of business establishments in the HBL market, specify their functions in the market, and describe the mechanisms by which they have pursued that objective. This market characterization is based upon the following sources:

- A literature review
- In-depth interviews conducted for this study with program staff, manufacturers, distributors, and installation contractors[220]
- Survey data collected from installation contractors, distributors, and end-users[221]

4.1 Overview

In this subsection, we characterize the roles that each key group of market actors plays in the HBL market. Subsequent subsections discuss external influences on the HBL market and present findings on the current state of the market for efficient HBL and the motivations and barriers that each group of market actors faces in promoting those products.

As stated earlier, this study primarily addresses the retrofit market for energy-efficient HBL technologies. Based on the team's experience with other non-residential new construction studies, one working assumption is that individual technologies such as HBL tend to be subsumed under a broader market system in the non-residential new construction market.

In-depth Interviews for Developing the Market Surveys

The study team conducted in-depth 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.

The in-depth interviews with program managers guided data collection efforts from the market actors. In general, the market structure is fairly well understood; however, the relative influences of specific sales and specification channels may vary across regions, and these relative influences represent the market components that the California IOUs seek to understand, target and

[220] In-depth interviews with contractors and distributors covered California and a Midwestern region of Pennsylvania, Ohio, and Michigan.

[221] CATI survey data collection covered California and a Southwestern region of Mississippi, Alabama, Georgia, and South Carolina.

influence. To avoid a potential for California bias, in-depth interviews were conducted with market actors in both California and nationally for manufacturers, and with a group of Midwestern states for lighting distributors and installation contractors.

In consultation with the study's sponsors and advisors, the Study Team originally specified Pennsylvania (excluding Philadelphia), Ohio, and Michigan.[222] The Study Team conducted in-depth interviews with representatives of 11 manufacturers (national and California), 15 distributors (seven in the original Midwestern comparison area), and 16 installation contractors (seven in the original Midwestern comparison area) active in the C&I HBL market.

Based on the in-depth interviews with manufacturers, manufacturers tend to be national in scope and target California because it is a large market. Indeed, this finding was confirmed by all manufacturers interviewed, selling products across the country and Canada. Manufacturers showed no regional variation, but recognized that California is a large market and focus for efficient lighting technologies, in general.

During the in-depth interviews with lighting distributors and installation contractors, the Study Team detected few, if any, differences between the market actors' responses in California versus the Midwestern comparison area. Any differences detected were subtle. The Study Team also found the following:

- Distributors tend to be regional or even national in size and organization, in California and in the comparison area. Distributors in the comparison area were similar in size to those in the California sample. The California distributors interviewed included four national firms, one west-coast regional firm, and four firms focusing on California. The in-depth interviews with distributors did possibly suggest perceptions of relatively greater awareness by contractors in California of the full range of energy-efficient HBL options than in the comparison area.
- Contractor firms can be large enough to extend their operations beyond states. The market structure, however, across all respondents generally reveals that contractors have little influence upstream in terms of supplier decisions, but manufacturers and distributors can have a great deal of influence over contractors as the most common sales channel. Contractors, in turn, have the most influence over the customer's decision-making and specification, but rely heavily on the distributors' specifications and recommendations.

The most significant difference that we identified between California and the Midwestern comparison area reflected a possible tendency of contractors to specify lower-efficiency HBL technologies in the comparison states than in California due to the recent soft economic

[222] The Philadelphia area was excluded because as a major metropolitan area bordering New Jersey, the study team anticipated some market influence from New Jersey's energy efficiency programs.

conditions. Several contractors in the comparison areas raised concerns about the lighting quality of the newer energy-efficient HBL technologies compared to none in California.

CATI Survey Data Collection

Based on further analysis of programs across the nation and discussions with the study's 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 felt that establishing a region with little or no history of HBL program activity was very important to the application of this quasi-experimental design. The in-depth interviews in the Midwestern region revealed that market actors had intermittent experiences with HBL programs which could affect awareness levels of efficiency and specification practices. The Study Team took the following steps in identifying the comparison area:

- After conducting a more detailed review of State-level HBL program activity, the Study Team determined that the Mississippi, Alabama, Georgia, and South Carolina region was a potential comparison area with little evidence of program activity.
- The Study Team compared employee counts in California and the specified comparison area by NAICS code for industries with high likely saturation levels of HBL fixtures to gain some understanding of the comparative industrial structure. While a plot of the employee counts showed that the scale of California end users to be larger overall than the comparison area, the profile of employee counts by NAICS code was similar (See Appendix H).
- In order to assess any systematic differences associated with commercial or cultural differences between California and the comparison area, the Study Team developed a battery of attitudinal questions for the HBL end user market survey to assess any systematic bias in the specified region as a comparison area.

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)

The market survey data collected for the study tend to support the Study Team's initial conclusions about the market structure.

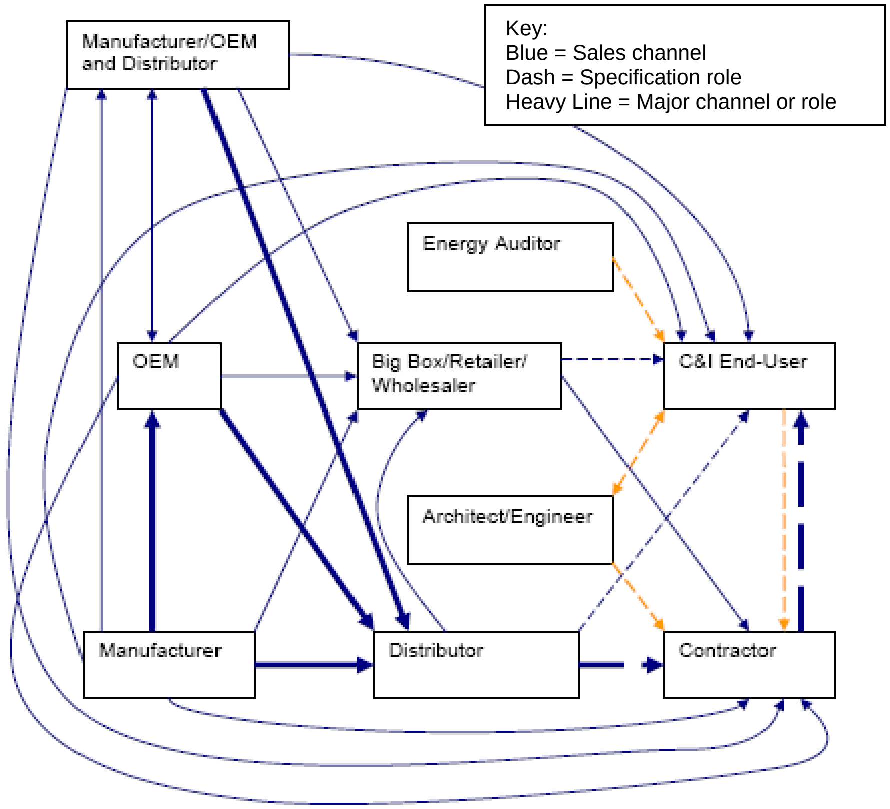
- The contractor is the most common sales channel to the end user and influencer in the specification process, followed by design services from engineers, distributors, architects, etc.
- The response patterns between regions are very similar from the battery of attitudinal questions. For example, about half of all end users in both regions claim to have some group or individual manage energy use and costs as part of an environmental or sustainability initiative. Substantial majorities in both regions have energy use reduction goals, track energy use and costs, and have staff to identify opportunities for reducing energy use. Some difference exists in terms of their organizations' focus on energy-related purchasing, however, with 70% of end users in California compared to about half (49%) in the comparison area (significant at 95%).
- Lighting distributors and installation contractors in California seem to be more specialized and sophisticated in their marketing approach to energy efficient high bay equipment than in the comparison area.
- All market actors in California tend to be more aware of higher efficiency high bay lighting solutions than their counterparts in the Southeastern United States.

4.2 Market Structure

Figure 2 reflects utility program staffs' and market actors' views of the market structure and basic mechanisms for installation of lighting for HBL applications.[223] Generally speaking, HBL products move from left to right. Manufacturers are located on the left side of the figure; installation contractors and end-users on the right. The blue arrows represent the movement of goods, i.e., sales. The dashed lines (regardless of color) represent specification roles, which can take several forms: instructions from customers to vendors; purchase suggestions from vendors to customers; or work products of professional design engagements. The heavy lines indicate the dominant channels of sales and specifications. The color and dashed line combinations reflect both sales and specification combinations (e.g., a heavy blue dashed line indicates a primary sales channel with a specification role; an orange dashed line indicates a specification role).

[223] The description that follows does not take into account specific market features or promotion mechanisms associated exclusively with the 2006 – 2008 programs operated by the California IOUs.

Figure 2: The California Market for HBL



The following sections summarize the functions of the key market actor groups.

Manufacturers

Manufacturing firms in the HBL market carry out three distinct functions: production, distribution, and marketing. Within the production function, there are two principal areas of activity: component manufacture and assembly. Component manufacture involves the design and production of lamps, ballasts, housings, reflectors, controls, etc. Assembly consists of putting those components together into finished products – mainly fixtures – for end-user consumption. In the industry, the term "manufacturer" refers to firms that generate most of their revenues through component sales, although they may also assemble some components into fixtures and other final products. The term "OEM"[224] refers to firms that generate most of their revenue from assembly and sales of fixtures. OEMs may market their products themselves or assemble products on a contract basis that other firms will market under their own name.

OEMs and manufacturers who sell directly into the customer market report selling 75 to 80 percent of their output to distributors. The remaining product is sold to other OEMs, a few large

---

[224] Original Equipment Manufacturer

customers, and big box retailers. The last category represents an alternative market channel to conventional electrical distributors. Some OEMs and manufacturers provide distribution, warehousing, and inventory management services, particularly for non-distributor sales.

Manufacturers play a key role in marketing HBL products through a variety of channels. These include advertising in the trade press, appearance at trade shows and conventions, direct mail and other media to distributors and contractors, and intensive personal marketing to distributors and contractors by in-house sales staff and independent manufacturers' representatives. Materials provided in support of the marketing and sales efforts include paper and Internet-based catalogues and price lists, specification guides, energy use and energy savings calculators, and customer-oriented brochures and point-of-sales (POS) materials. Contractors and distributors from both California and the non-program areas frequently reported that they received marketing support from manufacturers.

Distributors also noted the high level of manufacturer marketing activity. One California distributor, discussing the knowledge level of contractors in regard to HBL, noted, "Manufacturers' reps directly target contractors, so they know their stuff by this point."

Distributors

Distributors purchase lighting equipment from manufacturers, warehouse it, and sell the equipment to contractors, end-use customers, and, occasionally, OEMs as needed. Thus, they perform a vital inventory management and financing function in the distribution chain. Some distributors also perform other functions, including provision of lighting design specification services, usually at no cost to the contractor as a means to promote sales and customer loyalty.

The results of the distributors' surveys suggest that distributors are extremely heterogeneous in terms of what they sell and to whom. The annual revenue sources for distributors (Table 10) suggest more specialization toward lighting versus general electrical supplies in the California market compared to the distributors in the comparison area. The highest percentage of revenues for distributors in California comes from lighting sales to contractors (44%). This is higher than sales to contractors in the comparison area (19%) and significant at the 95% confidence level. For lighting business activities, direct lighting sales to customers are second highest in both the comparison area (27%) and California (14%). In the comparison area, the overall highest percentage of revenues is from some other source (41%) unrelated to lighting, which is the second highest source of revenue (21%) in California. Lighting sales to retailers, lighting layout and design services, as well as lighting installation and maintenance services are relatively small percentages of distributors' revenues in both California and the comparison area. These response patterns are similar to the in-depth interview data.

Table 10
Approximate Percentage of Annual Revenue Coming From the Following Activities (All Distributors)

Ratio Estimates	CA	SC-GA-AL-MI
n	**114**	**73**
Lighting Sales to Customers	14%	27%
Lighting Sales to Original Equipment Manufacturers (OEMs)	4%	3%
Lighting Sales to Contractors	44%	19%**
Lighting sales to retailers	5%	7%
Lighting layout and design services	3%	2%
Lighting installation services	5%	1%
Lighting maintenance services	4%	<1%*
Other	21%	41%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

In terms of distributor sales to contractors, distributors describe similar sales processes between the regions, with most of the sales in each region being specified by the contractor (Table 11). The most common sales process is where contractors provide a list of their needs and request a quote (34% of sales in California and 33% in the comparison area). A similar percentage of sales (33%) in the comparison area is completed by contractors interacting generally with the distributors compared to 23% in California. Sales situations in which distributors actually perform specification services account for 34% of California sales and 24% of comparison area sales. None of the values compared between the regions differ significantly.

Table 11
What percent of your sales to contractors would you describe as follows?
(All Distributors)

Ratio Estimates	**California**	**SC-GA-AL-MI**
n	116	73
Contractors come in with a list of what they need and only ask for a price	34%	33%
Contractors come in with a layout and you discuss their options in a general way	23%	33%
You work with contractor to develop lighting layouts and equipment schedules	23%	19%
You work with project engineer or architect to develop lighting layouts	11%	5%
Other approach	9%	10%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

When asked what percent of customers are aware of the full range of energy efficient HBL options prior to making any recommendations (Table 8), over half (52%) of California distributors report that a majority (50% or greater) of their customers are aware of the full range of options versus 43% in the comparison area.

Table 12
About what percent of your customers are aware of the full range of options for energy-efficient high bay lighting available to them before you provide recommendations about the lighting system?
(All Distributors)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**132**	**68**
Between 0 and 10	8%	9%
Between 11 and 25	13%	11%
Between 26 and 50	27%	37%
Between 51 and 75	20%	15%
Between 76 and 100	32%	28%
Do Not Know	<1%	<1%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

In the in-depth interviews, manufacturers state that big box stores account for a relatively small portion of total HBL product sales. However, they do provide some specification help to contractors. According to program staff, "out of program" sales are probably also a very small proportion of overall sales for retrofit applications; however, big box do-it-yourself stores (such as Home Depot) probably account for a high portion of those "out of program" sales. We did not include representatives of big box stores in the original distributor interviews or follow-up market survey.

Contractors

Electrical and lighting contractors specify and install lighting fixtures, controls, and related equipment in C&I facilities. As such, contractors' decision making is fairly critical to the market share for various HBL technologies. Their willingness to specify higher efficiency—and higher cost—products is a function of their product awareness and business profile. HBL projects tend to be larger jobs and, therefore, tend to favor larger installation firms.

Recent studies of the C&I lighting market in states outside of California[225] have made the following findings in regard to the structure and operations of the contracting sector:

- Firms with 25 or more employees, which account for 10 percent of total establishments, completed 50 percent of C&I lighting projects. These firms are, therefore, very important in the overall operation of the market and in the level of adoption of energy-efficient products and practices. Firms with 5 – 24 employees accounted for roughly one-third of C&I projects.
- Installations of HBL technologies in new construction projects accounted for one-half of installation revenues. However, that pattern may change in the next few years due to the poor economy in the commercial real estate market.
- Contractors worked directly for owner/occupants in roughly one-half of their projects, and with general contractors in one-third of their projects. Clients for the rest of the projects included developers and other specialty contractors.
- On average, contractors won one-third of their projects through price bids on detailed specifications, and an additional 25 percent through more loosely structured competitive proposals. The remaining projects were obtained through no-bid situations through established business relationships. The percentage of price-only bids was higher in new construction than in renovation and replacement projects.

[225] KEMA, Inc. (2005). *Business Program Market Characterization and Baseline Study.* Madison, WI: Wisconsin Energy Conservation Corporation; XENERGY,Inc., Rising Sun Enterprises, and Pacific Energy Associates (2001). *Commercial Lighting Market Research Study.* Portland OR: Northwest Energy Efficiency Alliance.

Contractors are extremely diverse in terms of size as well as business activities. Table 13 shows the distribution of lighting and general electrical contracting establishments in California by number of employees. Sixty-five percent of the establishments employ fewer than five individuals. Most of these are engaged in residential work.

Table 13
California Contractors Establishments & Employees by Size Category

Employment Size Category	Number of Establishments	Percent of Establishments	Number of Employees	Percent of Total Emp.
1	1,341	37%	1,341	4%
2 to 4	1,013	28%	2,702	8%
5 to 9	525	15%	3,318	9%
10 to 24	446	12%	6,340	18%
25 to 49	164	5%	5,278	15%
50 to 99	70	2%	4,473	13%
100 to 249	44	1%	5,972	17%
250 to 499	10	<1%	3,280	9%
500 to 999	2	<1%	1,610	5%
1,000 to 2,499	1	<1%	1,000	3%
Total	**3,616**		**35,314**	

Source: Dun & Bradstreet Selectory Database

Annual revenue sources for contractors (Table 14) suggest more specialization toward lighting versus general electrical services in the California market compared to contractors in the comparison area. For contractors in California, the highest percentage (39%) of revenues is coming from lighting installations whereas in the comparison area, the highest percentage revenue source is from activities unrelated to lighting (32%). For the second highest revenue sources this is reversed with 26% from lighting installations in the comparison area and 18% of non-lighting related revenue in California. Revenues from contracted lighting maintenance services are higher in California, at 18% of revenues, compared to 14% of revenues in the comparison area (significant at the 90% confidence level). Lighting sales directly to customers as a source of revenue is similar between the two regions (15% for California compared to 13%). Lighting sales to other contractors and other lighting services account for relatively similar and small proportions of revenues in both regions.

Table 14
Approximate Percentage of Annual Revenue Coming From the Following Activities
(All Contractors)

Ratio Estimates	CA	SC-GA-AL-MI
n	**139**	**93**
Lighting Sales to Customers	13%	15%
Lighting Installations	39%	26%
Lighting Sales to Other Contractors	5%	5%
Contracted Maintenance Services for Lighting	18%	14%*
Other Lighting Services	6%	9%
Other Non-lighting revenue	18%	32%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

While a larger percentage of contractors' annual revenues are derived from lighting installation projects in California than in the comparison area, the proportions of those installation projects going into high bay applications are very similar (Table 15). During 2008 in California, nearly two-thirds (66%) of C&I revenues were derived from lighting installations versus 44% in the comparison area. For over 60% of contractors in both regions, less than 25% of projects relate to high bay lighting, at 65% in California and 62% in the comparison area.

Table 15
Approximately what percentage of the lighting installed in all commercial and industrial projects your firm completed in 2008 went into high bay applications?
(All Contractors)

Unweighted Frequencies	CA	SC-GA-AL-MI
n	**141**	**90**
Zero to Ten Percent	43%	40%
Eleven to Twenty-five Percent	22%	22%
Twenty-six to Fifty Percent	18%	18%
Greater Than Fifty Percent	17%	20%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

Contractors' perceptions of energy efficiency in HBL fixtures are predictably similar for a few technologies but they otherwise vary in specific ways. As shown in Table 16, high percentages of contractors in both regions consider LEDs to be energy efficient (78% to 79%). Very few contractors in both regions consider T-12 fluorescent fixtures to be energy efficient (3% to 4%). Most contractors in both regions generally do not consider HID technologies to be energy efficient, with the exception of PSMH.

Table 16
Which of the following kinds of lighting equipment do you consider to be energy efficient in high bay applications?
(Multiple Response; All Contractors)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**143**	**93**
T5HO	96%	62%**
T-8	88%	44%**
T-12	3%	4%
HID: Pulse-Start Metal Halide	21%	70%**
HID: Probe Start Metal Halide	14%	18%
HID: High-Pressure Sodium	6%	22%
HID: Low-Pressure Sodium	4%	1%
HID: Mercury Vapor	1%	18%
LED	79%	78%
Induction	52%	5%*
Other	<1%	<1%
Don't Know	1%	0%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

The differences in perceptions of energy awareness are most striking for the HBL technologies that are supported by the California IOU programs, probably reflecting overall higher levels of awareness of energy efficiency among California contractors versus the comparison area. For the energy-efficient fluorescent HBL technologies (including induction technologies), contractors in California more frequently consider those to be energy efficient than in the comparison area. For T5HO fluorescent tubes, 96% of California contractors believe they are energy efficient compared to 62% in the comparison area (significant at the 95% confidence level). The difference is similar for T-8 technologies, with 88% of California contractors considering them to be energy efficient compared to 44% of the comparison area contractors (significant at the 95% confidence level). A majority (52%) of California contractors consider induction lighting technologies to be energy efficient whereas only 5% consider them efficient in the comparison area, possibly reflecting an overall lack of awareness of the technology itself (significant at the 90% confidence level).

Perceptions of energy efficiency are reversed, however, for the most prevalent HBL technology, PSMH which are also eligible for IOU incentives. Whereas 70% of contractors in the comparison area consider PSMH to be energy efficient, only 21% of California contractors consider them similarly (significantly different at the 90% confidence level), possibly reflecting substantial differences in market evolution between the regions, experience with and knowledge of the technologies, and standards for energy-efficient lighting specification.

For contractors, the tendency to recommend energy-efficient types of HBL equipment is higher in California than in the comparison area. In California, contractors "always" recommend energy-efficient types of equipment 72% of the time, compared to 48% of the time in the comparison area (see Table 17). This contrast is especially striking when considering the relative standards in each region for what is perceived as "energy efficient."

Table 17
How often do you recommend energy efficient types of equipment for high bay applications?
(All Contractors)

Weighted Frequencies	CA	SC-GA-AL-MI
n	143	93
Always	72%	48%
Most of the Time	8%	29%
Sometimes	18%	6%
Rarely	<1%	3%
Never	1%	7%
Don't Know	<1%	<1%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

Contractors' recommendations in the comparison area are accepted more frequently than in California. For California contractors, 51% of their recommendations for energy efficiency HBL are accepted at least "most of the time," compared to 75% of recommendations in the comparison area. Recommendations in California are "rarely" accepted 41% of the time compared to 6% in the comparison area (significant at 95% confidence level). The contrast between the regions may be a relative comparison based on the heightened awareness of energy-efficient technologies in California compared to the comparison area (See Table 18). For example, California contractors may be recommending higher efficiency solutions than in the comparison area and more frequently encountering a higher first-cost barrier.

Table 18
In cases where you recommend energy efficient high bay lighting, how often did customers follow this recommendation in 2008?
(Contractors who have recommended energy efficient high bay lighting)

Weighted Frequencies	CA	SC-GA-AL-MI
N	135	83
Always	10%	10%
Most of the Time	41%	65%**
Sometimes	8%	19%
Rarely	41%	6%**
Never	<1%	<1%
Don't Know	1%	<1%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

According to contractors in both regions, most end users are unaware of the full range of energy-efficient HBL options before providing recommendations on their lighting system. Ten percent of contractors say that over 50% of end users are fully aware of their energy-efficient HBL solutions, and 17% of contractors say that end users in the comparison area are fully aware of their energy-efficient HBL solutions. These data may be showing relative perceptions of awareness, reflecting the heightened awareness of energy-efficient technologies in California compared to the comparison area (see Table 19).

Table 19
About what percent of your customers are aware of the full range of options for energy-efficient high bay lighting available to them before you provide recommendations about the lighting system?
(All Contractors)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**139**	**86**
Between 0 and 10	50%	33%
Between 11 and 25	27%	12%
Between 26 and 50	13%	37%
Between 51 and 75	2%	3%
Between 76 and 100	8%	14%
Do Not Know	<1%	1%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

End-users

The population of establishments that use significant quantities of indoor HBL is very diverse in terms of facility size, use, management structure, and criteria applied to facility-related investments. The principal end-user segments for the HBL market include:

- Industrial production facilities, with an emphasis on process activities that require significant vertical space
- Warehouses, including retail and other commercial warehouse space
- Garages and other utility structures
- Athletic facilities, freestanding and in schools.

The Study Team has conducted a number of fairly recent market characterization studies that estimate the volume of lighting projects among industrial customers and the frequency with which HBL is included. Specifically, the study of Wisconsin's manufacturing customers cited above found that 52 percent of respondents had undertaken improvements to their lighting systems in the three years previous to the survey, or 17% of respondents each year over three years. Forty percent of the reported projects included the substitution of fluorescent lighting for incandescent lighting or high intensity discharge (HID) lighting in HBL applications. A study of Vermont's industrial facilities found similar levels of overall facility improvement activity and adoption of fluorescent HBL.[226] We have not been able to identify existing studies on the volume of lighting projects and adoption of HBL among the commercial segments identified as the primary markets for HBL.

Table 20 shows that more end users' high-bay space in California is lit by equipment purchased between 2006 and 2008 than in the comparison area. Two thirds (67%) of California end users installed their HBL solution to cover over three-quarters (76% to 100%) of their high-bay space during the 2006 to 2008 period compared to 50% in the comparison area (significant at 95%). Overall, 75% of California end users installed HBL in over half (51% or higher) of the high-bay spaces in their facilities compared to 54% in the comparison area. For lower percentages of high-bay space (1% to 10%) upgraded, only 6% of California end users installed HBL during the 2006 to 2008 period, compared to 20% of comparison area end users (significant at 95% confidence level).

Table 20
Roughly what percentage of the high-bay space in your facility or facilities you manage is lit by the equipment you purchased between 2006 and 2008?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	110	74
Between 1 and 10	6%	20%**
Between 11 and 25	3%	9%
Between 26 and 50	17%	18%
Between 51 and 75	8%	4%
Between 76 and 100	67%	50%**

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

226 RLW Analytics and KEMA, Inc. (2005). *Phase 2 Evaluation: Efficiency Vermont Business Programs.* Montpelier, VT: Vermont Department of Public Service.

California end users' spaces eligible for HBL lighting are served by fluorescent tubes more frequently than in the comparison area (76% versus 55%), and the difference is significant at the 95% level. By contrast, HBL eligible spaces served by HID lamps in the comparison area are more frequently served than in California (36% versus 13%). This difference is also significant at the 95% confidence level.

Table 21
What percentage of your total high-bay space is served by the following types of lighting equipment?
(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	111	75
Fluorescent Tube Fixtures	76%	55%**
High Intensity Discharge Lamps	13%	36%**
Compact Fluorescent Fixtures	4%	3%
Incandescent Fixtures	2%	3%
Other	4%	2%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

As shown in Table 22, in both regions a majority of end users mention contractors (either electrical, lighting, or general) as the firm or individual who specified the type of HBL equipment installed. In California, 53% of end users and 58% of comparison area end users mention contractors. A larger percentage of comparison area end users (32% versus 24% in California) mention individuals or firms providing design services more exclusively such as distributors, architects/interior designers, and engineers. This difference is significant at the 90% confidence level. Utility support is mentioned by 13% in California and 5% in the comparison area.

Table 22
What types of firm or individual specified or recommended the type of high-bay lighting equipment you installed?

(Multiple Response; End Users who received a recommendation regarding the high bay lighting equipment from a firm or individual)

Weighted Frequency	CA	SC-GA-AL-MI
n	70	37
General Contractor/Electrical Contractor/Lighting Contractor	53%	58%
Architect or interior designer/Engineer/Lighting Distributor	24%	32%*
Utility	13%	5%
Parent Company	5%	<1%
State or Local Government	4%	<1%**
Upper Management/Corporate	2%	<1%
Landlord	2%	<1%
Friend/work colleague	1%	<1%
Lighting Manufacturer	1%	2%
Trade association	<1%	<1%
Other	<1%	<1%
Don't Know	4%	<1%

* Significantly different from the comparison area at the 90% confidence level.

** Significantly different from the comparison area at the 95% confidence level.

Appendix G provides end user survey data in detail, including specific firmographic detail of the survey's respondents. The firmographic profiles are fairly similar across regions with the following noteworthy exceptions:

- California shows more HBL use in offices (7% versus 1% in the comparison area) and Food Sales than in the comparison area (5% versus <1% in California). Both differences are significant at the 95% confidence level.
- The weighted average of the electricity bills paid for the building stock of the HBL installations is smaller in California than in the comparison area ($9,389 versus $11,707).
- The vintages of the building stock of the HBL installations tend to be slightly older in the comparison area.
- The weighted average of square footage of the building stock of the HBL installations is considerably larger in California (203,258 square feet versus 128,880 in the comparison area).

5 Program Theory and Logic Model

This section describes the California IOUs' programs affecting the replacement and retrofit market for energy-efficient HBL equipment, including the following:

- A summary of programs that include HBL measures for the 2006-2008 period
- A characterization of the California IOUs' program logic and theory of change for the key programs' elements and expected outcomes—or effects—in the market place
- An overlay of the program and market theories and expected points of intervention.

5.1 Summary HBL Measure Data for 2006 to 2008 IOUs' Programs

Table 23 summarizes the contribution of HBL measures to the portfolio, shown as a percent of lighting measures for the 2006 to 2008 period. For the California IOUs as a whole, lighting measures account for 69.8 percent of total portfolio ex ante energy savings and HBL measures account for 1.2 percent of the total savings.

Table 23: Summary of Lighting Measure Savings across IOU Portfolio

	Portfolio kWh Savings	Total Lighting Savings	Total HBL	HBL % Portfolio	Lighting as % of Portfolio
PG&E	6,278,262,259	4,451,204,469	73,035,445	1.16%	70.90%
SCE	5,106,105,779	3,493,443,171	48,517,446	0.95%	68.42%
SDGE	989,458,677	689,812,780.66	29,774,644	3.01%	69.72%
Total IOUs	**12,373,826,714**	**8,634,460,420**	**151,327,535**	**1.22%**	**69.78%**

Source: Data received through EEGA (http://eega2006.cpuc.ca.gov/Default.aspx) by request to IOUs.

This study primarily addresses the retrofit market and associated programs for energy-efficient HBL technologies. Based on the team's experience with other non-residential new construction studies, one working assumption is that individual technologies such as HBL tend to be subsumed under a broader market system in the non-residential new construction market. Therefore, this study focuses on the retrofit market to define the scope for measurement and assessment.

As of December 31, 2008 (Fourth Quarter - Q4), twelve programs had recorded HBL measure installations (Table 24).

Table 24: Summary of HBL Measures by Program

EEGA Program ID	Program Description	Mass Market (MM)/ Third-Party (3P)/Local Government (LGP)	Savings (Kwh)	Percent of Total Savings	Cumulative Percent of Total Savings	Unique Measures
PG&E2080	Commercial Mass Market	MM	69,490,189	45.92%	45.92%	3
SCE2517	Business Incentive Program	MM	48,367,093	31.96%	77.88%	3
SDG&E3020	Small Business Super Saver	MM	15,425,510	10.19%	88.08%	12
SDG&E3012	Express Efficiency	MM	14,349,134	9.48%	97.56%	4
PG&E2027	PG&E Motherlode	LGP	1,056,166	0.70%	98.26%	1
PG&E2074	Small Business Energy Alliance (SBEA)	3P	1,729,853	1.14%	99.40%	3
PG&E2049	Wine Industry Efficiency Solutions	3P	383,441	0.25%	99.65%	2
SCE2569	Dept. of General Service Partnership Programs	LGP	89,552	0.06%	99.71%	1
PG&E2015	PG&E ABAG	LGP	192,133	0.13%	99.84%	3
PG&E2077	School Energy Efficiency Program	3P	183,663	0.12%	99.96%	2
SCE2525	SCE San Gabriel	LGP	49,671	0.03%	99.99%	2
SCE2544	California Preschool Energy Efficiency Program	3P	11,130	0.01%	100.00%	1
Totals			**151,327,535**			

Source: Data received through EEGA (http://eega2006.cpuc.ca.gov/Default.aspx) by request to IOUs.

An important distinction between the different programs above is whether the program is a Mass Market (MM) program, Local Government Partnership (LGP), or a Third Party (3P) program. The programs that target the mass market—or incentivized measures that can be installed through standard market vendors, suppliers, and service providers—address nearly all potential C&I measures and for implementation purposes are usually segmented into "Upstream," "Midstream," or "Downstream" programs. According to CPUC and utility staff, HBL measures are only addressed through "Downstream" programs—or programs that directly interface with the C&I customer, potentially with the support and assistance from the IOU's sales and service teams and/or other customer support systems.

Third Party and Local Government Partnership programs are designed to address specific market sectors and are implemented by contractors (especially the 3P programs) which support customer efforts cradle-to-grave.

As shown in Table 24, the mass market (98% of HBL measure savings) accounts for nearly all HBL measure savings. According to CPUC staff, this was not particularly surprising in that it matches the general profile of the overall portfolio in which the mass market programs represent the overwhelming majority of savings and the partnerships/third-party programs represent a fraction of the total. As of April 29, 2010, for the four MM programs listed above, 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.[227]

This Market Effects Study focuses on the programs—or the 98% of savings—that comprise the savings claims from the mass market. Appendix I lists the four mass market programs and describes them, including the program implementer, the target market, key market actors, and a brief summary of the delivery strategy. The program data below are summarized from the 2006 to 2008 program plans that were posted on the CPUC's EEGA website.[228] Third party and Local Government Partnership programs are also summarized in Appendix I.

5.2 Characterization of the Program Theory and Logic

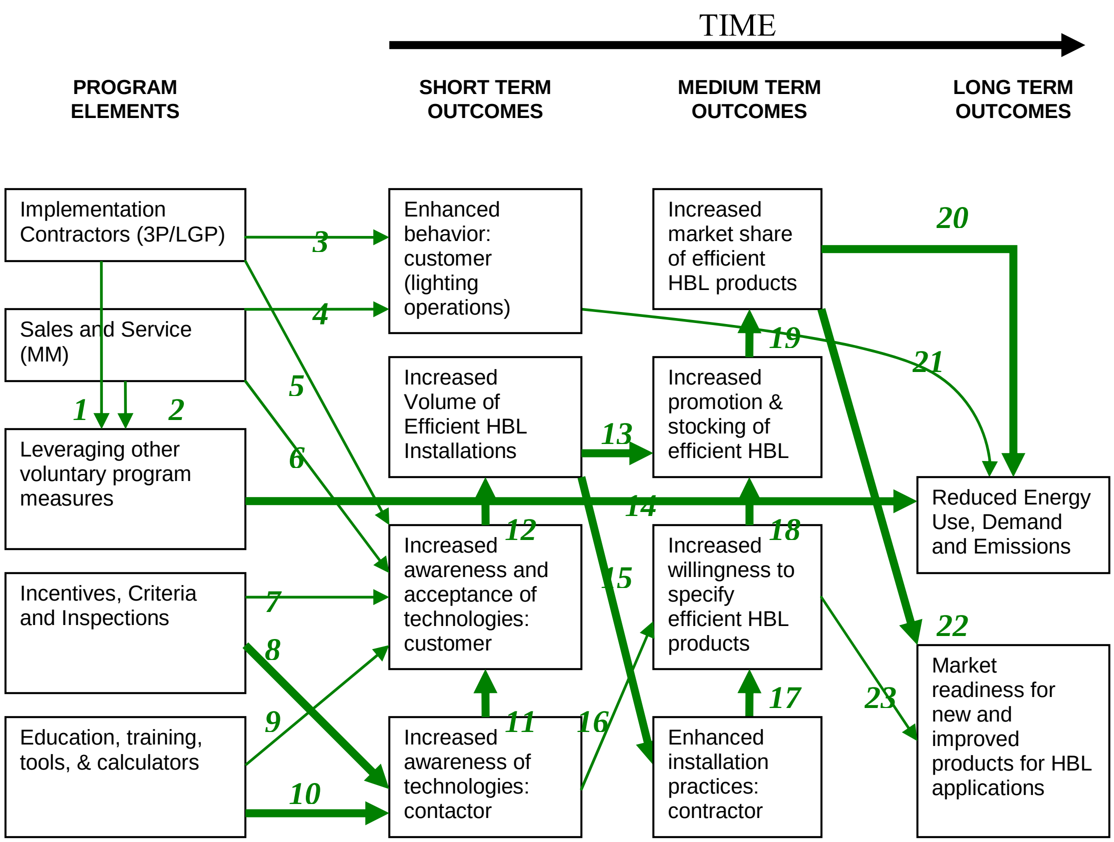
Figure 3 reflects a distillation of information from program plans and utility and CPUC staffs' descriptions of the function and intent of programs that support HBL measures. Indeed, there is no specific HBL retrofit or replacement program; rather, HBL measures are promoted as a key opportunity in a definable market segment that is subsumed in a broader portfolio strategy. On the left side are the essential program elements, including an indication of whether the element is supported by the MM programs, the 3P/LGP programs, or both. The outcomes—or the market and societal changes that the programs are intended to achieve—are specified to the right of the

[227] Quarterly reports accessed on EEGA (http://eega2006.cpuc.ca.gov/), April 29, 2010.

[228] http://eega.cpuc.ca.gov/PublicHome.aspx

program elements. The outcomes are divided into three general time categories according to their expected order of realization: the short-term, medium-term, and long-term. The expected logical progression of individual program elements carried through to the various intended outcomes is indicated by arrows that signify those linkages by number and their directionality. The heavier arrows indicate the most common paths by which the outcomes are intended to be achieved.

Figure 3: Program Logic of HBL Measure Installations through IOU Programs



The Study Team notes an important distinction between the following characterization of the programs' expected market effects as expressed in the short-, medium-, and long-term outcomes versus the broader assessment of market effects which is the subject of this particular study. A broader assessment of market effects may include evidence for additional unintended program outcomes, emphasis or de-emphasis of anticipated program outcomes, or the elimination of expected program outcomes. Moreover, the objective of this study is not to answer research questions related to a process evaluation or implementation effectiveness. The program theory and logic above represents a valuable starting point for determining what the actual market effects are and the mechanisms by which they are happening. Chapter 6 presents an analysis and discussion of the broader market effects from the California IOU programs.

The remainder of this section describes the individual program theory elements in detail, as well as the intended outcomes as articulated in the program planning documents and as expressed through the interviews with program managers.[229] The linkages between program elements and outcomes are presented from the perspective of the "how test"—or how one outcome logically relates to the next one—for a program progressing over time as described in McLaughlin and Jordan (1999).[230]

5.2.1 Program Elements

The key program elements that apply to HBL measures are described below and how they relate to the short-term outcomes, as shown in Figure 3.

- **Incentives, Criteria, and Inspections (Links 7 and 8)** are the cornerstones of all program efforts to implement HBL measures, and they are the "downstream" incentives that target the end-user or customer and induce them into the market for energy-efficient measures. The level of incentive is specified with the intent of bringing the incremental cost of the efficient HBL measure down to be cost-competitive with less efficient measures and provide customers with energy-efficient alternatives. Moreover, as the market actor and program manager interviews revealed, the lighting contractor is at the center of all decision making and specification of lighting installation decisions, and needs the incentives and calculation tools to specify what the market would otherwise supply at a higher cost.

  For projects in the mass market, inspections are often conducted for projects specifying significant values of incentive dollars (which may or may not include HBL). For example, PG&E requires inspections for projects receiving over $2,500 in incentives. Anecdotally, most projects that include HBL installations exceed $2,500. PG&E also maintains a "three strikes and you're out" policy for underperforming contractors, in which underperforming contractors may not be able to have incentives signed over to them. Additionally, all IOUs maintain lists of lighting contractors that are shared with customers seeking assistance with energy efficiency upgrades. The IOUs do not endorse any installation contractor, in particular; however, underperforming contractors may be removed from the list.

---

229 Based on a review of the available documentation and in-depth interview data with program managers, the program logic model and descriptions were simplified and modified to better capture the intent of the program design.

230 McLaughlin, John A., and Jordan, Gretchen B., "Logic Models: A Tool for Telling Your Performance Story," Evaluation and Program Planning, Elsevier Science: New York, Vol. 22, Issue 1, February 1999, Pp. 65-72.

The inspections are also intended to serve an education and awareness function for contractors that actively work within the program constraints, learning to install the higher efficiency products appropriately and efficiently, so that they can, in turn, make selling the product with the higher up-front customer cost more profitable to them.

The incentives by IOUs for lighting technologies in HBL applications are described in detail in Appendix B. Program managers report that the incentives are designed to offset a substantial proportion of, if not totally offset, the incremental cost of the new efficient technology; however, a higher objective is to reduce lighting wattage and not create an incentive that increases overall load through the incentives. The incentives shown in Table 22 reflect a sliding scale for the technology/wattage combination of what is replaced and the technology/wattage combination of what is installed. For example, a 400 watt base case that is replaced with an induction fixture of 360 watts or less will receive $100 per fixture, but exterior or PSMH replacements will not get the incentive. The incentives are also flexibly designed to accommodate different replacement fixtures than in the base case by specifying lamps in the base case (e.g., bulbs), but fixtures (PSMH) in the replacement case. In all cases, the total wattage in the replacement case is less and sometimes prescriptive in order to receive the incentive. In summary, Pacific Gas & Electric's (PG&E) and Southern California Edison's (SCE) incentives structures are nearly identical; San Diego Gas & Electric's (SDG&E) incentive structure is summarized separately, and the key differences are described.

Third-party or partnership programs may provide additional incentives in creative ways as well, which encourage customers to become aware of, and install more, energy-efficient measures. For example, one 3P program offered additional incentives of 10% for commitments within one month of an audit and 20% for completion within six months of the commitment. Additionally, implementation contractors may structure the program to provide additional matching incentives under specific circumstances.

Program managers report that for the vast majority of the time, for projects following the dominant channel of contractor installation, the financial incentives are signed over to the contractor as a more efficient arrangement. In those cases, the contractor takes the lead in preparing the application forms. Indeed, program managers express support for this particular solution because it is relatively more efficient from an administrative perspective and engages the contractor in the program to help sell the program.

- **Education, training, tools, and calculators (Links 9 and 10)** targeting C&I contractors and customers are an ongoing program element, mostly in the form of literature and tools to facilitate their participation in the program, with a limited amount of technical information. The primary goal of the education initiatives is to educate customers and contractors of energy-efficient alternatives, in order to get customers and contractors "outside of their comfort zone" as a necessary complement to the incentives. Education outreach tends to focus on installation contractors because they are more easily targeted than potential customers, and educated and enabled contractors can "carry the water" for them. Some general marketing materials and calculation tools are available for contractors to use in sales with customers.

When asked about distributors, the IOUs did not conduct any outreach in the 2006-2008 cycle. As of early 2009, PG&E recently ordered its first set of distributor-specific outreach materials.

Trainings are offered to lighting contractors through the MM programs to raise contractor awareness of mostly administrative process issues, but they are not regularly scheduled. When asked about marketing activities to lighting contractors, one program staff member claimed that the activities were more about technical and program administrative training rather than marketing. On occasion, distributors will attend a training event; however, they are not targeted for invitation.

- **Program leveraging (Link 14)** is central to the broad-based support of efficiency measures through both MM and 3P programs. Lighting upgrades are generally recognized as either an "ice-breaker" in engaging customers or contractors for more significant participation and energy savings through other, more comprehensive energy efficiency measures.
  - Customers are introduced to energy-efficient upgrade opportunities by the sales and service teams (for PG&E and SCE customers requesting assistance), energy auditors, or entrepreneurial contractors familiar with the mass market program's offerings. One program manager summarized that the role of the sales and service teams: "The sales and service team are energy advisors who guide customers into what makes sense for that customer location, including alternative options, and that the customer needs to contact someone for bidding and installation. They work with the customer from beginning to end until the customer receives the incentive." Program managers state that lighting upgrades are frequently the easiest measures to take new customers "outside of their comfort zone." After lighting upgrades, the sales and service teams and/or other customer support systems are available to leverage other opportunities to promote higher efficiency measures.
  - The installation contractor pool is also enlisted for customer support and program leveraging purposes, as one respondent noted: "To have the sales/service team reach out and maximize the impact on the market place."
  - SDG&E does not provide similar support through a formalized sales and service support structure, but instead they do the following: "Typically, the customer is given assistance through the contractor, but in very large accounts, usually for complex projects, an in-

house engineering staff will assist the customer, but no lighting design is performed." SDG&E relies primarily on the contractor pool to leverage other program opportunities.

  - The degree of leveraging is also a function of the customer's size and "the technical sophistication of the customer in the market [and] currently this sophistication is both uneven and a function of a large market." Larger firms have sales and service representatives generally permanently assigned; smaller firms tend to serve themselves and seek assistance on their own.
  - Program leveraging in the 3P programs is provided both by the program implementer and the installation contractor.

- **The sales and service teams (Links 2, 4 and 6)** use in-house utility support staff that facilitate efficiency measures to the mass market for customers in PG&E and SCE service territories. Sales and service teams also play a significant role in encouraging the customer to get energy audits.
  - Sales and service teams support and utilize other customer support systems (which all three IOUs offer) such as web site tools and information, program catalogues, trainings, and educational resources. Interest in HBL technologies—especially fluorescents over HIDs—is reportedly high, and they want to know more.
  - Relationship management with installation contractors is handled slightly different between all three IOUs, but in all cases specific contractors are not promoted, recommended, or endorsed by the IOUs. SCE has a list of past participants of installation contractors and knows which ones are particularly large, but SCE does not "manage" a list, and any vendor can participate. SDG&E requires a signature on a "Vendor Participation Agreement," and the lists are managed. PG&E maintains a list for outreach with its installation contractor pool (or "allies") as well, and they may make it available to customers. PG&E maintains a list of disqualified vendors who fail inspections three times.
  - Technical services to customers are provided through SCE's and PG&E's sales and service teams. All IOUs provide technical literature and guidance on the application forms.
  - Sales and service teams also provide follow-up support to encourage commissioning services and other opportunities to save energy through the operation and maintenance of any installed measures.

- **Implementation contractors (Links 1, 3 and 5)** are primarily a third-party or partnership program element: the provision of efficiency measures for C&I customer is supported and facilitated through implementation teams. The typical model for this is the following:
  - Sign up a customer through marketing/outreach with a participation form.

- Conduct an energy audit, present the report with recommended measures for installation, and try to get the customer to sign a commitment form to install measures that were recommended.
- Support installation services to get the customer to install measures, and then report back to the utility.
- Installation contractors are targeted by the 3P implementers because they are a relatively smaller group and the logical gateway to the customers. Moreover, 3P program implementers believe that contractors are reasonably active and aggressive in seeking out opportunities to find customers that require efficiency upgrades.
- Implementation teams also provide follow-up support to encourage commissioning services and other opportunities to save energy through the operation and maintenance of any installed measures.

5.2.2 Short-term Outcomes

Key short-term outcomes and how they relate to the medium-term outcomes, as shown in Figure 3, are described below:

- **Increased awareness by contractors (Links 11 and 16)** is a desired outcome in concert with the incentives, because when contractors realize the benefits of and gain experience in installing efficient HBL measures, their willingness to specify them increases. Contractors also need to gain a comfort level with the support offered by the IOU programs, their ability to successfully install the technologies, and to sell the efficient products to their customers.

  By empowering the contractors, the IOU program managers say they can educate many more customers—and the right customers—than the IOUs could directly. When asked which market actor has the most influence on the specification of lighting equipment in both the existing program logic and the market place, all three IOUs state that the contractor has the most influence. As stated previously, the incentives make the efficient product cost-competitive to the consumer, but not necessarily more profitable if any additional installation costs for the new and efficient product are assumed by the contractor. One program manager emphasized that the contractor exercises relatively more influence on the customer than normal when the customer signs over the incentives to the contractor as part of the installation contract.

  Increased awareness of the efficient technologies also increases their willingness to specify them. Not only do the benefits of efficient HBL products include features that satisfy their customers, but also the IOU programs intend to make the energy-efficient HBL technologies easier to install as a result of the increased awareness resulting from their information, training, inspection, and education efforts. For example, one program manager argues that newer, efficient HBL technologies are easier to install (more "plug and play") and offer safety benefits (e.g., less exertion on ladders or scaffolds in high ceiling installations) during the installation process. Contractors also need to overcome consumer reticence to fluorescents because of the fear of breakage and the resulting released mercury vapor.

- **Increased awareness and acceptance by customers (Link 12)** also increases their likelihood to request and accept efficient HBL products. IOU program managers say that the customer is in second place behind the contractor in terms of influence in the logic models and the market place. One program manager qualified this statement, however, stating that depending on which specific MM program avenue that the customer chooses (e.g., Express Efficiency Program or Standard Performance Contracting Program [SPC]), the customer can have co-equal influence with contractors. In the case of a customer having significant in-house technical capability, it may choose the SPC route that offers higher incentives and more latitude for customer specification.

  One of the primary means by which customers become educated about the benefits of efficient HBL technologies is through installing them. When educated about the benefits of efficient HBL technologies over the existing lighting solution, IOUs argue that their program support mechanisms foster a greater willingness by customers to pay the incremental costs, accept the recommendations from contractors, or suggest them to their contractors. Program managers cite multiple benefits of efficient HBL installations, including better lighting quality, reduced energy bills, and reduced maintenance. The benefits are especially greater for T8 and T5HO fluorescents, which they claim, anecdotally, to have helped to increase installations over the 2006 to 2008 period. The T8 and T5HO technologies offer dimmability, sensor control compatibility and performance, as well as instant-on features as greater benefits than other incentivized products and standard products for HBL applications.

- **Increased volume of efficient HBL installations (Links 13 and 15)** through program incentives and other support activities are intended to induce a supply-side response by reducing manufacturing costs and distributor risk associated with maintaining those inventories. Generally speaking, program managers articulate that incentives "pull people into the market by making the products cost-effective." Program managers echo that efficient HBL installations are a fairly important short-term outcome of the mass market program. The effect is to increase promotion and stocking of efficient HBL technologies and develop economies of scale in the short term.

  The increased volume of installations through the program in the short term also enables contractors to learn how to enhance the services that they provide to their customers through learning by doing. Lighting installations for the efficient HBL technologies and any associated controls become more efficient, and specification decisions including energy-efficient HBL technologies become more routine. This also reduces their business risk associated with recommending and specifying new products—especially at a cost premium.

- **Enhanced efficiency behavior (Link 21)** is a relatively smaller, albeit important, direct contribution to long-term energy, demand and emissions savings as a result of energy-efficient HBL measures. The IOU sales and service teams support cradle-to-grave efficiency efforts including enabling technologies that enhance efficiency-purposed behavior and other education measures. Examples of efficient behavior include efficient operations through adding occupancy sensor technologies, reducing supplemental lighting from HBL technologies with instant-on capabilities, and daily scheduling through energy management systems (EMS).

5.2.3 Medium-term Outcomes

Key medium-term outcomes and how they relate to the long-term outcomes, as shown in Figure 3, are described below:

- **Enhanced installation practices by the contractor (Link 17)** increases contractors' willingness to specify efficient HBL products by reducing incremental costs compared to standard-efficiency products which are then passed on to the customer. These decreased incremental costs also reduce the business risk to contractors who specify the equipment. As one program manager stated: "In the past, there was a skepticism that a fluorescent high bay could replace metal halide or HPS. This skepticism has shifted to customers and contractors being more comfortable with the technology." Enhanced installation practices should also be reflected in higher penetration rates of efficient HBL technologies and also participation rates by contractors.
- **Increased willingness to specify efficient products (Links 18 and 23)** results in several desired outcomes. In the medium term, increased willingness in the marketplace to specify efficient HBL equipment sends market signals to suppliers to promote and stock the equipment.

  In the long term, the willingness to specify the efficient HBL products prepares the marketplace for all market actors, including end-users, contractors, and distributors. This willingness should be reflected in higher penetration rates of efficient HBL technologies and also greater participation rates by IOU customers and contractors.
- **Increased promotion and stocking of efficient HBL technologies (Link 19)** increases the market share of efficient HBL products in the medium term. Increased market share is not only primarily reflected in higher penetration rates of efficient HBL technologies, but also reflected in changes in stocking practices by distributors. As one program manager stated: "Trends have been observed such that if you've got customers or sale/service folks who are

helping the customers asking for the right equipment and product, then there is going to be a trend toward having that product [being] more available vs. things that aren't on the list or not eligible for rebates." Program managers unanimously state that distributors exercise little influence in their logic models or the specification of efficient HBL products in the market place. One program manager stated that, "Distributors take the path of least resistance."

- **Increased market share (Link 20 and 22)** has a powerful effect on the market place as a market signal to prepare for new and improved high-efficiency products in the long-term, and is the primary avenue through which efficient HBL technologies reduce energy use, demand and emissions—the long-term outcomes specified in the program logic and described by program managers. Two of the IOU's program managers state that efficient HBL technologies—linear fluorescent T5HO and T8 fixtures, in particular—are increasing in sales over the past two years; the third IOU did not know. Overall, the CPUC staff person interviewed for this study observed that the distribution of efficient HBL installations in the MM versus 3P programs is representative of the portfolio overall, and savings though energy efficiency has been growing over time.

  Clear market signals of the increased market share of efficient HBL products can result in economies of scale in manufacturing and inventory operations with sufficient demand. These signals help reduce the perceived risks to distributors of maintaining inventories for, and manufacturers for production of, relatively higher-priced, energy-efficient products and can broadly impact their overall market posture.

5.2.4 Long-term Outcomes

Also shown in Figure 3, the two key long-term outcomes of the IOU programs are reducing energy use, demand and emissions, as well as preparing the marketplace for new and improved measures.

- **Reduced energy use, demand, and emissions** are the most significant long-term outcome of the IOU's C&I programs. Together, they represent benefits to the public and the IOUs. In summary, over time the increased market share of efficient HBL installations, additional leveraged efficiency measures resulting from HBL installations, and increased efficiency behavior become the primary drivers of this particular outcome.
- **Market readiness for new and improved products** is also a significant long-term outcome of the IOU's programs targeting the C&I market. Program managers emphasized the importance of this outcome, as one program manager summarized what others believed: "We're trying to develop an energy efficiency aware populace." Program managers believe that they are creating that long-term change through economies of scale that prime the pump

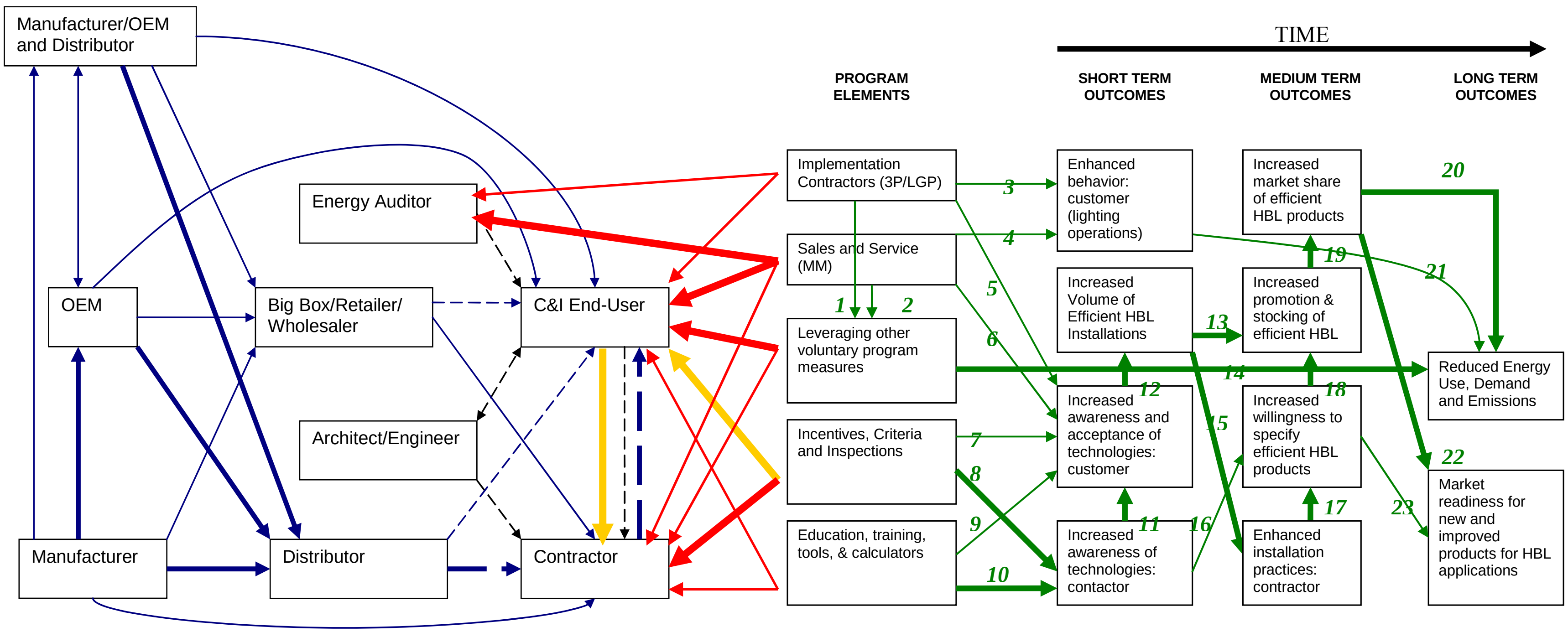
in the market place for efficient products and through efforts to foster end-users' and contractors' willingness to specify HBL products.

5.3 Overlay of Program and Market Theories

This section discusses the mechanisms by which the program is intended to impact the market, ultimately leading to the long-term outcomes described above, namely, reduced energy use, demand and emissions and market readiness for new and improved products. Figure 3 illustrates the CPUC and utility programs staffs' view of how the programs are designed to affect the market for HBL technologies through various intervention points. On the left-hand side is the market theory diagram showing how HBL products move through various channels from left to right. Manufacturers are located on the left side of the figure; installation contractors and end-users on the right. On the right-hand side is the program theory. The expected logical progression of individual program elements carried through to the various intended outcomes is indicated by arrows that signify those linkages by number and their directionality. The following notation in Figure 5 is summarized:

- Blue lines represent sales channels.
- Dashed lines represent specification roles.
  - Blue lines with dashes represent both sales and specification roles.
  - Black lines with dashes represent only a specification role.
- Green lines show program linkages.
- Red lines show market interventions by program activities.
- Yellow lines show the flow of incentives that either stops at the customer or continues to the contractor if the incentive is signed over.
- The heavier arrows indicate the most common paths for a particular market or program dynamic.
  - Heavy blue lines are major sales channels.
  - Heavy dashed lines are major specification roles.
  - Heavy green lines represent the path by which the program's outcomes are most commonly intended to be achieved.

Figure 5: Utility Programs with HBL Measures in Relation to the HBL Market



External Influences:
Technology development, codes and standards, other voluntary programs, environmental awareness, economic growth

Key:
Blue = Sales channel
Dash = Specification role
Heavy Line = Major channel or role
Yellow = Flow of incentives
Green = Program linkage
Red = Intervention by programs into the market

6 Analysis of Expected Outcomes and Market Effects

This section consolidates the findings from the previous sections into a summary assessment of the IOU program market effects and develops a quantitative estimate of the energy and demand savings associated with those effects. It concludes with an analysis of the strength of evidence for attributing the observed market changes to the program, as opposed to other possible influences and with an assessment of the sustainability of those market changes.

6.1 Assessment of Market and Program Theories

This section presents an assessment of the market and program theories presented in Sections 4 and 5. As presented in Section 4, the study team used in-depth interviewing techniques and secondary literature sources to develop a theory of the market structure. The theory argued that the installation contractor holds a central role in the specification and procurement process for HBL equipment. In the market theory section, the study team focused on confirming the roles of the contractor, distributor, and end users in the specification and procurement process.

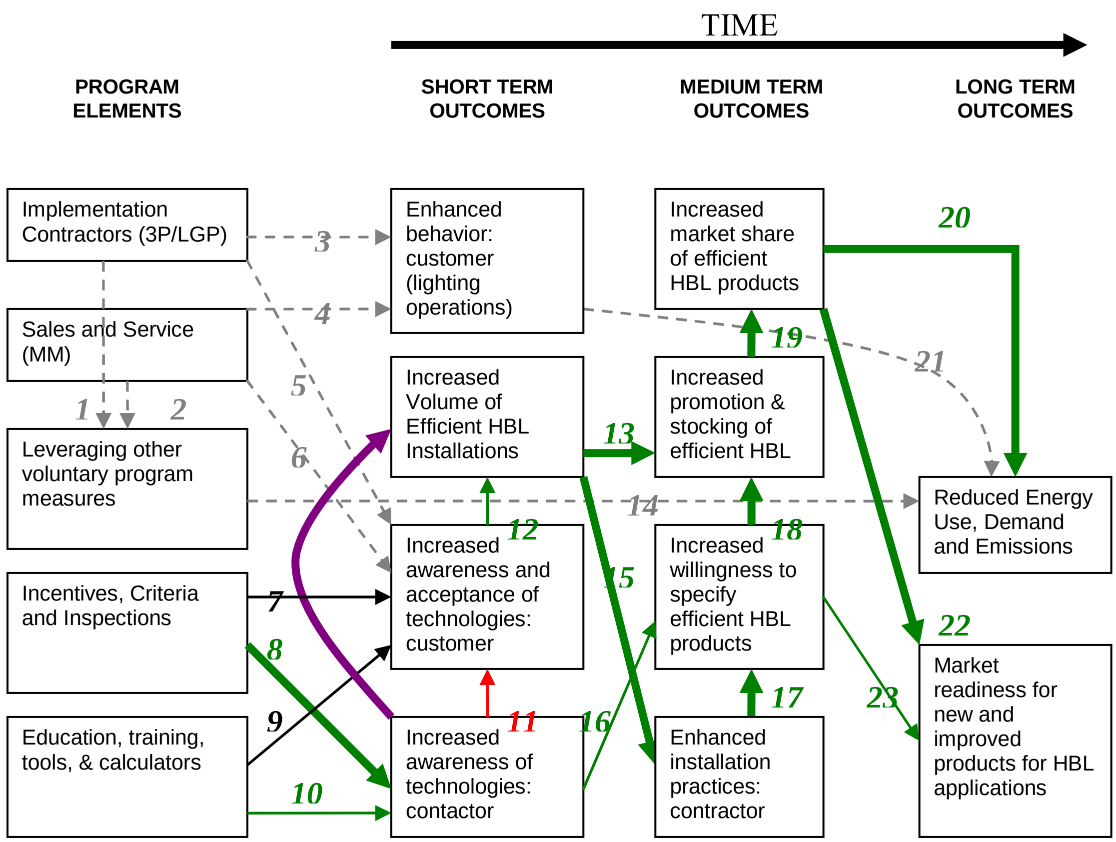
In Section 5, we presented a characterization of the California IOUs' program theory logic for the potential effects of incentives for efficient HBL equipment on the HBL retrofit market. The study team developed the program logic model based on available literature on the program logic from the IOU's mass market programs and in-depth interviews with IOU program managers. As presented in Section 5, based on a review of available literature and the IOU program manager interview data, the program logic model was simplified and modified slightly to more accurately reflect the intent of the IOUs.

Figure 4 shows a market effects model that reflects the Study Team's findings and the extent to which the hypothetical program chain 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 4. Modified Program Logic Model with Support for Market Effects



The table below (Table 25) summarizes our findings and conclusions in regard the causal links depicted in Figure 4.

Table 25: Summary of Market Effects Indicators

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
1 & 2	**Program Element: IOU Support Teams and Other Energy Efficiency Measures** Field support teams (sales and service and implementation contractors) use promotion of efficient HBL to interest program participants in implementing other energy efficiency measures.	Not Assessed	**An assessment of these links is not necessary to assess market effects in the HBL retrofit market.** Program staff interviews and logic documents described the roles of the sales and service teams for the mass market programs and the implementation contractors for the third party and local government partnership programs, including introducing customers to other energy efficiency measures. The third party and local government partnerships are not included in the scope of this study because of their insignificance to the portfolio and share of HBL measure savings. End users were not asked whether they participated in any IOU programs outside of any support they may have received for their HBL installations.
3 & 4	**Program Theory: Information and Advice and Behavior** Information and advice provided by field support teams result in enhanced efficiency behavior by the end-user.	Not assessed	**An assessment of these links is not necessary to assess market effects in the HBL retrofit market.** Program staff interviews and logic documents described the roles of the sales and service teams for the mass market programs and the implementation contractors for the third party and local government partnership programs, including advising customers on how to save energy through operations. The third party and local government partnerships are not included in the scope of this study because of their insignificance to the portfolio and share of HBL measure savings.
5 & 6	**Program Theory: Information and Advice and Awareness** Information and advice provided by field support teams' increases customer awareness of efficient HBL technologies.	Not assessed	**An assessment of these links is not necessary to assess market effects in the HBL retrofit market.** Program staff interviews and logic documents described the roles of the sales and service teams for the mass market programs and the implementation contractors for the third party and local government partnership programs, including advising customers on energy efficient HBL technologies.

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
7	**Program Theory: Incentives, Criteria, Inspections and Customer Awareness** Incentives, inspections, and the associated criteria result in increased customer awareness of efficient HBL technologies.	Insufficient Data	**The California end user surveys did not include sufficient number of aware participants to assess this potential market effect.** A majority (52%) of California end users are aware of IOU programs to reduce energy use and costs, but end users were not asked whether they sought assistance from the IOUs for any support they may have received for their HBL installations. Only nine of the 123 respondents are aware and installed eligible equipment to receive financial incentives from the IOUs, even though program records suggest that 75 percent of end-users who purchased high bay lighting of any type during the study period received support from IOU programs. This finding suggests that the IOU programs did not exercise a great deal of influence on end-users via customer education and information channels.

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
8	**Program Theory: Incentives, Criteria, Inspections and Contractor Awareness** Incentives, inspections, and the associated criteria result in increased contractor awareness of efficient HBL technologies.	Strongly Supported	**Contractors are aware of the incentive programs, energy efficient HBL technologies, and rate the importance of the IOU programs highly in marketing decisions and market share.** A majority (52%) of California contractors are aware of incentive programs for energy efficient high bay lighting. For the energy efficient fluorescent high bay lighting technologies (including induction technologies), contractors in California more frequently consider those to be energy efficient than in the comparison area. For T5HO fluorescent tubes, 96% of California contractors believe they are energy efficient compared to 62% in the four selected Southeastern States.** The difference is similar for T-8 technologies, with 88% of California contractors considering them to be energy efficient compared to 44% of the comparison area contractors.** A majority (52%) of California contractors consider induction lighting technologies to be energy efficient whereas only 5% consider them efficient in the comparison area, possibly reflecting an overall lack of awareness of the technology itself.* Perceptions of energy efficiency are reversed, however, for the most prevalent high bay lighting technology, pulse-start metal halides which are also eligible for IOU incentives. Whereas 70% of contractors in the comparison area consider pulse-start metal halides to be energy efficient, only 21% of California contractors consider them similarly*, possibly reflecting substantial differences in market evolution between the regions, experience with and knowledge of the technologies, and standards for energy efficient lighting specification. Contractors rate the importance of IOU programs fairly highly in their firm's decisions to promote energy efficient high bay lighting, with 79% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 13% of contractors rated the importance between 5 and 7 (out of 10). Contractors rate the influence of IOU programs market shares of energy efficient high bay lighting high, with 73% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 21% of contractors rated the importance between 5 and 7 (out of 10).
9	**Program Theory: Education, training, tools, calculators and customer awareness** IOU's education and outreach strategy increases customer awareness of efficient HBL technologies.	Insufficient Data	**The California end user surveys did not include sufficient number of aware participants to assess this potential market effect.**

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
10	**Program Theory: Education, training, tools, calculators and contractor knowledge and awareness** IOU's education, training, and outreach strategy increases contractor knowledge and awareness of efficient HBL technologies.	Supported	**Contractors in California refer to IOUs as a source of marketing support for energy efficient HBL technologies with limited evidence of non-rebate program support from the IOUs.** Contractors in the program area receive marketing support from distributors (57%) and IOUs (54%). Manufactures (14%). Public/Municipal Utilities (12%) provide support but considerably less frequently. The state government is not mentioned at all. Contractors in the comparison area receive training from manufacturers (64%) more frequently than in California (26%)*. Only 7% of California contractors report receiving training from the investor owned utilities (0% reporting for the comparison area). California contractors receive training on high bay lighting technologies from closer networks including contracting organizations (36%) and trade associations (22%). Comparison area contractors also receive training from other sources for training (27%) with some frequency (27%) but contracting organizations and trade associations fairly infrequently (6% each). When asked what percent of customers are aware of the full range of energy efficient HBL options prior to making any recommendations, over half (52%) of California distributors report that a majority (50% or greater) of their customers are aware of the full range of options versus 43% in the comparison area. The contrast between the regions is especially relevant in light of the heightened awareness of energy-efficient technologies in California compared to the southeastern United States region.

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
Un-specified	**Unintended Market Effect: Increased contractor awareness leads to increased volume of efficient HBL installations without increased customer awareness and acceptance of energy efficient technologies prior to installation.**	Strongly Supported	**Contractors frequently leverage the IOUs financial incentives by incorporating them into their contracts and are not educating the end users of the programs in the process.** Among contractors in the program area, substantial proportions of contractors received rebate support from the IOUs either paid to them directly (79%) or paid to their customers (82%). Most contractors (60%) participated in 50 or fewer HBL projects during the last three years receiving support from the IOUs, and 21% of contractors did not participate in any receiving support. Contractors in California install one of the most efficient options, T5HO fluorescents, in much higher proportion (65% of all fixtures) than in the comparison area (29% of all fixtures).** The T5HO fixtures are considerably more expensive than other efficient alternatives such as pulse start metal halides. While proportions are similar for another energy efficient option, T-8 fixtures, at 14% and 16% in California and the comparison area, respectively, the proportion of installations of the relatively inefficient fluorescent option, T-12 fixtures, is significantly higher in the comparison area (11%) than in California (1%).* Contractors in the Southeastern States install pulse-start metal halide fixtures in 31% of installations compared to 14% in California.* This is in spite of the incentive offered for pulse-start metal halide technologies by the California IOUs. In terms of the kinds of marketing support provided by the IOUs, California distributors most frequently report receiving paid rebates either directly (56%) and/or to their customers (21%). As discussed under Link 7, HBL purchasers in the program area reported little awareness of IOU programs to promote efficient HBL equipment. A majority (52%) of end users in California replace operable equipment in order to upgrade performance compared to 31% of end users in the comparison area. End user HBL installations from remodeling (21%) and failure (21%) are higher in the comparison area than in California (9% and 5% respectively). **

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
11	**Program Theory: Contractor Knowledge and Awareness and Customer Awareness and Acceptance** IOU's education and training strategy increases contractor knowledge and awareness of efficient HBL technologies who, in turn, help educate customers and customers accept the recommendations	Not Supported	**End users in both regions do not exhibit high awareness of specific energy efficient HBL technologies, and neither region is predisposed to higher awareness than the other—especially through contractor or vendor sources.** For 51% of California contractors, recommendations for energy efficiency high bay lighting are accepted at least "most of the time," compared to 75% of recommendations in the comparison area. Recommendations in California are "rarely" accepted 41% of the time compared to 6% in the comparison area.** Respondents in both regions were generally unaware of pulse-start metal halide technologies (about 80% not aware in each area) prior to undertaking their HBL installation project(s). Respondents in both territories claim similar awareness of fluorescent technologies (about 50%)—most likely a large proportion recall older T-12 technologies since these awareness levels are higher than for pulse-start metal halides, the predominant HBL technology. California end users are more likely to learn about pulse start metal halide high-bay lighting equipment from vendors than in the comparison area (26% versus 3%)*, whereas they hear about fluorescent technologies from vendors with equal frequency (19% each). From the survey data, we cannot determine awareness channels for specific fluorescent technologies (e.g., T5HO, T8, or T12). A majority of end users in both regions have individuals outside their organization specify or recommend the type of HBL equipment used in the installation project, but a higher majority exists in California. Nearly two-thirds (65%) of California end users have outside individuals specify or recommend equipment whereas in the comparison area this percentage falls to 51%.* By contrast, 38% of comparison area end users do not use outside individuals compared to the 20% of California end users that do not either.**

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
12	**Program Theory: Customer Awareness and Efficient Installations** IOU's education strategy and support teams increase customer awareness of efficient HBL technologies leading to efficient HBL installations. Educated customers through contractor sales efforts lead to efficient HBL installations.	Supported	**End users in California recognize the benefits of energy efficient HBL technologies more frequently than in the comparison area and replace HBL fixtures to achieve them more frequently than in the comparison area.** For the comparison area, end users claim to receive more information on HBL technologies from experiences with past projects than in California. For pulse start metal halides, 20% of end users rely on previous experience for their information in the comparison area compared to less than 1% in California.* For fluorescent high-bay equipment, 38% of end users rely on previous experience for their information in the comparison area compared to 11% in California.* End user reasons for installing the HBL equipment differs substantially between the regions. A majority (52%) of end users in California replace operable equipment in order to upgrade performance compared to 31% of end users in the comparison area.** End user HBL installations from remodeling (21%) and failure (21%) are higher in the comparison area than in California (9% and 5 % respectively).** In both regions, end users' primary objectives are most frequently to save energy and save money. In California, 45% of end users chose their HBL technology to save energy compared to 30% in the comparison area. Likewise in California, 33% of end users chose their HBL technology to save money compared to 20% in the comparison area.* The comparison area end users also selected their specific HBL technologies to improve lighting (19%) more so than those in California (5%).** Also, a relatively high number of comparison area end users (22% versus 8% in California) offer reasons (verbatim responses from the "other" category) for why they replaced what was previously installed, including five respondents who replaced the same technology and one who upgraded to meet building code. Other objectives for selecting the specific HBL technology, when probed, are similar across the board, we note that "Available Rebates" in California increased from 4% to 10% as a secondary objective.

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
13	**Program Theory: Increased Installations, Promotion and Stocking of Efficient HBL** HBL installations increase in volume and lead to increased promotion and stocking of efficient HBL equipment.	Strongly Supported	**Distributors and contractors recognize the value of the IOU rebates with respect to increased installation volume of energy efficient HBL technologies resulting in supply side responses.** Contractors rate the importance of IOU programs fairly highly in their firm's decisions to promote energy efficient high bay lighting, with 79% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 13% of contractors rated the importance between 5 and 7 (out of 10). For distributors representing over a majority (53%) of HBL sales in California, IOU programs are considered very important (score of 8 or above on a scale from 1 to 10) to their firm's decisions about how to promote energy-efficient HBL equipment. When including all responses above 5 (out of a 1 to 10 scale), over three-quarters (79%) of distributors' sales are represented.
14	**Program Theory: HBL Installations and Other Measures** HBL measures allow field support to leverage other efficiency program measures and further reduce energy use, demand, and emissions.	Not Assessed	**An assessment of this link is not necessary to assess market effects in the HBL retrofit market.** End users were not asked whether they participated in any IOU programs outside of any support they may have received for their HBL installations. Program staff emphasize that HBL measures are often a very important "ice breaker" in terms of engaging C&I customers to adopt other energy efficiency measures once they see results and become comfortable with the programs.
15	**Program Theory: Increased Efficient HBL volume and enhanced installation practices** Increased volume of efficient HBL installations creates opportunities for contractors to learn by doing on new efficient technologies, decreasing incremental installation costs, business risks, and further increasing willingness to specify efficient HBL products.	Strongly Supported	**Market size analysis (Section 6.2) shows high out-of-program sales for T5HOs in program area despite significantly higher material costs, hence marketing and sales challenges.**

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
16	**Program Theory: Contractor Awareness and Specification** Increased contractor awareness increases their willingness to specify efficient HBL products and market efficient products.	Supported	**Contractor awareness of energy efficient HBL technologies in California is higher than in the comparison area and recommend "energy efficient" types more frequently.** Market size analysis (Section 6.2) shows high out-of-program sales for T5HOs in program area despite significantly higher material costs, hence marketing and sales challenges. For the energy efficient fluorescent high bay lighting technologies (including induction technologies), contractors in California more frequently consider those to be energy efficient than in the comparison area. For T5HO fluorescent tubes, 96% of California contractors believe they are energy efficient compared to 62% in the four selected Southeastern States.** The difference is similar for T-8 technologies, with 88% of California contractors considering them to be energy efficient compared to 44% of the comparison area contractors.** A majority (52%) of California contractors consider induction lighting technologies to be energy efficient whereas only 5% consider them efficient in the comparison area, possibly reflecting an overall lack of awareness of the technology itself.* Perceptions of energy efficiency are reversed, however, for the most prevalent high bay lighting technology, pulse-start metal halides which are also eligible for IOU incentives. Whereas 70% of contractors in the comparison area consider pulse-start metal halides to be energy efficient, only 21% of California contractors consider them similarly,* possibly reflecting substantial differences in market evolution between the regions, experience with and knowledge of the technologies, and standards for energy efficient lighting specification. For contractors, the tendency to recommend energy efficient types of high bay lighting equipment is higher in California than in the comparison area. In California, contractors "always" recommend energy efficient types of equipment 72% of the time, compared to 48% of the time in the Southeastern States.
17	**Program Theory: Learning by Doing and Specification** Increased volume of efficient HBL installations increases their willingness to specify efficient HBL products.	Strongly Supported	**California contractors are installing accessories to the energy efficient technologies more frequently than in the comparison area, and are specifying them despite the higher first cost.** Occupancy or motion sensors were installed in 39% of the California end user projects compared to 12% in the comparison area.** For nearly three-quarters (74%) of comparison area end users, simple on/off switches were installed compared to 56% of end users in California.** Market size analysis (Section 6.2) shows high out-of-program sales for T5HOs in program area despite significantly higher material costs, hence marketing and sales challenges.

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
18	**Program Theory: Willingness to Specify and Increased Promotion and Stocking** End-users and contractors' willingness to specify new and efficient HBL technologies increased adoption of efficient equipment and installation practices.	Strongly Supported	**Distributors and contractors recognize the value of the IOU rebates with respect to increased installation volume of energy efficient HBL technologies resulting in supply side responses.** Contractors rate the importance of IOU programs fairly highly in their firm's decisions to promote energy efficient high bay lighting, with 79% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 13% of contractors rated the importance between 5 and 7 (out of 10).
19	**Program Theory: Increased Promotion, Stocking, Economies of Scale and Market Share** Economies of scale from increased installations can lead to reduced product prices and installation costs, increased promotion, stocking and market share for efficient HBL technologies.	Strongly Supported	**Market size analysis (Section 6.2) shows high out-of-program sales for T5HOs in program area despite significantly higher material costs, hence marketing and sales challenges and distributors and contractors are promoting energy efficient HBL technologies in California more frequently than in the comparison area.** Incremental costs for T5HO fixtures remain high in 2008 – 2009, while incremental costs for pulse start MH are negligible compared to probe start MH. It is not clear how sustainable the market share for T5HOs, which have better lumen maintenance, will be if program efforts or rebate levels are reduced. Contractors rate the influence of IOU programs fairly highly on market shares of energy efficient high bay lighting, with 73% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 21% of contractors rated the importance between 5 and 7 (out of 10). Contractors in both California and the comparison area report similar perceptions in the trend for fluorescent lighting in high bay applications, with approximately three quarters observing an increase in use, one quarter observing no change and a small percentage (1% to 2%) observing a decrease. Contractors perceive decreasing usage in California compared to increasing usage in the Southeastern States over the past three years. Over one third (35%) of contractors in the Southeast perceive an increase in pulse-start metal halide usage compared to 5% in California.** Three quarters (75%) of contractors in California report a decrease in use of pulse-start metal halide fixtures compared to one quarter (26%) in the comparison area.** The remainder (19% in California and 39% in the Southeast region) reports no change over the past three years.

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
19 (cont.)	**Program Theory: Increased Promotion, Stocking, Economies of Scale and Market Share** Economies of scale from increased installations can lead to reduced product prices and installation costs, increased promotion, stocking and market share for efficient HBL technologies.	Strongly Supported	As is the case with contractors, installations of the most efficient technology, T5HO fluorescents, are greater in California (35% of all fixtures) than in the comparison area (30%), but to a lesser degree. Also in accordance with the contractors, the proportion of installations of the relatively inefficient fluorescent option, T-12 fixtures, is significantly higher in the comparison area (18%) than in California (4%).** In contrast to the contractors, the installation of T-8s in both regions are reportedly higher overall, and the comparison area (38%) represents a statistically greater percentage of all fixtures than T8s in California (22%).** Distributors in California also report a significantly greater percentage of pulse-start metal halide fixture installations (16% of all fixtures) compared to the comparison area (8%).** Distributors report in similar proportions that they observed an increase in installations of fluorescent high bay lighting technologies over the past three years (77% in California and 83% in the comparison area). Perceived trends in the market by distributors for pulse start metal halides are different than for fluorescent technologies. A lower percentage of California distributors (37%) report an increase over the past few years, compared to 45% in the four Southeastern States. Accordingly, 32% of California distributors perceive a decrease versus 14% in the comparison area.** When asked what influence the California IOU programs have on the market share for energy-efficient lighting technologies, distributors in California representing 61% of sales claim the programs have been very influential, rating the influence at 8 or higher (on a scale of 1 to 10). When including all responses above 5 (out of a 1 to 10 scale), 91% of distributors' sales are represented.
20	**Program Theory: Market Share and Long-Term Outcomes** Increased market share of efficient HBL technologies delivers reduced energy use, demand, and emissions.	Strongly Supported	**Compared to baseline lighting efficacy, the net savings due to the IOU programs is approximately 37 MW or 109,604 MWh/year.** See savings analysis in Section 6.2.

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
21	**Program Theory: Behavior and Long-Term Outcomes** Enhanced efficiency behavior by end-users delivers reduced energy use, demand, and emissions.	Not Assessed	**An assessment of this link is not necessary to assess market effects in the HBL retrofit market.** Occupancy or motion sensors were installed in 39% of the California end user projects compared to 12% in the comparison area (significant at 95% confidence level). For nearly three-quarters (74%) of comparison area end users, simple on/off switches were installed compared to 56% of end users in California (significant at 95% confidence level). End-users in program area show greater staff resources and awareness for energy efficiency, but no link of this behavior to program
22	**Program Theory: Increased Market Share and New Products** Increased market share for efficient HBL technologies and installation practices prepares marketplace for new and improved products for HBL applications.	Strongly Supported	**The increased market share and economies of scale have prepared the California market for new and improved energy efficient HBL products.** Nearly all (99%) distributors in California consider T5HO fluorescents to be energy efficient versus 88% in the comparison area.** Nearly all (85%) distributors in California consider LED technologies to be energy efficient compared to 39% in the Southeastern States.** A much lesser, but statistically significant proportion of California distributors (44%) include induction technologies compared to 34% in the Southeast.** T-8s are considered energy efficient by nearly all (84%) distributors in the comparison area compared to 68% in California, but not significantly different. Nearly three quarters (74%) of California distributors consider pulse-start metal halides to be energy efficient compared to 36% in the four Southeastern States, but the difference is also not significantly different. Contractors selling a large volume of T5HOs outside the program despite significantly higher costs. End user reasons for installing the HBL equipment differs substantially between the regions. A majority (52%) of end users in California replace operable equipment in order to upgrade performance compared to 31% of end users in the comparison area. End user HBL installations from remodeling (21%) and failure (21%) are higher in the comparison area than in California (9% and 5 % respectively).**

Link	Market Effects Indicators	Finding	Discussion (* Significant at the 90% confidence level; ** Significant at the 95% confidence level)
23	**Program Theory: Specification and Installations** Willingness to specify efficient HBL products prepares marketplace for new and improved products for HBL applications.	Supported	**The increased willingness to specify and install energy efficient HBL technologies has prepared the California market for new and improved energy efficient HBL products.** Nearly all (99%) distributors in California consider T5HO fluorescents to be energy efficient versus 88% in the comparison area.** Nearly all (85%) distributors in California consider LED technologies to be energy efficient compared to 39% in the Southeastern States.** A much lesser, but statistically significant proportion of California distributors (44%) include induction technologies compared to 34% in the Southeast.** T-8s are considered energy efficient by nearly all (84%) distributors in the comparison area compared to 68% in California, but not significantly different. Nearly three quarters (74%) of California distributors consider pulse-start metal halides to be energy efficient compared to 36% in the four Southeastern States, but the difference is also not significantly different. Contractors selling a large volume of T5HOs outside the program despite significantly higher costs. End user reasons for installing the HBL equipment differs substantially between the regions. A majority (52%) of end users in California replace operable equipment in order to upgrade performance compared to 31% of end users in the comparison area. End user HBL installations from remodeling (21%) and failure (21%) are higher in the comparison area than in California (9% and 5 % respectively).**

6.2 Assessment of Net Energy and Demand Savings

This section presents an assessment of net energy and demand savings, including the methodological framework, a technical requirements analysis, and key market parameters. Compared to baseline lighting efficacy, the net savings due to the IOU programs is approximately 37 MW or 109,604 MWh/year.

6.2.1 Methodological Framework

KEMA has adopted the basic framework established in the California *Evaluators' Protocols*[231] for estimating energy impacts associated with the market effects of programs to promote efficient HBL. The key elements of that framework are as follows:

- **Definition of Market Effects.** The *Protocols* adopt the definition of market effects developed by Eto, Prahl, and Schlegel (1996) as the basis for discussion of appropriate methods.[232] The *Scoping Study* defines market effects as: "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 intervention(s)." The one-time nature of this study makes it difficult to characterize market changes over time in response to the program. However, we used observations of sales and installation practices in a comparison area to represent baseline conditions in California, i.e., what the market share of efficient HBL lighting and the prevalence of behaviors associated with promotion and adoption of those technologies would have been in the absence of the program.

- **Focus on estimation of energy impacts.** The *Protocols* emphasize the importance of quantifying the program-induced changes *and* the energy impacts associated with those changes.

- **Level of aggregation for program efforts and impacts.** The Market Effects Evaluation Protocol is designed to be applied to programs that target markets that span areas served by individual program sponsors. Specifically, it applies to "program-induced market changes that could be missed or double-counted if measured program by program." Clearly, the supply chain for HBL is national and even international. Moreover, as discussed earlier, there have been many utility and government interventions in the HBL

---

[231] The TecMarket Works Team. *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals.* (San Francisco: State of California Public Utilities Commission, 2006.) pp. 142 – 162.

[232] Joe Eto, Ralph Prahl, and Jeff Schlegel. *A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs. (Berkeley, CA: Ernest Orlando Lawrence Berkeley National Laboratory,* 1996.

market over the past decade through the development of product standards and voluntary programs. In order to take proper account of these influences, it is necessary to focus analytical efforts at a higher level of aggregation than the individual sponsors' programs.

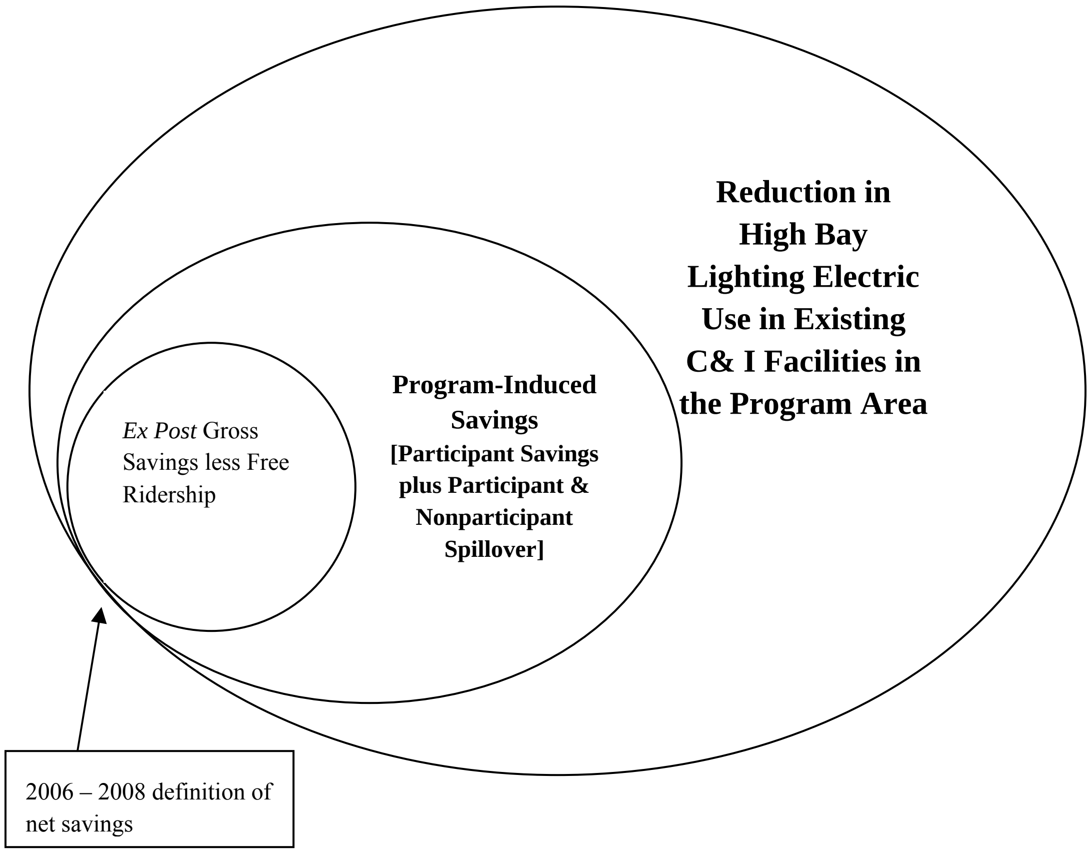
- **Operational definition of market effects.** Figure 5, which is adapted from the *Protocols*, depicts the relationship among the following concepts: net savings as it was defined in the last round of impact evaluations for California's IOU energy efficiency programs, energy savings due to market effects, and total reductions in high bay lighting electric use in existing commercial and industrial facilities in the program area market during the evaluation period. As discussed earlier, the efficiency of equipment sold into the national HBL market increased over the study period (2006 – 2008) driven by many factors, including:

    - Competition among manufacturers, distributors, and contractors
    - Trends in the relative costs and performance of alternative technologies
    - Increasing energy prices
    - Increasing environmental awareness
    - Programs and other market interventions by utilities and governments nationwide

The large outer oval in Figure 5 depicts the effects on total energy consumption by the HBL equipment sold into the program area market during the study period. The smallest oval in the diagram represents the concept of net savings as it was implemented in the impact evaluations of the 2006 – 2008 energy efficiency programs: participant gross savings less free ridership.[233] The middle oval represents all energy savings attributable to the program, which includes participant net savings *plus* efficiency gains in high bay lighting applications experienced by participants and non-participants outside the program that would not have occurred in the absence of the program. As we will see in Section 6.2.5, the most likely mechanism for the achievement of those savings was the promotion and installation of T5HO fixtures by California contractors without the use of program incentives.

[233] Participant spillover was evaluated in only a few program evaluations.

Figure 5. Representation of Net Effects Concepts



In the paragraphs that follow, we describe the methods we used to estimate the magnitude of program-induced savings and the results of those methods. Our approach proceeded in the following steps:

1. Estimate the size of the installed base of HBL in the program and comparison areas in terms of square footage, fixtures installed, and lumen output of those fixtures.
2. Estimate the portion of the installed base that is replaced or retrofitted each year in both areas during the study period.
3. Estimate average watts per square foot in the spaces in which HBL was replaced or retrofitted during the study period, based on customer and contractor reports of the share of technologies purchased or sold.

4. Use the difference in watts per square foot coupled with estimates of market size (Step 2) to estimate energy savings associated with program-related influence on technology shares.

Following this approach, the sum savings achieved through program impacts on technology shares and acceleration of retrofits can be understood to represent program-induced savings, including those associated with market effects.[234]

The Study Team notes that the controllability of T5HO fixtures is a significant additional potential resource for the California IOU's HBL programs. Compared to PSMH, T5HO fixtures can not only reduce the lighting load profile for a given facility, but also lighting controls can reduce hours of use resulting in additional savings not accounted for in this study. The data requirements for estimating savings associated with HBL lighting controls exceeded the scope of this study and this particular methodological approach.

6.2.2 Market Size: Square Footage Served by 2006 – 2008 Purchases

Table 26 shows the calculations and information sources used to estimate the size of the market in terms of square feet served by HBL that customers reported having purchased during the study period. Using the fairly straightforward process outlined in

[234] We also analyzed potential savings due to accelerated replacement of operable equipment in the program area. We found that while there were some differences between the program and comparison areas in some related key areas, such as the percentage of first undertaking retrofit projects and the average portion of high bay spaces addressed, these differences were not statistically significant.

Table 26, we estimate the total square feet served by 2006 – 2008 high bay lighting at 458.1 million square feet in the program area and 107.8 million square feet in the comparison area. The survey results and calculations shown in Table 26 show the following key similarities and differences between the program and comparison area samples.

- **The portion of facilities in which high bay space is reported is significantly higher in the program area than in the comparison area: 30.7 percent v. 23.0 percent.** This difference is statistically significant at $p<.05$. The allocation of the program and comparison area samples to North American Industrial Classification System (NAICS) categories was roughly similar. The observed difference in the presence of high bay spaces may be related to the difference in average facility size between the samples, as discussed below.
- **The portion of customers who reported purchasing HBL during the study period is slightly higher in the program area: 28.5 percent v. 25.5 percent.** However, this difference is not statistically significant.
- **The average size of facilities in the program area sample is 203,258 square feet v. 128, 880.** While this difference is substantial, it is not statistically significant due to the high variability of size among the sample facilities in the program area. The 90 percent confidence interval around the mean was 167,937 square feet or 83 percent of the average value, due largely to the presence of a few very large facilities. Variability among the facilities in the comparison area was significantly lower. The median of the size distribution of sample end-user facilities was 36,442 square feet in California versus 45,584 square feet in the comparison area. Thus, the distribution of the California sample was more heavily concentrated in the lower size categories than the comparison area sample. However, the three largest facilities in the California sample were substantially larger than any in the comparison area.

Table 26: Estimate of Market Size: Square Feet Served by 2006 – 2008 High Bay Lighting Purchases

	MARKET PARAMETERS/Inputs	California	Comparison	Notes/Sources
	NUMBER OF PURCHASERS			
1	Population of End-Users	59,413	37,608	Dun & Bradstreet Selectory Database: Manufacturing + Selected Commercial NAICS codes
2	% with High Bay Spaces	30.7%**	23.0%	Customer Surveys. 90% confidence intervals: ± 2.0% for CA; ± 1.9% for Comparison.
3	Population of End-Users w/ High-bay Spaces	18,252	8,650	Row 1 * Row 2. 90% CI for CA: ± 369 customers
4	Percent of end-users w/ high bay spaces who purchased high bay lighting in 2006 – 2008	28.5%	25.5%	Customer Surveys 90% confidence intervals: ± 3.6% for CA; ± 4.0% for Comparison.
5	***End users who purchased high bay lighting in 2006 – 2008***	***5,203***	***2,203***	Row 3 * Row 4. 90% CI for CA: ± 208 customers
	SQUARE FEET SERVED BY HIGH BAY LIGHTING PURCHASED: 2006 – 2008			
6	Average square feet of purchasers' facilities	203,258	128,880	Customer Survey 90% CI for CA: ± 167,937 sf.; ± 30,231 for the Comparison
7	Percentage of facility sf with ceiling height > 15 f	61%	68%	Customer Survey 90% CI for CA: ± 4.3%
8	Average square feet of high bay space	123,987	87,638	Row 6 * Row 7
9	Average percent of high bay space served by 2006 – 2008 purchases	71%	56%	Customer Survey
10	***Total square feet of space served by 2006 – 2008 purchases***	***458.1 million***	***107.8 million***	Row 5 * Row 9 * Row 10

- **The average percent of high bay space served by equipment purchased in 2006 – 2008 was somewhat higher in the program area than in the comparison area: 71 percent v. 56 percent.** This estimate is based on interpolation of values into ranges provided by the respondents. We, therefore, cannot estimate variance or assess the statistical significance of the difference between the samples. We note that more than half of the respondents in each sample reported that 75 – 100 percent of their high bay space was served by their recent equipment purchases.

6.2.3 Market Size: Lumens Installed

The next step in the market sizing process is to estimate the number of lumens provided by the 2006 – 2008 purchases of HBL equipment. Once that quantity is established, survey results on technology shares can be combined with various engineering guidelines and equipment specifications to estimate the number of fixtures purchased and their associated wattage.

This portion of the analysis necessarily involves a number of simplifying assumptions. "High bay spaces" comprise a large number of different uses including: active and long term storage, public assembly, gymnasiums, food preparation, coarse and fine materials processing, coarse and fine assembly, and precision manufacturing. Suggested lighting levels for these activities range from 14 to 60 foot candles (fc = 1 lumen per square foot).[235] Moreover, these activities have different demands for contrast, color rendition, and illumination of vertical surfaces.

[235] After taking into account allowances in retail and storage spaces for illumination of vertical surfaces.

Table 27 shows lighting levels for various types of high bay spaces as recommended by the Illuminating Engineering Society of North America (IESNA) as well as allowed lighting power densities from the 2008 version of California Title 24[236] and the Commercial Lighting Program operated by the New York State Energy Research and Development Authority (NYSERDA)[237]. We note that the allowed lighting densities in Title 24 is significantly lower than that in the NYSERDA guide for most spaces, and particularly for high-bay spaces. This may be due to recent advances in lighting technologies that have not been reflected in the NYSERDA materials.

Table 27: Recommended Lighting Levels and Lighting Power Densities for Activities in High Bay Spaces

		Lighting Power Densities	
Space Type	**IESNA Target Lighting Level (FC)**	**Title 24 Area Method w/sf***	**NYSERDA CLP Allowance w/sf**
Exhibition Hall	10	1.4	1.0
Grocery Store	50	1.6	1.9*
Industrial Area, >20' ceiling	30	1.0	2.7
Gymnasium	60	1.0	1.7
Mall Arcade/Atrium/Concourse	30	1.3	1.3
Manufacturing area, > 20' ceiling	50	1.0	2.7
Retail Sales: General Merchandise	34	1.6	1.9*
Warehouse Area, > 20' ceiling	14	0.6	2.7

* Includes wattage for accent and task lighting.

This step of the analysis required the estimation of an average level of installed lumens across the various types of commercial and industrial spaces. Unfortunately, we were unable to identify a source for the distribution of C&I spaces across the categories listed in Table 26 at any level of geographic aggregation. The recent California Commercial End-Use Survey238 developed estimates of total square feet by commercial building type. Manufacturing energy use is generally rendered in terms of consumption per employee or unit of value added, and we found no sources on estimated manufacturing building area. However, the 2002 Economic Census provides estimates of the number of establishments, value of shipments, and number of employees by various levels of

[236] California Energy Commission. *2008 Building Energy Efficiency Standards for Residential and Non-Residential Buildings.* Sacramento, December 2008. p. 121.

[237] IESNA recommended lighting levels and CLP lighting power allowances from the New York State Energy Research and Development Authority Commercial Lighting Program, http://www.nyserda.org/sclp2/technicalGuide/about/avgIlluminance.asp?section=1.1.7, accessed February 2, 2010.

[238] Itron, Inc. 2006. *California Commercial End-Use Survey.* Sacramento: California Energy Commission. p. 150.

NAICS classification at the state level.239 These figures show that manufacturing accounts for 15 percent of the establishments and 37 percent of employment in the industries that are most likely to be housed in facilities with high bay lighting.

Table 28 summarizes the results of these assumptions and calculations. We assumed that manufacturing floor space equaled 35 percent of floor space for commercial buildings that are likely to have high bay spaces, which is slightly lower than what would be suggested by the portion of employees accounted for by manufacturing facilities. The percent of square footage of each building type accounted for by high bay spaces represents a best estimate based on survey data and experience in conducting commercial building audits. We adjusted those estimates until the sum of high bay spaces equaled 61 percent of total floor spaces, which corresponds to the end user survey results shown on Line 9 of Table 23. Based on the calculations summarized in Table 28, we set the average lumens of high bay lighting installed in California during the period 2006 – 2008 at 39.9 lumens per square foot. Total lumens installed was estimated at 18.28 billion lumens (458.1 million square feet of space affected * 39.9 lumens per sf).

Table 28. Estimate of Lumens of HBL Installed

	Total Area Million SF	% of Total Space High Bay	Hi Bay Area Millioin SF	% of total High Bay	Lumens per SF
Building Sector					
Small Office	361	0%	0	0%	
Large Office	660	0%	0	0%	
Restaurant	149	0%	0	0%	
Retail	702	40%	281	12%	34
Food Store	144	90%	130	6%	50
Refrigerated Warehouse	96	70%	67	3%	14
Unrefrigerated Warehouse	554	70%	388	17%	14
School	445	7%	31	1%	60
College	206	7%	14	1%	60
Health	233	0%	0	0%	
Lodging	270	0%	0	0%	
Miscellaneous	1,100	15%	165	7%	34
Total Commercial	4,920		1076	47%	
Manufacturing	1,722	70%	1205	53%	50
Total/Average			2281		39.9

239 U. S. Bureau of the Census, *2002 Economic Census*. California Table 1: Selected Statistics by Economic Sector: 2002, http://factfinder.census.gov/servlet/GQRTable?_bm=y&-geo_id=04000US06&-ds_name=EC0200A1&-_lang=en. Accessed April 8, 2010.

6.2.4 Technology Shares and Average Lumens per Watt

The next step in the analysis is to estimate the average lumen output per watt for the cohort of HBL equipment installed in the program and comparison areas, based on the best information available from the contractor and customer surveys. Table 28 summarizes the technology share findings from the End-User and Contractor surveys.[240]

Table 29: Reported Technology Shares of 2006 – 2008 High Bay Lighting Equipment Sales/Purchases

	Contractor-Reported Sales		End User-Reported Purchase	
Technology Type	**California**	**Comparison**	**California**	**Comparison**
Fluorescent Tube: T5HO/Electronic Ballast T5HO	65%	29**%	16%	8%
Fluorescent Tube: T-8 /Electronic Ballast T-8	14%	16%	31%	22%
Fluorescent Tube: All other, including T12	1%	11%*	29%	19%
FLUORESCENT TUBE SUBTOTAL	**80%**	**58%**	**76%**	**49%**
HID: Pulse-start metal halide	14%	31%*	3%	5%
HID: High-pressure sodium	3%	8%	1%	5%
HID: Other HID: probe-start metal halide	1%	3%**	9%	26%
HID SUBTOTAL	**18%**	**42%**	**13%**	**36%**
OTHER: INDUCTION, LED, CFL, INCANDESC.	**2%**	**2%**	**11%**	**14%**

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

Given the differences in respondent population and sampling approach, the similarity between the contractor and end-user results are remarkable, at least at the highest level of technology aggregation. Specifically, the sales-weighted share of contractor sales for fluorescent tube fixtures in the program area was 80 percent, versus a weighted average share of 76 percent of customer purchases. The corresponding figures in the comparison area were 58 percent and 49 percent. Estimates of the HID share of installations and purchases within the program and comparison areas are similarly close for the two methods. Given the differences in the methods used to make the estimates from the contractor and customer surveys, it is not possible to assess the statistical significance of the differences between the results of the two methods. However,

[240] Contractors were asked to estimate the percentage of the fixtures that they installed in high bay applications and that fell into the technology categories shown in Table 29. End-users were also asked to estimate what percentage of the high bay fixtures that they installed that fell into the basic categories of fluorescent tube, metal halide, high pressure sodium and other. They were then asked about sub-categories within each. We also questioned distributors on the technology shares of fixtures that they sold for high bay applications. However, the pattern of their responses was so heavily weighted to T-8 tube fluorescents that we concluded that they had understood the question to be asking about overall commercial fixture sales.

the two methods clearly yield similar results. Moreover, the difference between the program and comparison area estimates of market share for fluorescent tube and HID fixtures is statistically significant using either market share estimation method. For subsequent calculations of market size and energy savings, the study team uses the technology share results from the contractor survey. Our rationale for this methodological decision is based on the fact that contractors' business requirements and experience better equip them than customers to distinguish between subgroups within the technology families, such as T-5s versus T-8s.

Within the basic fluorescent tube and HID groups, the estimated share of specific technologies differs substantially depending on the population surveyed. Contractors report that they sold a much higher share of T5HO fixtures than customers report buying in both the program and comparison area. However, we note that the proportional difference between the program and comparison areas in T5HO market share is roughly the same – 2 to 1 – regardless of the population surveyed. Given contractors' greater familiarity with lighting technologies and the difficulties that customers would have in distinguishing between technologies in the fluorescent tube and HID groups, we believe the market share results from the contractors are more likely to be accurate than the results of the end-user survey. Moreover, as we discuss below, the contractor survey results are much more consistent with the volume of T5HO installations supported by the IOU programs.

In order to calculate market size and savings, we need to develop an estimate of the average efficacy (lumen output per watt) of the HBL equipment purchased during the study period in both the program and comparison areas. We can then apply the average efficacy to the estimate of total lumen output for the equipment sold to arrive at an estimate of total wattage installed.

To estimate average efficacy, we need a figure for the efficacy of each of the technology categories shown in Table 29. Moreover, the efficacy must correspond to the actual lumens delivered, since the lighting level requirements shown in Table 27 refer to the foot candles on the surfaces to be illuminated.

Many technical resources, such as California's Database of Energy Efficiency Resources (DEER), show the output of lighting fixtures in terms of their initial efficacy, that is: their lumen output per watt when newly installed. However, according to the IESNA *Lighting Handbook*[241] and many other guidebooks, the amount of lighting installed should be sufficient to deliver recommended lighting levels at the output available after 40 percent of the fixtures' rated life has elapsed. This level is referred to as the design efficacy or design lumens. As discussed in Section 3, the alternative HBL technologies differ significantly in the pace of lumen degradation. Also, different wattage fixtures within HID technologies have different efficacies, with the higher

[241] Rea, Mark S., Editor-in-Chief. 2000. *IESNA Lighting Handbook,* (New York: Illuminating Engineering Society of North America).

wattages generally being more efficient. For purposes of calculating the average population efficacy, we assumed an even mix of high and low wattage fixtures in the HID categories.

The percentage of a fixture's lumen output delivered to the surface to be lighted depends on the design of the fixture. Most fixtures used in commercial and manufacturing high-bay spaces deflect a portion of the output upwards and outward to provide even illumination and avoid heavy shadows. In storage situations, elliptical reflectors are typically used to focus light downward and gain efficiency.[242] The far right hand column of Table 30 shows the efficacies for each technology adjusted for the efficiency of fixtures in which the technology is commonly housed plus a design allowance for ceiling height, assuming a fixture height of 27 feet.

Table 30: Efficacy of High Bay Lighting Technologies

	Efficacy: Lumens/Watt		
Technology	**Initial**	**Design (40% of Rated Life)**	**Adjusted for Height & Fixture Efficiency**
Fluorescent Tube: T5HO/Electronic Ballast T5HO	93	88	66
Fluorescent Tube: T-8 /Electronic Ballast T-8	92	88	68
Fluorescent Tube: All other including T-12	62	58	45
HID: Pulse-start metal halide: 250w	95	64	43
HID: Pulse-start metal halide: 400w	110	78	53
HID: High-pressure sodium	96	78	53
HID: Other HID probe-start metal halide: 250w	82	54	36
HID: Other HID probe-start metal halide: 400w	100	65	44
Other: technologies such as Induction or LED	70	62	47

Applying the adjusted design efficacies shown in Table 30 to the technology shares developed from the contractor surveys and displayed in Table 29, we estimated the following weighted average efficacies:

- Program Area (California IOUs): 62.2 lumens per watt.
- Comparison Area: 56.0 lumens per watt.

[242] Ruud Lighting, *High Bay Lighting Comparison Guide*. www.ruudlighting.com/literature/high_bay_lighting_guide.pdf, Accessed January 26, 2010.

6.2.5 Estimated Volume of Fixtures Purchased and Wattage Installed

In this section, we use the results of analyses in Sections 6.2.2 through 6.2.4 to estimate the total wattage and number of fixtures installed in California. To assess the reasonableness of those estimates, we check them against quantities that we know with greater certainty, including the number and type of fixtures supported by the IOU programs during the study period and design guidelines for number of fixtures and wattage installed per square foot.

Estimate of total wattage

To estimate the total wattage of the fixtures installed, we simply divide the estimate of total lumen requirements for the spaces served by high bay equipment purchase (Section 6.2.3) by the average efficacy of the equipment purchased (Section 6.2.4). The result of this operation is 294 MW (18.28 billion lumens / 62.2 lumens per watt) of total input requirements for the HBL equipment purchased by business establishments served by the California IOUs between 2006 and 2008.

Reasonableness of the estimate

To assess the reasonableness of the total wattage estimate, we compared the average lighting power density it implies to lighting power allowances for high bay spaces included in the 2008 version of Title 24 (the California building energy code). Using the estimate of total square feet served by the equipment purchased during the study period, we estimated average lighting power density of that equipment at 0.64 watts per square foot (294 MW installed capacity/458 million square feet). By contrast, the lighting power allowances in Title 24 for the high bay spaces ranged from 0.6 to 1.6 watts per square foot. The largest building category in the sample is warehouses, which have the lowest power density. The next largest is retail, which has the highest. Thus we conclude that the average lighting power allowance for high bay spaces is in the range of 1.1 – 1.2 watts per square foot. These lighting allowances include wattage for task and accent lighting, as well as for wall and exit lighting. Together, these additional allowances can add from 0.2 to 0.7 watts per square foot to the total lighting power allowance, depending on the type of space. Thus, we believe that our estimate of 0.64 watts per square foot is consistent with engineering practice.

Number of Fixtures Purchased

There are several strategies by which the number of fixtures sold and purchased during the study period could be estimated from the analyses developed so far. These include dividing the total number of square feet that the purchased fixtures serve by an average square footage lit per fixture. Alternatively we could divide the total watts installed by an average fixture wattage. Reviewing the technical literature, we found that the guidelines for the number of fixtures to install per square foot was much more consistent than fixture wattage. This is due to a combination of factors including:

- **Lighting fixture performance characteristics.** Fixture placement guidelines are driven as much by dispersion patterns as by light output.

- **Project economics.** For retrofit and replacement projects, it is often more cost-effective to replace fixtures than to engineer new lighting layouts.

For this study, we reviewed a wide range of lighting guides that included sample fixture layouts for a variety of high-bay spaces. Virtually all of the layouts for open areas specified one fixture per 320 – 400 square feet of floor space. Layouts for warehouses with long aisles tend to be more dense – one fixture per 160 – 200 square feet, due to aisle layout and blockage of light by high racks. For this study, we use an *average area lit per fixture of 375 square feet*. This yields an estimate of *1.22 million fixtures sold to California businesses for use in HBL applications during the study period*, or 407,238 fixtures per year.

Dividing the estimate of total wattage for the fixtures sold (294 MW) by the estimate of total fixtures sold (1.22 million fixtures), we arrive at an average of 240 watts per fixture. This figure is consistent with the technology share data and engineering-based information on wattage per fixture. The latter run from 240 watts for a typical 4-lamp T5HO high output fixture to 455 watts for a high wattage probe start metal halide fixture.

We note that the estimate of installed wattage developed through the calculations described above are in the low range of what we would expect given typical fixture wattages and Lighting Power Density guidelines. Given the large number of assumptions and survey results required to generate those estimates, it is difficult to pinpoint the reasons why the estimates are in the low range. However, the input on which we have the least data is average lumens of high bay lighting, which could be underestimated because actual contractor practice may involve installing higher lighting levels than required by the IESNA guidelines, or because the distribution of high bay spaces among the various space types may be different from what we assumed.

6.2.6 Reductions in Energy Use due to Differences between Program Area and Baseline Technology Shares

Table 31 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 of Table 31.

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 associate 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 difference between actual and baseline annual usage for HBL purchased and installed in existing California buildings during the period 2006 – 2008 at 97,166 MWh per year.

Table 31: 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**	Row 5 – Row 4
7	**Difference in GWh/Year Usage**	**97.2**	Row 6 * average annual operating hours per lighting logger study conducted for Impact Evaluation of 2006 – 2008 Small Commercial Program[243]

[243] 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.

6.2.7 Comparison of Estimates of Program-Induced Savings to Net Savings Developed by Direct Impact Evaluations

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. Table 32 summarizes the results of the direct impact evaluation of HBL measures installed through the Small Commercial programs. As discussed earlier, virtually all of the fixtures that received incentives through the program used T5HO high output tube fluorescent technology.

Table 32: Gross and Net Savings for Small Commercial Program High Bay Measures

IOU	Ex-Ante Gross Savings	Ex-Post Gross Savings	Gross Realization Rate	Installed Ex-Post Gross Savings	Install Rate	Installed Ex-Post Net Savings	Ex-Post NTGR
Demand Reduction: MW							
PG&E	19.6	9.7	49%	8.9	92%	6.1	68%
SCE	14.3	7.8	55%	7.3	93%	4.5	61%
SDG&E	6.0	3.5	58%	3.5	100%	3.2	90%
Total	39.9	21	53%	19.7	94%	13.8	70%
Energy Savings: GWh/Year							
PG&E	67.6	46.8	69%	42.9	92%	27.9	65%
SCE	46.6	34.5	74%	32.3	93%	20.3	63%
SDG&E	29.7	16.3	55%	16.3	100%	14.8	90%
Total	143.9	97.6	68%	91.5	94%	63.0	69%

A review of the results summarized above illustrates a number of interesting points of comparison for this study.

- The net-to-gross ratio of 69 percent 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.

- 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.[244]

- 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 High Bay Lighting measures supported by IOU programs totaled 67.0 GWh per year.

To summarize the proceeding two sections, we 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 yea
- The difference in the estimate of net energy consumption reductions generated by the two methods is 30.2 GWh.

6.3 Assessment of Attribution and Alternate Hypotheses

In this section, we assess the extent to which the difference between the program and comparison areas in technology shares for energy-efficient HBL technologies was due to the effects of the IOU programs. To put this analysis in context, we also assess the strength of evidence for alternative hypotheses concerning drivers for the observed differences. 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

[244] Personal correspondence with the Itron project team.

building codes. Energy code enforcement is generally not invoked in replacement 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 marketing effort 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 the 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.

6.3.1 Hypothesis 1: Evidence Linking Difference in Technology Shares to IOU Programs

The basic argument for linking the observed high market share of T- 5 technologies to activities of the program runs as follows.

1. Throughout the study period, T5HO technology commanded a steep price premium compared to other "efficient" HBL technologies: 22 to 65 percent compared to equivalent PSMH technologies: 300 – 400 percent 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.
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 area. Clearly, if contractors can sell products without the administrative and time investment associated with the rebate, they have an incentive to do so. 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. 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.[245]
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 DEER, T5HO fixtures were anywhere from 22 percent to

[245] 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.

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.[246] These cost relationships do not necessarily indicate costs of alternative approaches for a given project, which will depend on the degree to which 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. For the average installation, the incremental cost of using T5HO versus PSMH technology would have 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,[247] the payback period for selection of T5HO over PSMH 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 HID technologies.
    - **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 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

---

[246] 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.

[247] $0.1392 per kWh for full service customers in California. http://www.eia.doe.gov/cneaf/electricity/epa/average_price_state.xls

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.

***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. Despite the availability of incentives for PSMH, induction technologies, and T-8 linear fluorescent technologies, T5HO technologies accounted for 93.4 percent of the units for which incentives were paid and 92.9 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 remainder were linear fluorescent fixtures of unspecified type. See Table 33 for details of program activity.

Table 33: 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. Table 34 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 34: 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 area. 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.

6.3.2 Hypothesis 2: Effects of Title 24

For projects that use the Prescriptive Area approach to compliance with the lighting provisions of the current version of Title 24, it will be easier to attain required lighting power densities using fluorescent technologies rather than pulse-start metal halide (PSMH) fixtures. Lighting design guides and layout books consulted for this study show examples of PSMH installations that would meet Title 24 guidelines, but by only a narrow margin. Approaches using primarily fluorescent fixtures deliver required lighting levels at well-below the Title 24 maximum lighting power densities. This finding was echoed in the in-depth interviews with California contractors and distributors.

Among the 150 California lighting contractors with whom we completed CATI interviews, seven contractors mentioned Title 24 compliance as an influence on their high bay lighting specification practice.

We also hypothesized that contractors and distributors who became familiar with high bay fluorescent technologies in order to comply with Title 24 in new construction projects would carry that experience over into specification for projects in existing buildings. However, there were no reports of such experience from any of the contractors or distributors interviewed for this study.

We conclude from the evidence reviewed above that Title 24 probably did exert some influence on the market share of fluorescent technologies in high bay applications in existing buildings, but that this influence was relatively weak. Our main reasons for this assessment are that:

- Those who did acknowledge the Title 24 influence did so clearly and without prompting in open-ended questions, *but..*

- Only four of the 150 contractors we interviewed identified Title 24 as an influence on their specification practices in existing buildings.

6.3.3 Hypothesis 3: Differences in prior customer awareness and ability to adopt energy-efficient technologies.

One alternative hypothesis concerning causes of the observed differences between the program and comparison areas in the adoption of efficient T5HO HBL technology is that customers in the former were more disposed to purchase those technologies than their counterparts in the comparison area. This predisposition could arise from two basic sources. The first would be a systematic pattern of differences between the regions in attributes that are known to affect adoption of energy-efficient products and practices: e.g., firm size, the presence of energy managers, and energy prices paid. The second would be the cumulative effects of the energy-efficiency programs and customer education campaigns that have been aimed at C&I end-users in California for two decades.

As discussed below, we find only weak support for this hypothesis in the data gathered for this study. Key findings in support of the hypothesis are as follows.

- **On average, HBL purchasers in the program area have larger facilities than their counterparts in the comparison area but employ roughly the same number of persons.** As discussed in Section 6.2, the average size of facility among HBL purchasers in the program area was 203,258 square feet versus 128,880 in the comparison area. Much of this difference is attributable to the presence of a few very large facilities among the program area respondents. By contrast, the average number of employees per facility was virtually the same in the two samples: 169 for the program area v. 162 for the comparison area.
- **HBL purchasers in the program area report more resources and processes dedicated to energy management than their counterparts in the comparison area.** The end-user survey contained a fairly lengthy series of questions concerning the respondent firms' energy management practices and resources. As Table 35 shows, end-users in the program and comparison areas were quite similar in terms of the resources that they devoted to energy management and the energy management activities that they undertook. Significant differences were observed only in the proportion of sample end-users who reported tracking facility-level energy use over time and who developed policies to promote purchases of energy-efficient equipment. Previous studies have found that the presence of an energy manager is one of the strongest predictors of efficient equipment or practice adoption. In this case, there was no significant difference between the samples on the presence or type of energy management capacity.

Table 35: End-User Self-Reported Energy Management Resources & Practices

	Weighted Frequency	
Practice or Resource	**Program Area**	**Comparison Area**
Have a person, group, or department assigned by top management to manage energy use and costs.	47%	52%
One person assigned	27%	28%
Group assigned	10%	11%
Department assigned	10%	12%
Has energy use reduction goals for the sample facility	80%	74%
Tracks energy use and costs over time for the facility	82%**	59%
Monitors energy use for key building or production systems	73%	63%
Identifies facility improvements to reduce energy use and costs on an ongoing basis	83%	77%
Tracks developments in lighting technologies	53%	48%
Develops policies to promote purchases of energy-efficient equipment	70%**	49%
Pursues corporate environmental sustainability initiatives	39%	49%
Energy management is a part of the sustainability initiative	96%	80%
** Significantly different from the comparison area at the 95% confidence level.		

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

- **Contractor characterization of customer knowledge and attitudes.** The contractor survey asked the following question: "About what percent of your customers are aware of the full range of options for energy-efficient high bay lighting available to them before you provide recommendations about the lighting system?" Table 36 shows the distribution of the responses, which do not differ significantly between the program and comparison areas.

Table 36: Percent of Customers Aware of Full Range of HBL Options as Characterized by Contractors

Weighted Frequencies	Program Area	Comparison Area
N	**139**	**86**
Between 0 and 10	50%	33%
Between 11 and 25	27%	12%
Between 26 and 50	13%	37%
Between 51 and 75	2%	3%
Between 76 and 100	8%	14%
Do Not Know	<1%	1%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

6.3.4 Hypothesis 4: Differences in support for efficient HBL from distributors

Contractors identify distributors as an important source of marketing support and education about new products. From this we could hypothesize that some of the observed difference between the program and comparison areas in HBL technology shares is due to distributors in California taking the initiative to promote T5HO fixtures over alternative technologies. This would serve distributors' business motivations by accelerating replacements and increasing the share of more expensive kinds of equipment. If this were the case, we would expect to see differences between the program and comparison areas in the proportion of distributors who perceive T5HOs as efficient (versus other technologies), who report promoting the most efficient forms of HBL lighting, and who work with contractors to specify equipment and layouts for projects at hand. In fact, as the following paragraphs show, we found no difference between the program and comparison areas on these items.

Identification of efficient HBL technologies

Virtually all distributors in the program area (99 percent) identified T5HOs as efficient technology, as did 88 percent of distributors in the comparison area. While this difference is statistically significant, it is quite small and the overall identification levels are high for an energy-efficient technology.

Consistency in recommending efficient HBL equipment

Seventy-eight percent of distributors in the program area report that they "always" recommend energy-efficient equipment for HBL applications. An additional 16 percent recommend efficient equipment "most of the time". The corresponding figures of the comparison area are 63 percent and 27 percent. There is no significant difference between the two distributions.

Role in development of lighting layouts and specifications

Table 37 shows the distribution of responses to a question probing the percent of sales in which distributors take one of a number of typical roles. These roles range from "order taking" to working actively with a contractor or engineer to develop the lighting layout and specifications. This distribution is nearly identical between the two regions, with distributors in the program area reporting a slightly higher portion of jobs in which they engage with contractors and designers in developing layouts and specifications. This difference is very small and not statistically significant.

Table 37: Distributors Perception of Role in Sales and Specification

Ratio Estimates	Percent of Sales to Contractors	
Role in Specification	**Program Area**	**Comparison Area**
N	116	73
Contractors come in with a list of what they need and only ask for a price	34%	33%
Contractors come in with a layout and you discuss their options in a general way	23%	33%
You work with contractor to develop lighting layouts and equipment schedules	23%	19%
You work with project engineer or architect to develop lighting layouts	11%	5%
Other approach	9%	10%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

6.3.5 Summary Assessment of Alternative Hypotheses and 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.

- Recall that 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.

The Study Team believes on the basis of the evidence reviewed above that the IOU programs were responsible for most of the efficient HBL sales outside the program. We arrive at this conclusion through the identification and testing of a wide-ranging set of hypotheses concerning alternative influences on HBL purchases by commercial and industrial customers in California. Based on primary data acquired from multiple market actors, as well as extensive literature review, we concluded that only the stringency of Title 24 lighting power density requirements relative to other states represented a plausible alternative explanation for out-of-program adoptions net of baseline levels. Thus, 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 38 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 38: 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

6.4 Assessment of Sustainability

Practitioners and analysts of market transformation in the energy end-use industry have developed a number of frameworks for assessing whether observed market changes are likely to be sustainable over time. For example:

- The Northwest Energy Alliance (NEEA) uses a combination of indices such as trends in market share, availability, and prices of efficient products, as well as measures of hypothesized barriers to customer and vendor adoption to assess conditions in the markets addressed by their programs. The design of these periodic Market Progress Evaluation Reports is customized to the structure of the markets and features of the products and services in question. NEEA uses the trends in adoption, prices, availability, and reported prevalence of barriers to develop a multi-dimensional assessment of whether observed changes in the market are likely to be sustainable.

- David Hewitt, in his 2000 paper "The Elements of Sustainability,"[248] identified the following indicators that a program's market effects may persist after it ends or scales back, all but one of which refer to supply-side conditions:

  - Is someone making money by offering it?
  - Has a private market developed to continue the facilitation?
  - Has the profession or trade adopted it as a standard practice?
  - Would it be difficult or costly to revert to earlier equipment or practices?
  - Are end-users requesting or demanding it?
  - Have the risks to private market actors been reduced or removed?

  Generally, adoption of the technology in a government building code or product standard is also a good indicator of sustainability.

- Reed et al. (2007) identify various concepts from the diffusion of innovation literature, including the staged adoption process model, as a potential framework for the assessment of sustainability.[249] The further an organization progresses along the chain from product awareness through assessment, adoption, and confirmation of value, the more likely it is to replicate the adoption decision. The authors identify specific indicators of movement through the stages for federal technology deployment programs.

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

---

[248] David Hewitt.. "Elements of Sustainability," Proceedings of the 2000 ACEEE Summer Study, Vol. 6, pp. 179-190, American Council for an Energy-Efficient Economy, Washington, D.C.. 2000.

[249] Reed, John, Gretchen Jordan, and Edward Vine. *Impact Evaluation Framework for Technology Deployment Programs.* Washington D. C.: U. S. Department of Energy. 2007.

commercial sector[250], as well as market effects studies of consumer products such as ENERGY STAR clothes washers[251] and compact fluorescent lamps[252] 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 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 where they also installed more T5HO technologies.

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

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

251 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.

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

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.

7 Suggestions for Changes to HBL Programs and the California Market Effects Protocol

The section provides the Study Team's observations and suggestions for changes in the program direction for HBL retrofit technologies, potential changes to the market effects protocol based on its application to this particular study, and opportunities for other market effects research in the HBL market.

7.1 Suggestions for Program Direction

This HBL market effects study argues that the market penetration of fluorescent and specifically T5HO technologies due to the program will persist in California and likely grow over time as market acceptance of T5HO technologies increases throughout the supply chain. These developments will be driven primarily by vendors who perceive clear advantages for fluorescent products in terms of customer benefits (lower operating costs and lumen degradation, better application of controls) and commercial benefits such as lower installation costs. The study suggests the following changes to the incentive structure for HBL end users:[253]

- **Discontinue financial support for pulse-start metal halide (PSMH) technologies for HBL retrofit and replacement applications.** Both Federal and State product standards and building codes are evolving in the direction of effective elimination of probe-start metal halide technologies. Therefore, pulse start metal halide lighting technology will become, by default, one of very few available HID alternatives. At any rate, HID technologies accounted for only 18 percent of reported sales of interior high bay lighting in California during the period 2006 – 2008.
- **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.** While market trends appear to be moving toward T5HO technologies, in general, as a resource acquisition strategy, the advantages of coupling control technologies and incremental energy savings are still substantial—as are the incremental costs for T5HO technologies, in particular. Without support for T5HO technologies, the California IOUs would lose a key measure in its portfolio that can be leveraged for additional non-lighting measures in the mass market.[254] In regard to T-8 technologies, we believe that

[253] These recommendations are those of the Study Team and do not represent the recommendations of the CPUC.

[254] As noted earlier, linear T5HO fixtures are shorter in length than T8s, requiring a redesign and replacement strategy for existing T12 fixtures whereas T8s can be usually retrofitted in the same design space using the existing design.

continuing use of incentives is also warranted given their strong savings potential in comparison to metal halide technologies. Moreover, given their relatively low incremental costs, incentives can be adjusted to provide high levels of cost-effectiveness.

- **Continue financial support for niche and emerging HBL technologies such as ceramic MH, induction and LED technologies.** Historically, the progression of technologies has been represented by the introduction of stepwise changes and benefits to the market place, and those technologies have gained acceptance over time. The three technologies mentioned above may offer potential improvements in specific niche applications now and some applications for broader use in the future.
- **Continue customer education and support through sales and service teams for fluorescent HBL fixtures and associated control technologies.** While the program theory argues for empowering contractors to educate end users, the data show that this effect is not occurring. Contractors in California tend to take advantage of administrative efficiencies associated with signing over incentives directly into the contracted terms. Decision makers are often not the purchasing agents and are uninformed of the terms and conditions including the IOU's financial support, and the purchasing agents are uninformed of the range of options associated with those specific incentives. Contractors in California also appear to encounter resistance to recommendations for higher first cost technologies, namely T5HOs. Therefore, any outlet or avenue to support customer education of the full range of high efficiency HBL technologies is important to maintain.

7.2 Suggestions for Changes to Market Effects Evaluation Protocol

The Study Team recognizes that this effort has generally benefited from the experiences of previous market effects study efforts and their application of the Market Effects Evaluation Protocol. That section of the *Evaluators' Protocol* identifies a broad range of analytic methods for estimating net program benefits that include spillover, as well as methods to assess the attribution of net benefits to effects of the program. The Market Effects White Paper[255] recently developed for the California PUC provides further guidance on the application of those methods. (See Section 6: Assessing Program Attribution.) Some of the key guidelines on application of methods to assess attribution were borne out in this HBL study, including the following:

- Methods that involve end-user self-reports of program influence to assess attribution of observed savings require that that end-users be aware of their participation in the

[255] Mitchell Rosenberg and Lynn Hoefgen. 2009. *Market Effects: Their Role in Program Design and Evaluation.* Berkeley, CA: California Institute for Energy and Environment.

program. In this study, the portion of purchasers of high bay lighting who recalled participating in the program was far lower than the portion in the population, based on participation records and end-user survey results. If we had relied solely upon end-user self reports to assess program influence, the results would have been unreasonably low, given our relatively certain knowledge of program participation levels.

- Cross-sectional methods to estimate measure adoption levels net of baseline can yield useful results under a limited range market conditions. Specifically, cross-sectional methods work well in situations where national product markets for the efficient products and services in question are in relatively early states of development. Under those circumstances, surveys and compilations of sales data can capture statistically-significant differences in market share between program and comparison areas. That was the case for this study. However, as national market share increases, those differences become too small to be captured by survey and statistical modeling methods.[256]
- On a related methodological issue, the results of this study demonstrate that it is still possible to identify appropriate comparison areas for cross sectional studies, despite the development of national markets for energy-efficient manufactured products used in both the residential and commercial sectors. However, we note that the team needed to go to some lengths to identify a suitable set of states for the comparison area.
- We found that contractors were able to provide plausible estimates of technology shares, while customers were able to provide plausible estimates of purchase volumes in the two areas. This approach will be useful in other cross sectional studies of program effects on markets for energy-efficient products used primarily in the commercial and industrial sectors.
- Finally, our experience in conducting this study shows the importance of using multiple data collection and analysis methods to support assessment of program market effects. While the cross-sectional methods were effective in quantifying net adoptions outside the program, we needed information from many sources to support a judgment concerning the proper apportioning of credit to the program for those net adoptions.

[256] See The Cadmus Group, et al. 2010. *CFL Market Effects Study.* San Francisco: California Public Utilities Commission for an example.

The study team encountered three specific challenges in applying the Market Effects Protocol which were interrelated.

- **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.** [257] The discovery of potential unanticipated market effects should be an explicit objective of a market effects study. For this HBL Market Effects Study effort, we considered the program theory to be a starting point in our specification of theorized market effects. During the analysis of market effects, however, the study team revealed an unanticipated market effect in the survey data that represented a significant departure from the California IOU's well-reasoned and intentioned program theory—namely, that many end users probably received a financial incentive without knowing it and without being educated on the technologies.
- **Researchers should include the discovery of unanticipated market effects, if any, as another objective of a market effects study.** The protocol does recognize that program designers and implementers cannot anticipate the complete range of expected outcomes of their programs with certainty; however, it does not explicitly direct researchers to discover them. Market effects studies should not be limited to developing and assessing indicators based on the articulated program theories alone. More often than not, unanticipated program outcomes—or in this case unanticipated market effects—are realized only through evaluation research. Some of these market effects are positive and some are be negative; both can impact a researcher's assessment of the preponderance of evidence.
- **The Market Effects Protocol should acknowledge that researchers need to apply some discretion in the use of theories in measuring market effects.** Although the HBL market and program theories were developed in the scoping stage, a re-review of the program literature and survey data revealed simplifications and subtle changes in the market and program theories for the market effects study objectives. These changes also affected the range of indicators used to assess market effects to some degree. While the Study Team recognizes the research value in preserving the originally specified program and market theories for some evaluation research objectives, the market effects protocol should recognize that the program theories are not being tested—as an evaluation research objective— in a market effects study. The Study Team should have the discretion to review the theories as warranted by the

[257] "Key aspects" of a market effects evaluation report are listed on page 158 of the California Energy Efficiency Evaluation Protocols.

data to develop and quantify the market effects as revealed in the data, literature, and throughout the study process.

7.3 Suggestions for Future HBL Market Effects Evaluation Work

The Study Team notes three potential future opportunities for market effects evaluation in the HBL market.

- **A reassessment of the need for financially supporting T5HO technologies in 2012 to 2013.** While the Study Team recommends continuing financial support for T5HO technologies in the near term, it also notes that support for these technologies was very strong during the 2006-08 period. Market progression from PSMH to T5HOs as the default HBL technology application is rapid, if it has not already been achieved. Another market effects study should be conducted in the next two-three years.
- **A white paper on the use of comparison areas in the nonresidential sector.** This study approach relied on the use of two different comparison areas[258] at different stages in the study process, and found the specification of an appropriate comparison area fairly challenging for two reasons:
    - o The prevalence of energy efficiency policies nationwide has limited the number of states and regions clearly appropriate for comparison, depending on the research requirements. Moreover, as this study discovered, even the absence of programs does not necessarily resolve all considerations for what is an appropriate comparison area—especially given the size, scale, and sophistication of the lighting market in California.
    - o Using comparison areas is a recognized quasi-experimental approach in the California protocol,[259] but its application has been historically reserved for the residential sector. As such, a similar body of knowledge for the use of comparison area approaches in the nonresidential sector does not exist.

  Accordingly, a white paper should be prepared on the use of comparison areas in the nonresidential sector.

[258] The Study Team conducted in-depth interviews with lighting contractors and distributors in Michigan, Ohio, and Pennsylvania to develop the market survey protocols. Based on this feedback, the study team concluded that an alternative comparison area was necessary because of intermittent influences of disparate commercial lighting programs across those states. As stated earlier in this report, the Mississippi, Alabama, Georgia and South Carolina region was ultimately used for comparison purposes.

[259] California Protocols: *Table 18. Required Protocol for Preponderance of Evidence Approach to Causal Attribution Estimation,* “Enhanced” Level of Rigor. P 156.

- **A study on HBL controls and changes in hours of use**. This study recognizes that controllability of energy efficient HBL technologies is a significant resource not quantified in this study. To adequately capture the impact of controls would be best achieved by a costly measurement and verification (M&V) effort. For HBL technologies, this is particularly costly given the need to provide access to high ceiling heights to install the logger or metering equipment, and the associated safety concerns for field staff. Nonetheless, the Study Team recommends this study because of the uncertainty associated with the potentially substantial reduction in lighting hours of use.
- **An HBL end user participants' study.** The research conducted under this effort revealed the market for HBL to be considerably larger than the presumed participant pool, however, few participants responded to the survey. As mentioned above, participant awareness of the program may be suppressed based on the different roles of purchasing and specification among end users. Accordingly, we recommend that an HBL end user participant study be conducted to shed useful information on a number of specific program and market effects, including why so many HBL end users do not take rebates and their awareness of the potential lost opportunities associated with T12 to T8 retrofits and lighting controls.
- **A new construction HBL market study.** In this examination of the market for retrofit HBL technologies, the new construction market was not addressed. The Study Team assumed that energy-efficient HBL technologies in new construction were subsumed into the broader mass market. This assumption, however, should be challenged based on the size of the new construction market and its influence on upstream (distributors and manufacturers) conditions. For the California IOUs, whether T5HO technologies represent a potential lost opportunity in the new construction market is unknown. Accordingly, we recommend that a new construction HBL market study be conducted to examine the influence of new construction on distributors and manufacturers with respect to high-bay lighting technologies.

APPENDICES

APPENDIX A: Summary of Previous High Bay Lighting Market Effects Studies

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
1960s	**Study Period(s):** Provides overview of HID lighting dating from 1960s to 2009. **Report Date:** April 3, 2008	Analysis of Standards Options for High-Intensity Discharge Lighting Fixtures http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-04-01_workshop/2008-04-04_Pacific_Gas_+_Electric_HID_Fixtures_CASE_study.pdf	Shipments of MH lamps have increased every year since 1992. In contrast, shipments of high pressure sodium lamps have leveled off since the late 1990s and shipments of mercury vapor have steadily declined since the early 1990s. Data on the relative proportion of high-bay versus low-bay fixtures are not widely available, but discussions with lighting distributors suggest that 90% of industrial-type fixtures are high-bay designs and 10% are low-bay. • Sales of low-bay fixtures have been on the decline in recent years as a result of the growing	Linear reactor ballasts are limited by their sensitivity to power quality and specific voltage requirements. • Higher efficiency alternatives have yet to capture significant market share.	• Pacific Gas & Electric • California Energy Commission • American National Standards Institute • Warehouse/Facility managers • Manufacturers	As of January 2006, all new MH fixtures with vertical, base-up lamps of 150W to 500W can no longer include probe-start ballasts. In addition, as of January 2008, ballasts included in the fixtures must meet a minimum ballast efficiency requirement of 88%, regardless of lamp-burning position. • While this has not had a big impact on new construction and large-scale renovation markets where the majority of projects in California have been using pulse-start MH technology, it is causing a big shift in retrofit and replacement markets where penetration rates of pulse-start MH have been much lower. • Over time, this will also lead to an increase in sales of pulse-start metal halide replacement lamps. In new construction, renovation, and retrofit markets, MH faces competition from other lighting technologies. • Building owners interested in investing in new technology are installing high-output T5 fluorescent lighting, T8 fluorescents, CFLs, induction lighting, and LEDs, or retrofitting their existing HID systems with these alternatives. • These technologies have advantages

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			popularity of high-output fluorescent lighting systems for low-bay applications.			over MH in applications where occupancy sensors can yield substantial savings. Experts estimate electronic ballasts account for only about 3-5% of pulse-start MH ballast sales. However, this figure is expected to grow with interest in the higher efficiency, energy savings from lamp dimming and the other performance benefits associated with electronic ballasts. • The number of manufacturers producing electronic ballasts continues to grow.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
1960s	**Study Period(s):** Provides overview of MH lighting dating from 1960s to 2010. **Report Date:** August 10, 2004	Analysis of Standards Options for Metal Halide Lamps and Fixtures http://www.energy.ca.gov/appliances/archive/2004rulemaking/documents/case_studies/CASE_Metal_Halide_Lamps.pdf	Improved MH technology has been introduced over the past decade and continued improvements are anticipated. As a result, pulse-start MH lamps can compete as a replacement for probe-start MH, high pressure sodium and mercury vapor. • These improvements include more widespread availability of pulse-start lamps and the introduction of electronic ballasts. • While high performance in horizontal and vertical base down positions continues to present challenges, manufacturers are making progress in correcting performance deficits.	Most existing pulse-start MH lamps are designated for the vertical, base up burning position (the typical burning position for common high-bay type applications). Most shoebox, wall pack, and pole-mounted shoebox fixtures require horizontal mounted lamps. • Manufacturers have somewhat limited offerings of horizontal or universal position lamps; but offerings are increasing. • Horizontal pulse-start MH lamps available today typically have a 5,000 hour shorter life than vertical lamps, making them less attractive in hard-to reach applications.	• Pacific Gas & Electric • California Energy Commission • Manufacturers	Pulse-start technology yields a number of benefits relative to probe-start: • Higher efficacy • Better lumen maintenance. • Longer lamp life. • Shorter warm-up and faster restrike times. • More consistent color temperature and less color shift. • Dimming capability. • Improved color rendering

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
1996	**Study Period(s):** Primary research - 1996 thru 2000 Secondary research - 1997-2000 Market predictions for 2010 **Report Date**: December 2000	Market Research Report: Commercial and Industrial Lighting Study, Volume 1 http://www.cee1.org/eval/db_pdf/242.pdf	Green buildings are the subject of increasing discussions and actions among government agencies responsible for construction, building professionals, and a growing niche of environmentally minded businesses. High efficiency lighting can provide a critically important contribution to the sometimes difficult task of meeting green building certification criteria. • Many lighting professionals are interested in the use of daylighting and other advanced design practices. These professionals are receptive to training and acknowledge their current limitations.	<u>Design cost minimization:</u> Building developers/owners/financiers are usually unwilling to increase building budgets to accommodate the added costs of daylighting. • Owners and developers generally seek to minimize design and commissioning costs. <u>Control technology cost, ease-of-use, reliability and reputation:</u> Lighting controls for daylighting are an immature market and require new products and new thinking. • Electronic dimming ballasts are still considered to be expensive and not yet standardized by many designers.	• Northwest Energy Efficiency Alliance • Supply-side market actors in the Pacific Northwest • Distributors • Designers/Architects • Installers • Regional and national lighting experts	Because of the energy efficiency community's success during the past decade in transforming much of the C&I lighting market from T12 lamps and magnetic ballasts to T8 lamps and electronic ballasts, and from incandescent lamps to CFLs, transforming the current C&I market will be more difficult. • By significantly reducing lighting power consumption (20 to 50% per fixture for T8/EB replacements and 50 to 75% for CFLs), there is less energy consumption and associated cost remaining from which to obtain and cost justify additional efficiency improvements. • Having achieved significant savings in lighting energy usage through the relatively easy process of substituting high-efficiency for standard efficiency lighting equipment components, the market may be complacent from the ease of obtaining previous improvements. • Because rebates were widely used to subsidize substitution with efficient components, the C&I lighting market may expect that rebate-based solutions will be employed by program administrators to bring about the next

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
				Lack of design/build integration: Lighting designs that make use of sunlight are often stifled by the traditional linear approach to design. Pervasive lack of professional knowledge: Electrical contractors are generally unfamiliar with dimming and daylighting technology and prefer to avoid them. • General contractors are known to be conservative and risk averse Lack of end-user demand for advanced lighting design and daylighting: Electrical engineers, architects, and lighting designers stated they were		level of efficiency improvements in this market. • Because the bulk of the C&I lighting market interventions in the 1990s focused on like-for-like equipment substitution, many rebate programs provided little of the groundwork needed to bring about the many design-based improvements in lighting that represent the bulk of the opportunity for further improvements.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
				asked by their clients in only 2½ percent of cases to include daylighting in their designs. • Despite recent advances in documenting the energy and non-energy benefits of daylit buildings, the message has not yet effectively penetrated and affected key end user decision makers.		
1996	**Study Period(s):** Secondary research - 1996-2002 **Report Date:** April 28, 2003	NLPIP Lighting Answers: T5 Fluorescent Systems http://www.sdeg.org/docs/LAT5.pdf	Since T5 lamps have smaller diameter, shorter lengths and higher luminances than T8 and T12 lamps, they are more suitable for indirect lighting, direct lighting for high bay applications and wall washing applications.	There can be a problem with glare if T5 lamps are used inappropriately.	• Manufacturers • Illuminating Engineering Society of North America • American National Standards Institute • Designers/Architects • Customers	The advantages of T5 lamps compared to T8 lamps include: • Smaller size of T5 lamps allows for more luminaires • Smaller lamp diameter of T5 lamps makes is easier to design optical systems that distribute light in the intended directions. • The higher light output of T5 high output lamps may reduce the number of luminaires per project.
1997	**Study Period(s):** Secondary research - 1997, 1999,	EMERGING ENERGY-EFFICIENT INDUSTRIAL TECHNOLOGIES	A range of advanced lamp, ballast, fixture, and light pipe technologies can significantly reduce	Promotional efforts have been mainly focused on commercial sector applications.	• LAWRENCE BERKELEY NATIONAL LABORATORY • Government	The potential for widespread application and large-scale energy savings in manufacturing facilities is beginning to spark an interest in greater promotion of the technology by utilities:

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	2000 The goal of the study was to collect information on a broad array of potentially significant emerging energy-efficient industrial technologies and carefully characterize a sub-group of approximately 50 key technologies. • The assessment began with the identification of approximately 175 emerging energy-efficient industrial technologies	http://ies.lbl.gov/iespubs/46990.pdf	lighting energy consumption in industrial facilities. Remote-source lighting technologies, :including fiber optics systems and light pipes using a variety of light sources such as sulfur lamps, LEDs, and hybrid artificial-natural lighting, offer numerous advantages in industrial settings: • Minimized heat gain in lit areas resulting in a lower cooling load • Improved safety from elimination of lighting-related electrical wiring and equipment in wet or explosive areas • Allowance for the use of more efficient and powerful light sources • More targeted and esthetically-pleasing	• The lack of readily available information targeted to industrial end-users and a lack of interest in upgrading facility lighting has prevented acceptance of the technology in the industrial sector. There has been reluctance on the part of contractors to share information on the technology and its benefits with their competitors.	agencies • Regents of the University of California • Pacific Gas and Electric Company • U.S. Department of Energy • U.S. Environmental Protection Agency • New York State Energy Research and Development Authority • Iowa Energy Center • Northwest Energy Efficiency Alliance • Policy makers	• In the Midwest, utilities are educating account representatives and customers about the products. • In California, several manufacturers and distributors of high-intensity fluorescent lighting products are expanding their marketing efforts and working with Southern California Edison to incorporate the technology into their new construction programs. • Additional information dissemination, a broader range of demonstrations and case studies, and continued utility incentives and support would create further demand for the technology.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	through a review of the literature, international R&D programs, databases, and studies. • The review was not limited to U.S. experiences, but aimed to produce an inventory of international technology developments. • A screening process to select the most attractive technologies was devised that had: (1) high potential energy savings; (2) lower comparative first costs		light • Reduced installation and maintenance costs			

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	relative to existing technologies; and (3) other significant benefits. • Based on the literature review and the application of initial screening criteria, profiles for 54 technologies were identified. • Each of the selected technologies was assessed with respect to energy efficiency characteristics (likely energy savings by 2015), economics, and environmental					

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	performance, as well as what's needed to further the development or implementation of the technology. **Report Date: October 2000**					
1998	**Study Period(s):** MARKET — COMMERCIAL AND INDUSTRIAL LIGHTING REMODELING AND REPLACEMENT UPGRADES Secondary research: 1998, 2000, 2002 - 2005 Market predictions for 2006 – 2015	Energy Efficiency and Customer-Sited Renewable Energy: Achievable Potential in Wisconsin 2006-2015: A technical analysis of options for investment in energy efficiency and customer sited renewable energy as an alternative to electric generation and natural gas usage. - Volume II: Technical Appendix http://energytaskforce.wi.gov/docview.asp?	There are significant opportunities to install compact fluorescent lighting within older existing C&I buildings. These include bathrooms, hallways, cafeterias, outdoor lighting, and other areas where newer styles and generations of lamps may be appropriate for applications previously considered but rejected by building owners. • Occupancy sensors save between 40 to	Not defined in reviewed document.	• Energy Center of Wisconsin • Alliant Energy • Madison Gas & Electric • Superior Water Light & Power • We Energies • Wisconsin Public Power, Inc. • Wisconsin Public Service Corporation • Xcel Energy • HVAC contractors • Homeowners	The C&I market comprises upgrades to lighting systems in existing buildings at the time of remodel or natural replacement. These improvements include: • Upgrading standard T8 fluorescent fixtures to high performance "super" T8 or T5 fixtures • Replacing incandescent fixtures with hard-wired compact fluorescent fixtures. • Replacing incandescent or fluorescent exit signs with LED exit signs. • Replacing high bay HID fixtures with fluorescent high bay fixtures in appropriate applications • Installing occupancy sensors in offices, classrooms, restrooms, and break rooms.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	MARKET — COMMERCIAL AND INDUSTRIAL LIGHTING AND LIGHTING CONTROLS RETROFIT Secondary research: 1998, 2000, 2002 - 2005 Market predictions for 2006 – 2015 **Report Date:** November 2005	docid=154	60% in restrooms, 17 to 29% in break rooms, 6 to 13% in office areas and 10 to 19% in classrooms.			
2000	**Study Period(s):** This study covers a 15-year period. The base year is the fiscal year (FY) 2000/01, with milestone	BC Hydro Conservation Potential Review 2002 Commercial Sector Report http://www.cee1.org/eval/db_pdf/426.pdf	Pulse-start metal-halide lamps have been better optimized for efficiency. Electricity savings estimates depend on ballast type. • In addition to electricity savings, other benefits include	There are currently some application limitations with HIF systems: • These lights are not suitable for use in cold weather or for very high ceilings or flood light applications.	• BC Hydro • Builders • Consultants • School/University boards • Warehouse/Facility managers	<u>Pulse-start Metal-halide</u>: Electricity savings of 11% over 400-W metal-halide fixtures can be achieved. <u>High-Intensity Fluorescent</u>: Electricity savings of 48% relative to the 400-W metal-halide fixture.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	periods at 5-year increments: 2005/06, 2010/11 and 2015/16. The base year of fiscal year 2000/014 was selected as this was the most recent 12-month period for which complete customer data were available. **Report Date:** June 2003		longer life, better color, faster warm-up time, less lumen depreciation over time and improved performance at cold temperatures. High-Intensity Fluorescent (HIF) systems can replace traditional metal-halide (HID) fixtures in many high-bay lighting applications. • HIF systems provide efficacies of 100 lumens/W compared to 60 to 80 lumens/W for a standard 400-W metal- halide fixture. Combined with the higher color rendition of the HIF lamps, electricity savings of 45 to 50% can be achieved over conventional metalhalide lighting. • Other benefits over	• The technology is very new and there is limited availability of some fixture types that are suitable for replacing HID lamps up to 400 W. • High- intensity fluorescent lamps have a rated lifetime of about 15,000 hours. This is slightly shorter than that of a typical metal- halide lamp (20,000 hours). However, metal-halide lamps are often replaced early because of the lumen depreciation associated with them.		

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			traditional instant-start metal- halide lamps include shorter restrike times, better color, better dimming options, better light quality and better light output maintenance over time.			
2000	**Study Period(s)**: No dates provided, but cites bibliography of 2000 and 2002 articles. Also makes note of Canada ratifying the Kyoto Protocol on February 16, 2005. **Report Date:** 2005	LIGHTING Reference Guide http://oee.nrcan.gc.ca/publications/equipment/lighting/doc/LightingReferenceGuide-NRCAN-E.pdf	School boards are usually the owners of their facilities (similar to municipalities, universities, schools and hospitals). In the mid-60s there was a tremendous expansion in the construction of facilities for this sector. Therefore, facility managers have inherited 45-year-old facilities with much of the infrastructure needing replacement. There are limited funds for	Not defined in reviewed document.	• Natural Resources Canada • Ontario Ministry of Energy • Ontario Hydro • Ontario Power Generation • Illuminating Engineering Society of North America • Customers • Manufacturers	Older schools may have incandescent, fluorescent or mercury vapor lighting in their gyms. • In these facilities, 50% or more of the energy in the gymnasium can be saved by redesigning the space with more efficient fluorescent systems using T8 or T5 lamps combined with occupancy sensors. • Some school boards prefer to use metal halide high bay fixtures because fewer fixtures are required, meaning lower maintenance costs. These fixtures can be specified with ‘high-low’ ballasts combined with occupancy sensors for additional savings.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			replacement, so upgrading the systems in these facilities is often the only option. • Lighting systems have a defined life span. At some point it is more economical to replace rather than to continue to repair. • There are many classrooms where the lighting technology is out-dated, the equipment is due for replacement, and the light fixtures are no longer appropriate for the illumination of the task.			
2000	**Study Period(s):** No dates provided. **Report Date:** 07/08/2000	Fluorescent Solutions for Industrial Lighting http://www.esilighting.com/Assets/PDF/ESISolutions.pdf	Many manufacturers are developing fluorescent industrial and commercial luminaires which will provide improved visual performance and lower life cycle costs over HID technologies.	Even as new technology displaces old fluorescent, incandescent, and high-intensity discharge sources, the use of fluorescent lighting in heavy commercial and industrial facilities	• Manufacturers	Combining high-performance fluorescent luminaires with dimming ballasts and building energy management systems can create a powerful tool for shaping building load profiles to take advantage of low energy costs, real-time pricing strategies, and load-shedding incentives from energy commodity suppliers of the future.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
				has been largely overlooked. • In the past, fluorescent systems took a back seat to high-pressure sodium and metal halide light sources because those systems offered greater system efficacy, better lighting performance at medium to high mounting heights and lower life cycle costs.		
2000	**Study Period(s):** Energy and peak demand baseline data presented here and throughout this report are based on sector and end use data from 2000, the latest detailed California Energy Commission	CALIFORNIA STATEWIDE COMMERCIAL SECTOR ENERGY EFFICIENCY POTENTIAL STUDY Study ID #SW039A FINAL REPORT VOLUME 1 OF 2 Main Report http://calmac.org/publications/CA_EEPotV1_rev.pdf	Significant commercial program savings were achieved in lighting from1990 to 2000. • By the late 1990s, utility programs had proved extremely successful in transforming the market for T8 lamps and electronic ballasts for many customer groups and trade allies.	The gap between potential and program savings regarding occupancy sensors is probably related more to market barriers such as concern over product performance and application appropriateness than to cost effectiveness. • Despite widespread availability throughout the 1990s, market penetration	• Pacific Gas & Electric Company • XENERGY Inc. • Regional Economic Research Inc. • Quantum Consulting Inc. • Energy Solutions Inc. • California commercial sector	T8/EB and CFL Measures Based on data from the 1997 PG&E Commercial Building Survey and analysis of program tracking data, the saturation of T8/EB lighting systems is estimated to be roughly 55% for four-foot fluorescent fixtures. • The saturation of T8/EB systems among the smallest customers is estimated to be significantly lower (probably around 20 to 25%). Data from the 1997 PG&E Commercial Building Survey also show CFLs had a much higher relative saturation among larger customers.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	data available at the time of this study. Thus, these figures do not account for the conservation-based reductions that occurred in 2001. Future updates of this study will incorporate the effects of the conservation and energy-efficiency actions taken in 2001. **Report Date:** July 9, 2002 (Additional appendix added May 2003)		The combination of the Express Efficiency prescriptive rebate program and the Large Nonresidential Standard Performance Contracting program is reaching a reasonable share of the available energy efficiency potential. • Although market penetration among smaller customers increased in PY2000, most of the impacts achieved throughout the 1990s tended to be among larger customers. • A recent report (Quantum Consulting Inc. 2001, Statewide Nonresidential Hard-to-Reach Study, prepared for Pacific Gas and Electric Company, draft, December) provides	has been modest. • Customers and contractors have had concerns over product applicability and performance. • Occupancy sensors have generally been relegated to marginally used spaces such as bathrooms and conference rooms. • Although there are limits to the feasibility of using occupancy sensors in many spaces, it is believed there remains significant opportunity to increase their use. This will likely require continued support for the technology in the form of improved awareness and knowledge of benefits, improving equipment		• However, the average saturation level for all commercial customers was fairly low at the time of study (around 20%). • Over the past 3 years, CFLs have become the most popular measure installed in the statewide Express Efficiency program, surpassing T8/EB systems. • As a result of this surge in CFL penetration, it is estimated the saturation of CFLs may have tripled over the past 5 years. • Combining data analyzed from the 1997 PG&E Building Survey and analysis of multiyear tracking data from the Express Efficiency and nonresidential SPC programs, it appears the remaining potential for CFLs may be small. However, there may be inconsistencies in the data sources that lead to forming this conclusion. The observation that high-efficiency lighting equipment has succeeded in penetrating large customers has been made for some years. Since 1998, both the CPUC and the utilities have been making efforts to focus lighting interventions on smaller customers. These efforts have met with some success: small (<20 kW) customer

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			a specific analysis of the hard-to-reach market segments in which the CPUC has expressed recent interest.	performance, and financial incentives. The insignificant market penetration of automated dimming systems to date is largely a function of poor economics and concerns over performance. • Retrofitting existing lighting systems to sense and adjust to daylight levels requires replacement of existing ballasts with dimmable ballasts, wiring of photocell sensors, and integration with a controller. • If the costs of properly installing automated dimming systems can be reduced, an enormous potential may be achievable. If not, few significant gains in market penetration		participation in the Express Efficiency program increased significantly in PY2000. • However, through the first half of 2001, the relative participation of small customers decreased, partly because of increases in participation among large customers. There is no gap between the potential for T8/EB systems and CFLs and the program achievements at an aggregate level. • The programs have achieved significant savings, but it is likely a gap remains between the level of saturation of these measures for large and small customers. • It is recommended to continue focusing on promoting and installing these measures in smaller customer facilities. However, policy makers must recognize that effectively reaching these smaller customers is significantly more expensive than reaching larger customers. <u>Lighting Controls</u> Significant potential was identified for lighting controls systems such as occupancy sensors and dimming

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
				should be expected.		systems. • Based on tracking data from the past 4 years, it is estimated that total savings from lighting controls between 1998 and 2001 were on the order of 50 GWh - most of which is associated with occupancy type controls. If this figure is doubled to account for activities in the preceding years, roughly 10% of the occupancy controls market may have been captured. • In the case of automated dimming, the 1997 PG&E commercial building survey and anecdotal information indicates only a small fraction of the potential market has been tapped. <u>Reflectors/Delamping</u> Combining specular reflectors with high-efficiency fluorescent lighting components can result in significant energy savings when applied appropriately and correctly. • These savings are often among the most cost-effective of lighting retrofits, with levelized costs per unit of conserved energy as low as $0.01 per kWh and paybacks of less than 1 year. • Anecdotal evidence suggests reflectors with delamping accounted for a large share of commercial lighting savings in

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						the early to mid-1990s, but that their application diminished in more recent program years. This is likely a deliberate programmatic effect that results from decreases in prescriptive rebate levels for this measure. If policy makers are interested in achieving fairly low-cost, near-term energy savings among smaller and hard-to-reach customers, they should consider increasing incentives for this measure for selected market segments. <u>T5 Lamps</u> T5s offer some incremental benefits as compared with T8 and T12 lamps, but their efficacy relative to T8s is modest and they are not simple like-for-like substitutions for T8s or T12s in existing fixtures. • To capture the energy savings and illumination benefits of T5s typically requires a redesign of an existing lighting system. • Estimates of T5 costs in the recent 2001 DEER Update Study indicates their cost premium relative to T8 lamps is still significant. The Express Efficiency program has been providing incentives for T5s to encourage their use in appropriate applications. Such

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						support may lead to increases product demand and decreases in price as occurred in the T8 market. However, expectations for this measure should be modest because it is likely to achieve only a niche penetration within the existing commercial construction market.
2001	**Study Period(s):** Secondary research: 2001 - 2003 **Report Date:** 2004	Shedding Light on Mercury in Fluorescents A Workbook for Design Professionals http://www.informinc.org/reportpdfs/chp/SheddingLight.pdf	Mercury is a toxic chemical that is building up to dangerous concentrations in fish, wildlife, and human beings throughout the US. • Choosing high efficiency lamps that contain less mercury reduce the environmental impacts and health risks of lamp breakage during use, transport, and disposal.	Metal halide systems are less expensive to purchase than fluorescent systems.	• Designers • EPA • Manufacturers • Warehouse/Facility managers • Schools/university board • Designers/Architects	Facility owners, managers, and architects specifying high-bay lighting applications should choose the most energy-efficient system with the lowest mercury content appropriate for their construction and remodeling projects. • Facilities should recycle all mercury-containing products, including all HID lamps, T5s, and induction fluorescents.
2001	**Study Period(s):** No date provided.	TECHNOLOGY BRIEF • Interior High Bay Lighting Applications	Standard metal halide fixtures have been the dominant technology in high bay lighting applications, but	Not defined in reviewed document.	• Pacific Gas & Electric • Manufacturers • Warehouse/Facility managers	PG&E offers eligible customers $100 per fixture for qualifying Interior High Bay Linear Fluorescent Fixtures. • With potential savings of $140 per year in energy costs when replacing a

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	Report Date: 2001	http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/agriculture/pge2001mo_collateral_factsheets_highbayfluorescents.pdf	developments in fluorescent fixtures include the following advantages: • Energy savings • Instant on and instant restrike • Occupancy sensors and photocells • Consistent light output • Enhanced light quality • Improved color • Better light distribution		• Schools/university board	400 Watt standard metal halide, a fixture can pay for itself in less than 2 years. • High bay fluorescent fixtures can use either T8 or high output T5 lamps. Performance is similar between the two lamp types, but each may provide advantages in particular applications.
2002	**Study Period(s):** No dates provided. **Report Date**: May 15, 2002	Customer Advanced Technologies Program Technology Evaluation Report: T5 Fluorescent High-Bay Lighting Systems http://www.cee1.org/eval/db_pdf/422.pdf	T5HO lighting systems appear to be ideal for use in high bay applications traditionally limited to metal halide systems. • T5 systems are energy efficient and offer higher color rendition, better lumen maintenance and even light distribution. • Since T5HO	The most significant barrier for T5 systems is the cost • T5 systems usually require new fixtures.	• Builders • Contractors • Schools/university board • Government agencies • Warehouse/Facility managers	T5 systems have become viable options for high-bay applications. • Many lighting professionals expect T5HO systems to continue to grow in popularity.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			systems do not require any time to re-strike the lamps, they can be combined with lighting control strategies to further reduce energy consumption and costs			
2002	**Study Period(s):** No date provided – Article describes the benefits obtained after metal halide light fixtures replaced 1960s-era mercury vapor light fixtures at Augusta Newsprint Company's facility. **Report Date:** March 2002	Upgraded Lighting System Leads to Energy and Cost Savings at Augusta Newsprint Company http://www1.eere.energy.gov/industry/bestpractices/pdfs/augustal.pdf	By upgrading older light fixtures, industries can save money on energy and maintenance costs, as well as increase safety and employee well being.	Not defined in reviewed document.	• Augusta Newsprint Mill • Department of Energy • American Forest and Paper Association	New metal halide light fixtures have replaced the 1960s-era mercury vapor light fixtures at Augusta Newsprint Company's facility. The results have included increased lighting levels, decreased maintenance costs, and reduced energy demand. Annual energy savings total nearly $65,000. Based on a $100,000 installation cost of, the project will pay for itself in 1.5 years. Additional benefits include: • Annual energy savings of almost 2 million kilowatt-hours • Increased lighting in mill operating area • Decreased energy use • Decreased maintenance costs • Increased safety
2002	**Study**	T-5 Fluorescent,	When working	The initial cost of	• Suppliers	It appears fluorescent fixtures are

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	Period(s): Cites secondary data from 2002, 2003 and 2004 **Report Date:** 2005	Bright Idea or just another flash in the pan? http://www.advancedenergy.org/progressenergy/T5versusT8.html	through lighting issues, there are several important factors to consider: • Light depreciation • Efficacy • Initial and operating costs • Fixture light dispersion • Controls • Light quality	fluorescent fixtures between T5, T8 and T5HO is somewhere between $11 and $15 per thousand mean lumens delivered, whereas metal halide fixtures run at around $9 per thousand mean lumens.	• Customers • Warehouse/Facility managers • Manufacturers • Lighting Research Center (NY)	currently winning the battle over metal halide fixtures for the lighting market: • In general fluorescent lamps provide better energy efficiency • The light output of an HID fixture will quickly degrade to about 60% of the rated output while fluorescent will only degrade to 90 or 95% • The control performance of fluorescent lights far exceeds that of HID by eliminating the 15 minute restrike time, allowing for occupancy sensors and dimming capability • Fluorescent lights outperform HID in terms of light quality • Fluorescents above about 20 feet should be T5 or T5 HO • Fluorescents below 20 feet should be T8 or T5 • Proper fixture selection is essential to having good light quality light efficiency • The difference in initial cost between metal halide and fluorescent systems is quickly dwarfed in annual operating cost (around $6.50 per thousand mean lumens for metal halide versus $4.50 per thousand mean lumens for the fluorescent systems). • Fluorescent fixtures are about 30% less expensive to maintain on a light

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						output basis.
2003	**Study Period(s):** 2003 **Report Date:** June 23, 2008	SMUD New Release: Slakey Brothers, Inc. wins SMUD award for responsible energy stewardship http://www.smud.org/en/news/Documents/08archive/06-23-08_board_awards_shiroma_slakey.pdf	The Sacramento Municipal Utility District (SMUD) Community Energy Award honors commercial customers who value efficiency and environmental sensitivity and have turned these beliefs into actions.	Not defined in reviewed document.	• Sacramento Municipal Utility District • Commercial customers	Slakey Brothers were recognized for being proactive in initiating energy-efficient lighting improvements that resulted in considerable energy savings and environmental benefits. • 153 metal halide high-bay fixtures were replaced with highly efficient T8 fluorescent high-bay fixtures throughout their 207,000 square foot warehouse. Occupancy sensors were also installed in each fixture to cycle the lights off during low production times. These sensors will reduce fixture operating hours by 1,850 hours. • The retrofit of the lighting fixtures and the installation of the occupancy sensors will result in total annual energy savings of 519,000 kilowatt-hours and 88 kilowatts, a reduction of 50% in lighting energy consumption and a reduction in CO_2 emissions by 716,000 pounds.
2004	**Study Period(s):** No dates provided - Researchers at Lawrence Berkeley National Laboratory	New Lighting Solutions for High-Bay Spaces: High-output T5 Lamps and Luminaires at Camp Pendleton http://www1.eere.energy.gov/femp/news/n	As energy conservation in industrial spaces becomes an increasing concern, lighting retrofit projects are being encouraged as a way to save energy and	Not defined in reviewed document.	• Lawrence Berkeley National Laboratory • Marine Corps Base Camp Pendleton • Tetra Tech EM, Inc. • San Diego Gas and Electric	A popular application for high bay industrial spaces is to replace existing HID fixtures with high output T5 (T5HO) fluorescent fixtures. • As a retrofit solution, the T5HO lamp offers several cost effective advantages including easier control, dimming ability, good color rendition, and high energy efficiency.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	investigated a retrofit project being carried out for 16 maintenance hangars and warehouses at the Marine Corps Base Camp Pendleton (Carlsbad, CA) by Tetra Tech EM, Inc. under a utility energy services contract of San Diego Gas and Electric. **Report Date:** November 30, 2004	ews_detail.html?news_id=8304	improve the quality of the work environment.			
2004	**Study Period(s):** No dates provided. **Report Date:** November 2004	High/Low-Bay Applications: Fluorescent or Metal Halide? http://www.aboutlightingcontrols.org/education/papers/high-	Fluorescent lighting offers a number of advantages versus metal halide lighting: • Higher efficiency/energy savings • Higher lumen	Relighting projects typically require installation of new fixtures, which can inflate payback periods and reduce return on investment.	• School/University boards • Warehouse/Facility managers • Manufacturers	Manufacturers have begun offering specialized T8 and T5HO fluorescent fixtures as an alternative for high-ceiling applications. • These fixtures provide distinct advantages over HID fixtures. Fluorescent lighting has dominated the <15 ft. ceiling height niche, but new

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
		low-bay.shtml	maintenance • Instant on and re-strike • Emergency ballasting options • Higher color rendering ability • Negligible color shift • Lamp-to-lamp color consistency • Wide range of color options • Longer lamp life versus 250W metal halide lamps. • Offer potentially more uniform lighting • Less shadows and less glare • Easily and inexpensively dimmable • More compatible with switching and control strategies using devices such as occupancy sensors, photocells and scheduling systems	Compared to fluorescent, metal halide lamps have several distinct advantages: • Metal halide offers high lumen packages and can present a lower installed cost due to fewer fixtures. • Metal halide is able to operate reliably in a wide range of temperature environments, whereas fluorescent performance can be dramatically impaired.		technology has now enabled it to be competitive with HID in higher ceiling heights.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
2004	**Study Period(s):** The 2003 Express Efficiency evaluation addresses several objectives: The evaluation (1) verifies energy savings, (2) assesses accomplishments (including hard-to-reach (HTR)), (3) evaluates program process, (4) assesses the program's influence on the participants' purchase decision, and (5) benchmarks program	2003 STATEWIDE EXPRESS EFFICIENCY PROGRAM MEASUREMENT AND EVALUATION STUDY - Study ID# SW205.01 - March 21, 2005 http://www.calmac.org/publications/!Final_2003_Express_Eval_Report_and_Appendices.pdf	The 2003 Express Efficiency evaluation addresses several objectives: • Verifies energy savings • Assesses accomplishments • Evaluates program processes • Assesses the program's influence on the participants' purchase decision • Benchmarks program success with respect to its cost-effectiveness	There are two stipulations that do not affect energy savings and compromise the ability of vendors to engineer super energy efficient systems. Eliminating the following restrictions would help vendors engineer super energy efficient high bay systems: (1) Fixtures must be mounted over 15 feet (2) Rebates are only paid for 4- and 6-lamp fixtures	• Pacific Gas and Electric Company • San Diego Gas and Electric Company • Southern California Edison Company • Southern California Gas Company • Lighting vendors • California Public Utilities Commission (CPUC) • California Public Goods Charge (PGC) • Customers	In 2003, CPUC authorized the Express Efficiency program to increase incentive levels up to 60% for energy efficient measures for small and medium-sized customers. Performance targets were set for the program in terms of energy and demand savings. These changes contributed to a successful year in 2003, as the program exceeded its statewide kWh and kW targets, and nearly doubled its therms goal. • High bay lighting was a popular measure for SCE. A fourth quarter promotion boosted business and tapped SCE's rebate budget. SCE attributes its success directly to the new rebate levels introduced in 2003. SCE views these rebate levels as solid, effective, and believes there should be no more sales. Despite substantially higher goals in 2004, SCE reports that it is on track to meet goals and that the new rebate levels have introduced a lot of participation. • SDG&E was fairly low as far as kWh savings and demand reduction accomplishments. However, they were quite high in therms reduction. This can be attributed to a high volume of greenhouse heat curtains rebated.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	success with respect to its cost-effectiveness. • To meet these objectives a variety of primary and secondary data sources were utilized. Telephone interviews were conducted in July 2004 with customers who purchased a rebated item (participants). Interviews were also conducted with lighting vendors, and utility and program staff to support the evaluation					With respect to increasing rebates, no other measure is mentioned as much as linear fluorescent fixtures. • About two-thirds of the respondents mentioned increasing some form of linear fluorescent — 4 foot T-8, 8 foot T-8, T-5, T-8 with electronic ballast, and high bay. • No vendor suggested decreasing rebates for linear fixtures.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	objectives. Secondary data sources used included a four-year history of program tracking data, and CPUC quarterly program reports submitted by the IOUs. **Report Date:** March 21, 2005					
2004	**Study Period(s):** The primary objective of the work underlying this report was to produce estimates of remaining potential energy savings	CALIFORNIA STATEWIDE RESIDENTIAL SECTOR ENERGY EFFICIENCY POTENTIAL STUDY Study ID #SW063 FINAL REPORT VOLUME 1 OF 2 Main Report	The 2006 CEUS database provided statewide data gathered from an in-depth on-site survey of commercial building equipment and characteristics. Prior to the completion of this database, data on commercial measure	While the increased number of lighting measures relative to the 2000 study might lead to an increase in the estimate of potential savings, many factors in the 2004 analysis restrain the forecast of the remaining lighting potential:	• Pacific Gas & Electric • Southern California Edison Company • Southern California Gas Company • San Diego Gas & Electric Company • California Public Utilities Commission • California Energy Commission	California's continued emphasis on nonresidential energy efficiency programs has resulted in significant energy savings and a substantial increase in the saturation of high efficiency measures in the nonresidential sector. • The average saturation of T8s in the 2000 study ranged from 55% for four foot T8s in large commercial establishments to 11% for eight-foot T8s in small commercial establishments.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	that might be obtainable in the near (2006-2008) and foreseeable (2009-2016) future through publicly funded energy efficiency programs in the existing and new residential, industrial, and commercial sectors. Market potential was estimated under three scenarios relating to incentive levels. One scenario reflects the continuation of the incentives in effect	http://www.calmac.org/publications/PGE_PotentialStudy_Vol1_05242006.pdf	saturation were utility-specific and limited to data collected for utility-specific commercial end-use surveys. • California has been rebating high efficiency measures in the commercial sector for over 30 years. • In recent history, energy savings for nonresidential energy efficiency programs has represented about 70 to 80% of energy savings from all of the California IOU energy efficiency programs.	• Currently higher saturation of efficient lighting • Reduction between 2001 and 2005 in the DEER hours of lighting operation which decreases the impacts for lighting in 2005 relative to 2001 • Implementation of new federal standards for commercial lighting	• Natural Resources Defense Council • Itron, Inc. • KEMA, Inc. • RLW Analytics, Inc. • Architectural Energy Corp.	• The saturation of four-foot T8 lamps in this study ranged from 19 to 91%, with a mean of 62%. The significant penetration of high efficiency T8 lamps illustrates the success of past commercial energy efficiency programs – however, it also limits the remaining energy savings potential of future programs in the area of commercial lighting. The saturation data from the 2005 CEUS database shows that many commercial buildings have converted their T8 and T12 lighting measures to high efficiency measures, lending supporting data to the effectiveness of previous commercial energy efficiency programs while limiting the remaining potential available with existing high efficiency lighting measures. • The combination of changes in DEER hours of operation and improved information on the technology saturation of high efficiency lighting works to reduce the estimate of the remaining potential associated with T8s from approximately 3500 GWh and 700 MW in the 2000 analysis to 1380 GWh and 250 MW in the 2004 analysis.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	during 2004. The results for this scenario were calibrated to actual program accomplishments for the 2004 program year. Another set of market potential estimates was derived on the assumption that incentives are increased to cover full incremental measure costs. A third set of estimates was developed to reflect a scenario in which incentives are equal to the average between current (2004)					

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	incentives and full incremental costs. The full incremental cost or average scenario-level rebates are implemented beginning in 2006. **Report Date:** May 24, 2006					
2005	**Study Period(s)**: 2005 **Report Date:** June 28, 2006	Measure BLD-1 Changes to Lighting Power Density Values Affected by Developments in Electronic Ballasts for Metal Halide Lighting 2008 California http://www.energy.ca.gov/title24/2008standards/prerulemaking/documents/2006-07-12_workshop/reviewdocs/MEASURE_BLD_01.PDF	Advances in electronic ballasts and metal halide lamps have been announced in 2005 that dramatically improve the energy efficiency of metal halide lamps over 150 watts. • The key improvement is electronic ballasts that have lower waste heat and produce superior lumen maintenance.	Not defined in reviewed document.	• HVAC contractors • Warehouse/Facility managers • Pacific Gas and Electric Company	Each standard pulse start metal halide high bay lighting system replaced by an electronic ballast saves about 112 watts when adjusted for equal light level. • The payback period is less than 2 years. • The net power reduction is at least 25%.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			• A related development is the introduction of ceramic metal halide and pulse start quartz metal halide lamps matched to the ballasts. • These technologies are very cost effective and can be used to reduce allowed lighting power in applicable facilities.			
2005	**Study Period(s):** No dates provided - fifth article on from author on subject. Previous articles include: 9-98 - 'Comparing Fluorescents and HID' (Energy User News)	HIBAYS It's All About The Details http://www.lightingwizards.com/Downloads/Hibays_It_is_all_about_the_details.pdf	Customers need to be wary of marketing hype from high bay manufacturers and salespeople. • In reality, the foot-candles per watt performance of PS or ceramic MH with high performance dome and electronic ballast is very similar to T5HOs or T8s with electronic ballasting and good reflectors.	A negative about horizontal fluorescent lamps is that dirt can land and stay on the top of them more easily than on vertical HID lamps. • Since there is more surface area, it can take more time to clean a linear fluorescent than an HID hibay.	• Customers • Manufacturers • Salespeople • Warehouse/Facility managers • Salespeople • Pacific Gas & Electric Distribution Center • Schools/university board	<u>Temperature – Ballasts</u> • Temperature is usually not a concern with HID magnetic ballasts, but is definitely a concern with fluorescent electronic ballasts. Hot temperatures can dramatically reduce the life of many electronic fluorescent ballasts. • Ballast temperature tends to be more problematic in T5HO than T8 hibays, because T5HO hibays are narrower so the heat is condensed from the lamps and ballasting. The heat has caused many T5HO ballasts to fail prematurely. There are several large national companies that have had so many problems with poorly designed T5HO

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	4-99 - 'Essay By Invitation' (LD+A) 6-01 - 'Essay By Invitation' (LD+A) 2/02 - 'Essay By Invitation' (LD+A) **Report Date:** September 19, 2005		• Although some of the dimming electronic MH ballasts cost significantly more, their flexibility and performance can often provide the best total solution in some applications.			hibays that they do not want to consider them in any new projects. <u>Luminaire Dirt Depreciation (LDD)</u> • An advantage of horizontal fluorescent lamps is that about 40% of the light comes from the bottom half of the lamps without having to bounce off a reflector or refractor like a vertical HID lamp. <u>Controls</u> • Digital addressable logic interface (DALI) may revolutionize the dimming electronic ballast industry. DALI is not proprietary, so several manufacturers are making interchangeable ballasts and controllers. <u>HPS Option</u> • In the early to mid 90s some of the California incentive programs basically covered the parts cost of HPS hibays to replace mercury vapor and old style HO and VHO T12 fluorescents. So many gyms and warehouses got new HPS hibays. <u>Pulse Start MH with Electronic Ballast Option</u> • Electronic ballasts for 250 to 450W PS MH have logged millions of

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						machine/lamp hours. • More manufacturers are coming out with their own ballasts, which validates that these ballasts really do work. • With higher volumes and competition, pricing is dropping. <u>Ceramic MH with Magnetic or Dimming Electronic Ballast Option</u> • Ceramic MH may be the future of metal halide. 320 – 400W ceramic MH lamps are becoming more popular in retail and other applications where very high color rendering is important. <u>F54T5HO Option</u> • T5HO lamp pricing is coming down, but until the major manufacturers start making the lamps in the US instead of shipping from Europe, they will still be considerably higher than the best T8s. • A number of Chinese and other Pacific Rim companies are shipping T5HOs to North America at quite low prices, but quality and warranty issues are big question marks.
2005	**Study Period(s):** Presents 2005/2006 Prescriptive	Commercial Services: Incentives for Lighting Controls http://www.smud.org	Sacramento Municipal Utility District (SMUD) provides financial incentives to lighting	Not defined in reviewed document.	• Sacramento Municipal Utility District • Customers • Lighting contractors	<u>2005/2006 Prescriptive Rebate Schedule</u> Incentive allowed for wall or ceiling mounted sensor (including high-bay): $55/sensor • No incentive payment can be greater

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	Rebate Schedule **Report Date:** 2005	/en/business/rebates/Documents/incentlightcontrol.pdf	contractors to install energy efficient equipment in customer facilities. Customers may apply for SMUD incentives if they are not working with a contractor. • The incentives help offset the cost to purchase energy efficient equipment, and the investment continues to deliver energy savings over the life of the equipment.			than the installed cost of the efficiency measure
2005	**Study Period(s):** Article that makes note of the following: Federal agencies are required by the Energy Policy Act of 2005 to specify and buy ENERGY STAR-	FEMP Designated Product: Industrial Luminaires http://www1.eere.energy.gov/femp/pdfs/pseep_ind_luminaires.pdf	Fluorescent high-performance T8 or T5HO systems should be considered for high-bay and low-bay lighting applications because they are more efficient than metal halide systems over their system life. • They also have other advantages	Not defined in reviewed document.	• Government agencies • Contractors • Federal Energy Management Program	Federal agencies are required by the Energy Policy Act of 2005 and Federal Acquisition Regulations Subpart 23.2 to specify and buy ENERGY STAR-qualified products or, in categories with no ENERGY STAR label, FEMP-designated products which are among the highest 25 percent of equivalent products for energy efficiency. • Agencies must use ENERGY STAR-qualified and FEMP-designated performance requirements for all procurements of energy-consuming

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	qualified products or, in categories with no ENERGY STAR label, FEMP-designated products which are among the highest 25 percent of equivalent products for energy efficiency. **Report Date**: 6/22/2007		including instant restrike, more uniform light distribution, and better color rendering.			products and systems including guide and project specifications, and construction, renovation and service contracts. These performance requirements should also be used in evaluating responses to solicitations. • Agencies can claim an exception to these requirements through a written finding that no ENERGY STAR-qualified or FEMP-designated product is available to meet the functional requirements, or that no such product is life-cycle cost-effective for the specific application. • High-pressure sodium (HPS) systems are not recommended. Although they have been widely used in industrial and outdoor applications, HPS systems do not meet the visual performance requirements of most high-bay and low-bay applications, and the availability of pulse-start metal halide and high-efficiency fluorescent systems has substantially diminished previous HPS advantages of long life and high efficiency compared to standard metal halide or fluorescent systems. In circumstances where it is still desirable to use HPS systems, they are required to meet the corresponding metal halide system requirements.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
2007	**Study Period(s):** Discusses an array of cost-effective third-party energy efficiency programs and energy management solutions targeted to business or industry segments. **Report Date:** July 2007	Lower Your Bills With SCE's Third-Party Efficiency Programs http://www.sce.com/NR/rdonlyres/170EDA29-C21D-4DDE-8CD2-463B07F27473/0/2007JulyPowerBulletin.pdf	In addition to saving energy and money and offering a demand response function during critical energy periods, the Lighting Energy Efficiency With Demand Response system helps conserve valuable energy resources.	Not defined in reviewed document.	• Qualifying SCE customers in commercial, retail, educational, government and industrial facilities	The "Lighting Energy Efficiency With Demand Response" program provides commercial, retail, educational, government and industrial facilities with long-term savings through state-of-the-art lighting equipment and controls. Qualifying SCE customers with HID or T12 lighting are eligible to receive products such as: • T5HO Wireless Dimmable High-Bay Lights - These fixtures use half the energy of metal halide or high-pressure sodium lights. A facility can save an estimated $188 annually for each 400-watt HID fixture replaced with an energy-efficient T5HO fixture. • Retrolux T5 Wireless Dimmable Lights - A facility that replaces four-lamp T12 fixtures with two-lamp T5 fixtures can save an estimated $53 per fixture per year.
2007	**Study Period(s):** No dates provided – Compares T5 and T8 lighting **Report Date:** June 5, 2007	T8 versus T5 High Bay Lighting http://www.nexstarlighting.com/FCKeditor/userfiles/File/PresentationT8vsT5.pdf	<u>T8 Technology</u> • In widespread use in Canada for over 15 years • Highest lumen per watt in most fixtures • Components (lamps and ballasts) are reliable and relatively inexpensive	Not defined in reviewed document.	• Nexstar Lighting Limited • Warehouse/Facility managers	<u>T8 Technology</u> • T8 solution offers greatest energy savings and lowest maintenance cost • T8 offers lowest total number of open fixtures (T5 offers lowest number if enclosed fixtures used) • T8 solution has the lowest capital cost

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			• Lamp life as high as 46,000 hours • Product range of lamps and ballasts for use with 347V is large <u>T5 Technology</u> • Available in Canada for 10 years, but limited market penetration • Highest light output per lamp • High lumen per watt in special fixtures • Component costs are high and reliability of 347V product has been a problem • Lamp life improving, but limited to 25,000 hours • Limited product options available at 347V			
2008	**Study Period(s):**	HID Versus Fluorescent for High-	High-intensity discharge light	<u>Electrodeless induction lamps</u>:	• Manufacturers • Warehouse/Facility	Although improvements in lamps, ballasts and luminaires may eventually

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	No date provided. **Report Date:** Dec 10, 2008	Bay Lighting http://www.bchydro.com/powersmart/technology_tips/buying_guides/lighting/hid_versus_fluorescent.html	sources, such as metal halide and high-pressure sodium lamps, have dominated the market for lighting indoor spaces with high ceilings. However, improvements in fluorescent lamps and the emergence of high-intensity fluorescent fixtures have made fluorescent lighting the most cost-effective choice for lighting high indoor spaces. High-intensity fluorescent systems contain the following advantages over HID solutions: • Lower energy consumption • Lower lumen depreciation rates • Better dimming options • Faster start-up and	• Offers lower efficacy than metal halide and conventional fluorescent lamps • Suffers from high lumen depreciation (about 40%). • Concerns about how their radio frequency energy might affect adjacent electrical equipment. <u>High-intensity fluorescent fixture designs</u>: • The compact size of these fixtures limits them to the use of shorter compact fluorescent lamps which are less efficient and have a shorter life than long twin-tube and linear T5 lamps.	managers • Schools/university board • Designers/Architects	make HID lighting systems as energy-efficient as the new fluorescent systems, it is unlikely that lighting manufacturers will ever be able to eliminate the warm-up and restrike delay associated with HID lights. This inability to instant-start severely limits the use of occupancy sensors and other switching methods that can save energy. It appears HID lighting has a ways to go before it can match the low lumen depreciation of T5 lamps. Even 20% lumen loss is a problem when compared with the five to 10% loss of T5 fluorescent systems. • Until these drawbacks can be eliminated, the market share for HID lighting will probably continue to erode.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			restrike • Better color rendition • Reduced glare			
2008	**Study Period(s):** No date provided. **Report Date:** November 19, 2008	High-Bay Lighting (multi-sections) http://oee.nrcan.gc.ca/industrial/equipment/high-bay/index.cfm?attr=24	High-intensity discharge lighting systems were previously considered the primary option for illuminating high-bay spaces. Recent advances in fluorescent lighting systems make them more attractive for lighting spaces that have high ceilings, with benefits that include: • Higher light output per unit of electric power • Higher light output as lamps age • Better color rendering • Energy-saving switching capability • Continued reliability when there is lamp failure	T5 HO luminaires may still be more expensive than HID luminaires.	• Customers	The purchase-price premium for high-bay fluorescent systems has been dropping and operating costs are low enough to make fluorescents worth considering when replacing HID systems. • With the fluorescent system there is a reduction of between 20 and 40 percent in annual electricity use.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			• Less mercury for equivalent lighting service-years • Superior performance at higher temperatures			
2008	**Study Period(s):** This report summarizes findings from research on new program and technology approaches and related best practices, conducted as part of the second phase of a national best practices study of energy efficiency programs. These findings build on the first phase of the study,	NATIONAL ENERGY EFFICIENCY BEST PRACTICES STUDY - ENERGY EFFICIENCY BEST PRACTICES: WHAT'S NEW? http://www.eebestpractices.com/pdf/whatsnew.pdf	Emerging energy efficiency trends in the nonresidential lighting arena reflect a mix of emerging technologies, more sophisticated controls, and greater focus on design practices, installation quality, and commissioning.	<u>LED Lighting</u> • There are challenges related to cost, low levels of light output, and narrow wavelengths. <u>Lighting controls</u> • Developing effective lighting controls remains an industry challenge. • A large-scale study of 123 buildings with daylight-responsive lighting controls found that more than half had non-functional controls.	• Pacific Gas & Electric • Itron, Inc. • Manufacturers • California Lighting Technology Center	<u>Reduced-wattage fluorescent lamps</u> Manufacturers are promoting a reduced-wattage T8 lamp that may draw as little as 25 watts, compared to the more typical 32 watts for standard T8s. Manufacturers report these versions now account for about 10% of all 4-foot T8 lamps sold. • These lamps provide higher efficacy, longer life, and better color quality than standard T8s. <u>LED Lighting</u> Recent innovations are bringing the technology cost down and feature the capability to generate blue light, which enables engineers to produce the full spectrum of lighting colors by mixing red, green, and blue. • Current research is focused on addressing heat dissipation issues on the back of the circuit chip. Improper heat dissipation changes the light color over time. • Federal lighting technology investment

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	completed in 2005, which benchmarked approximately 100 programs in order to identify and compare energy efficiency best practices at the program component level. Notes projections through 2010 and makes mention of Architecture 2030's "2030 °Challenge **Report Date:** July 2008					is exclusively focused on LEDs. <u>Hybrid Technologies</u> The California Lighting Technology Center is developing and field-testing hybrid technologies for the following applications: • Ambient night lighting for hotel bathrooms • Combined ambient and task lighting for offices • Bi-level lighting for audio-visual presentations (e.g., classrooms, conference rooms) • Stairwell lighting • Parking lots <u>Lighting Controls</u> Energy savings potential from effective controls is substantial. Lighting control research at the California Lighting Technology Center focuses on developing lighting controls that are virtually self commissioning and simpler from the user's perspective. Researchers are also looking at demand-response lighting as a way to gradually dim lighting in response to peak load constraints without people noticing. • It was found that the top quartile of controls were achieving 82% of their

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						design savings targets reducing lighting energy consumption by 51% and lighting power density by 65%. <u>High Intensity Fluorescent (HIF) Lighting</u> Improvements in fluorescent lamps and the emergence of new HIF fixtures have made fluorescent lighting the most cost effective choice for lighting high indoor spaces. HIF systems present the following advantages over HID solutions: • More energy-efficient • Lower lumen depreciation rates • Better dimming options • Virtually instant start-up and restrike • Better color rendition • Reduced glare Innovations in Program Designs and Incentive Structures 1) Utilities in the New England states adopted a “Performance Lighting” program model. • The program model incorporates hybrid performance standards for both energy efficiency and lighting quality. • They ensure that participating projects exceed code requirements by at least 25% while avoiding projects that utilize

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						outdated, inefficient technologies or achieve low LPDs by under-lighting spaces or “massaging” the calculation process. 2) The New York Energy $mart Small Commercial Lighting Program (SCLP), implemented by NYSERDA, promotes energy-efficient lighting through proper lighting design and deployment. • The program has trained over 1,300 lighting practitioners (lighting contractors, distributors, designers, and manufacturers and their representatives), responsible for nearly 580 qualifying projects that have generated annual end-user energy savings in excess of 26 GWh. • SCLP’s lighting design model requires conformance with specific requirements for task light levels, lighting uniformity, glare, and color rendering and that the project lighting power density be 10% below that allowed by the State regulations.
2008	**Study Period(s):** This report summarizes the findings of the California	California Energy Efficiency Potential Study - CALMAC Study ID: PGE0264.01	The study forecasts short- and mid-term gross and net market potential resulting from the installation of energy efficiency	Market barriers to adoption include: • Customer understanding of the savings possibilities and the measure	• Itron • Pacific Gas and Electric • Southern California Edison Company • Southern California	In many space types, higher efficiency lighting sources or fixtures with improved optics were used to lower the lighting power densities (LPD). • For some spaces, the measure values were further reduced by the ratio of

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	Energy Efficiency Potential Study (Itron 2008 study). The primary focus of the study is the gross and net potential estimates for electricity and gas savings in the existing and new residential, commercial, and industrial sectors. The study builds on the 2006 Energy Efficiency Potential Study (Itron 2006 study), updating input assumptions and unifying the approach undertaken for	http://calmac.org/publications/PGE0264_Final_Report.pdf	measures funded through publicly funded energy efficiency programs. • Short-term potential was defined as market potential achievable through 2016 while the mid-term potential was defined as achievable potential through 2026. • The geographic area covered by the study includes the service areas of the four major investor-owned utilities (IOUs): PG&E, SCE, SCG, and SDG&E. • The potential energy savings estimated include savings resulting from the installation of high efficiency measures for retrofit, replace-on-burnout, conversions, and new construction	characteristics • Customer inertia or buying patterns that are hard to change. • Vendors' knowledge of the measure and willingness to stock the measures	Gas Company • San Diego Gas & Electric Company • California Public Utilities Commission • California Energy Commission	available higher efficacy light sources over common practice (e.g., using CFL high bays in place of metal halide lamps for commercial storage space). • Measure values for allowed LPD were primarily based on Savings By Design (SBD) values, Advanced Buildings guideline values, or common practice data adjusted for a change in source efficacy.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	all sectors of analysis. The study forecasts the short- and mid-term gross and net market potential resulting from the installation of energy efficiency measures funded through publicly funded energy efficiency programs. For this analysis, the short-term potential was defined as market potential achievable through 2016 (10 years) while the mid-term potential		situations. • Energy savings resulting from changes in behavior, or requiring major redesign of existing systems, were not included in this study.			

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	was defined as achievable potential through 2026 (20 years). **Report Date:** September 10, 2008					
2008 (est.)	**Study Period(s):** No dates provided – Discusses rebates involving HBL **Report Date:** No date provided	The Value of High Bay Retro-fits http://www.scribd.com/doc/5311906/The-Value-of-High-Bay-Retrofits	Value of high bay retrofits: • Increased quality of light • Save up to 70% off your energy bill • Depending on the business's annual operating hours, utility rebates can cover up to 100% of total cost of the retrofit • Less maintenance • Brand-new fixtures that emit less heat and no hum • Better for the environment	Not defined in reviewed document.	• Customers • San Diego Gas & Electric • Pacific Gas & Electric • Southern California Edison • California Public Utilities Commission	<u>Examples of Energy Savings</u> • With 3,600 annual operating hours the business' saving would be $ 15,098.40 in Annual Energy Savings (for 100-453 Watt Metal Halide fixtures retrofitted to 100-220 Watt T-8 Florescent Lamp + Electronic Ballast System) <u>SDG&E, PG&E & SCE Rebates</u> • California Utilities pay the highest energy efficiency rebates in the nation (SDG&E pays more than the other two major utilities). • The rebates are incentives for businesses to install energy efficient measures. • The utility companies all made commitments to the California Public Utilities Commission that must be met. As a result, rebates have risen to an all-time high to meet quota.
2008	**Study**	State of Wisconsin	**Primary Program**	Lack of Awareness of	Contractors were	There was an increase in net Wisconsin

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	Period(s): 18-Month Contract Period: July 1, 2007, through December 31, 2008 (High bay fluorescent lighting has been marketed and promoted by the Focus program for the last 6 years. It is important to understand the status of new and replacement markets for high bay fluorescents in comparison to Illinois, relative to standard HID technology, and to understand the	Public Service Commission of Wisconsin: Focus on Energy Evaluation Business Programs: Channel Studies—Fiscal Year 2008 Final Report: January 17, 2009	**Activities:** Provide prescriptive incentives, training and information to substantially increase the use of high efficiency fluorescent systems for high-bay lighting instead of or to replace HID lighting systems. **Goals:** Increase net Wisconsin market share of high bay fluorescent lighting systems compared to increase in net market share in Illinois, and to standard HID technology. **Metrics:** Increase in net Wisconsin market share of high bay fluorescent lighting systems, across all market segments, compared to any increase in net market	opportunity with some market segments and financial barrier with customers with lower hours of operation.	selected because they were considered more knowledgeable than lighting distributors about where lamps are installed. In addition, it was thought that contractors could provide better market-level data than end-users.	market share of high-bay fluorescent lighting systems, across all market segments, compared to any increase in net market share from Illinois baseline, and to standard HID technology. • On average, contractors in Wisconsin installed high-bay lighting equipment in 28% of the commercial and industrial lighting projects completed over the previous twelve months. Wisconsin lighting contractors recommended fluorescent as opposed to HID fixtures in an average 69% of these high-bay lighting projects, and actually installed fluorescent as opposed to HID fixtures in an average 72% of such projects. Illinois contractors performed high-bay lighting installations in 25% of completed projects. Illinois firms recommended fluorescent fixtures in 51% of applicable projects. The rate of fluorescent fixture installation in Illinois was 28%. • While contract metric baseline values for high-bay lighting installation rates and fluorescent fixture recommendation rates were comparable in Wisconsin and Illinois, baseline values for fluorescent fixture installation rates differed significantly. The difference between the states' fluorescent fixture installation rates, with Wisconsin contractors installing efficient fixtures at a 44-percentage-

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	impact of potentially reduced Focus support for this technology on the stability of the market.) **Report Date:** January 17, 2009		share from Illinois baseline, and to standard HID technology. **Milestones:** Establish high bay fluorescent lighting baseline, across all market segments, for Wisconsin and Illinois by January of 2008.At the end of 2010 program year, Wisconsin will have a 10% greater growth in net market share of high bay fluorescent lighting systems, compared to Wisconsin baseline, than any increase in net market share from Illinois baseline, and to standard HID technology.			point higher level than Illinois contractors, was statistically significant at the one-percent level. This stands as strong evidence that fluorescent lighting systems account for a substantially larger share of the high-bay lighting market in Wisconsin than in Illinois. Given that the existence of the Business Programs is one of the major differences between these two markets, it is reasonable to infer that Focus on Energy is at least partially responsible for the higher market share of high-bay fluorescent fixtures in Wisconsin. • In Wisconsin, high performance T-8 systems were recommended in an average 60% of lighting projects completed over the previous year, and T-8 systems were installed an average 60% of recommended projects.2 T-5 technology was recommended in an average 20% of projects and actually installed in an average 14% of recommended projects. Occupancy controls were recommended in an average 61% of Wisconsin projects, and installed in 69% of them. Automatic daylighting controls were recommended in an average 15% of Wisconsin lighting projects and installed in 19% of recommended projects. In Illinois, contractors recommended T-8 systems in 58% of projects and installed them in 68% of recommended projects. T-5 technology was recommended in an average 32% of lighting projects, and

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						installed in an average 41% of recommended projects. Illinois contractors recommended occupancy controls in 21% of lighting projects and daylighting controls in 16% of them, and installed these two technologies in 22% and 14% of recommended projects, respectively. • Differences in recommendation rates between Wisconsin and Illinois for high-performance T-8 systems, T-5 technology, and automatic daylighting controls were not statistically significant. However, the difference in occupancy control recommendation rates between Wisconsin and Illinois, measured at 60% and 21%, respectively, was statistically significant at the one-percent level. Similarly, the difference in occupancy control installation rates between the two states, measured at 69% in Wisconsin and 22% in Illinois, was statistically significant at the one-percent level. Differences in high-performance T-8 system installation levels and daylighting control installation levels were not significant. Illinois lighting contractors installed T-5 technology at a rate of 41% compared to 14% for Wisconsin contractors. The following results generally support the notion that Focus has affected the market for energy efficient lighting in

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						Wisconsin. • Wisconsin contractors representing 47% of projects completed responded their promotion of energy-efficient lighting had increased over the previous two years. Contractors representing 53% of projects completed reported their promotional levels had not changed. No Wisconsin lighting contractors reduced their promotional efforts. • The most important reason Wisconsin contractors promoted energy efficient lighting was "customer satisfaction/retention"; the most important reason cited by Illinois contractors was "increase revenue or margin." Only 5% of Wisconsin contractors cited "increase revenue or margin." Firms in both states mentioned, energy savings, cost savings, and environmental concerns as reasons to promote energy-efficient lighting technology. • The results suggest a substantial increase in energy-efficiency promotional efforts by Wisconsin contractors, driven in large measure by a perceived need to ensure customer satisfaction. Wisconsin vendors appear to have altered their promotional

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						practices in response to consumer demand. This demand is less pronounced in Illinois, and vendors there have not changed their levels of high-efficiency equipment promotion. With no parallel program in Illinois, it is reasonable to infer that Focus on Energy contributed to changes in customer preferences, and thus is indirectly responsible for consequent changes in vendor behavior. • Illinois lighting contractors representing 77% of projects attributed customer refusals to the view that “cost is too high.” In Wisconsin, where recommendations are accepted much more often, firms representing only 32% of projects cited customer cost concerns. • On a scale of 1 to 10, where 1 is not at all important and 10 is very important, Wisconsin contractors assigned Focus on Energy a score of 5.7 on the question of program influence on decisions to increase promotion of energy-efficient equipment. • On a scale of 1 to 10, where 1 is no influence and 10 is a great deal of influence, these contractors assigned the program a score of 6.3 on the question of program influence on the market

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						share of efficient lighting technologies. • Wisconsin firms responsible for 68% of projects said that the share of projects in which they installed high-bay fluorescent fixtures would have “stayed about the same” in the absence of Focus on Energy. • Results indicate that Wisconsin consumers take greater account of multiple lighting equipment characteristics when selecting technology to purchase than do Illinois consumers. The Lighting Channel surveys provide potentially strong evidence of supply-side effects. However if contractors are still using the rebates to realize their energy efficiency sales then these are direct impacts because the energy savings are being tracked by the program. Using the number of projects completed in the past 12 months that received rebates as a proxy for in-program sales (direct impacts), it is estimated that 65% of projects are out-of-program sales (indirect impacts). If vendor estimates are to be believed, then a large fraction of energy efficiency sales are out-of-program sales and potentially attributable to the program.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						Wisconsin lighting contractors tended to discount the influence of Focus on Energy on the state's lighting market. The ratings given to Focus for program influence on decisions to increase promotion of energy-efficient equipment and program influence on the market share of efficient lighting technologies are low relative to scores provided by the HVAC distributors for a similar sequence of questions. A large majority of Wisconsin contractors also claim the share of projects in which they installed high-bay fluorescent fixtures would have "stayed about the same" in the absence of Focus on Energy. One possibility for this disconnect may be that the Business Programs have helped to transform the market to such an extent that their importance has become obscured.

APPENDIX B: Summary of Incentives for HBL Measures by Utility

Unless otherwise noted, PG&E/SCE generally offer rebates for the one-to-one replacement of new, hardwired fixtures for existing Incandescent, Mercury Vapor, T12/High Output Fluorescent, T12/Very High Output Fluorescent, Standard Metal Halide, or High Pressure Sodium. SDG&E primarily offers rebates for the one-to-one replacement of new fixtures for existing Incandescent and Mercury Vapor and provides more rebates and a greater breakdown of those rebates for certain Wattages.

		IOU				
		PG&E/SCE		SDG&E		
	Rebate Measure	Rebate/ Fixture or Lamp	Qualifications	Rebate/ Fixture or Lamp	Qualifications	Differences Between PG&E/SCE & SDG&E
Interior Linear Fluorescent Fixtures	>400 Watt lamp basecase, up to 600 Watt replacement fixture	$125.00	Only new T8, T5, or High Output T5s qualify. Change out wattage must be lower than existing fixture. Existing pulse-start metal halide and exterior installations do not qualify. ≥ 400 Watt must be installed above 12' to qualify.	$230.50	Certain rebates are isolated to high bay applications (Tier 1 and Tier 2). Only new T8 or T5 qualify. Change out wattage must be lower than existing fixture. Exterior installations do not qualify. Besides Mercury Vapor, new fixtures must be a one-to-one replacement of existing Incandescent, T12/High Output Fluorescent, T12/Very High Output Fluorescent, Standard Metal Halide, or High Pressure Sodium Fixtures in interior installations.	SDG&E does not necessarily exclude existing pulse-start metal halide installations from qualifying. SDG&E does not include Mercury Vapor in those fixtures requiring a one-to-one change out. SDG&E provides more rebates and a greater breakdown of rebates for Wattages below 100 Watts. Additionally, SDG&E specifies that fixtures have reflectors with at least 90% reflectivity.
	400 Watt lamp basecase, up to 244 Watt replacement fixture (Tier 1)	$100.00		$101.50		
	400 Watt lamp basecase, 245 to 360 Watt replacement fixture (Tier 2)	$75.00		$100.00		
	176-399 Watt lamp basecase, up to 192 Watt replacement fixture	$75.00		-		
	101-175 Watt lamp basecase, up to128 Watt replacement fixture	$50.00		-		
	>100 Watts, incandescent basecase	-		$169.00		
	>100 Watts, mercury vapor basecase	-		$74.50		
	<100 Watt lamp basecase, up to 64 Watt replacement fixture	$35.00		-		
	90-99 Watts, mercury vapor basecase	-		$74.50		
	90-99 Watts, incandescent basecase	-		$169.00		
	66-90 Watts, mercury vapor basecase	-		$51.00		
	66-90 Watts, incandescent basecase	-		$95.00		
	27-65 Watts, mercury vapor basecase	-		$29.50		
	27-65 Watts, incandescent basecase	-		$43.50		
	14-26 Watts, incandescent basecase	-		$21.50		
	5-13 Watts, incandescent basecase	-		$11.00		

T8 or T5 Linear Fluorescent Lamps with Electronic Ballasts

Rebate Measure	IOU: PG&E/SCE Rebate/ Fixture or Lamp	IOU: PG&E/SCE Qualifications	IOU: SDG&E Rebate/ Fixture or Lamp	IOU: SDG&E Qualifications	Differences Between PG&E/SCE & SDG&E
Installed					
2-ft lamp/installed	$3.50	Rebate applies to T12 lamp and magnetic ballast change outs, T8/T5 high frequency electronic (>20kHz) UL ballasts with 5 year mechanical and electrical defect warranty plus a Power Factor > .90. Total Harmonic Distortion of ≤20% for 4' and 8' lamps and ≤32% for 2' and 3' lamps. Both T8 and T5 must meet CRI and Rated Lamp Life standards - the manufacturer's specifications sheet must document these for each ballast type.	$5.00	Same as PG&E and SCE	None
3-ft lamp/installed	$4.25		$8.00		
4-ft lamp/installed	$4.25		$6.00		
8-ft lamp/installed	$7.50		$7.50		
De-Lamped					
2-ft lamp/removed	$4.00	Must accompany the permanent removal of existing T12 lamps/ballasts and unused lamp-holders from existing fixtures without replacing the lamps. To qualify, greater than half the existing lamps/ballasts (along with lamp holders) from each fixture must not be removed. Qualified de-lamping may not exceed the number of installed T8 or T5 replacement lamps.	$6.00	Same as PG&E and SCE	None
3-ft lamp/removed	$4.00		$8.00		
4-ft lamp/removed	$6.00		$10.00		
8-ft lamp/removed	$9.00		$25.00		

T5/T8 Lamp and Ballast Requirements

T8 – 2-ft, 3-ft, 4-ft ; Programmed Start or Programmed Rapid-Start ballast; ≥ 80CRI; 24,000 hrs Minimum Rated Lamp Life

T8 – All Sizes; Instant-Start ballast; ≥ 80CRI; 18,000 hrs Minimum Rated Lamp Life

T5 - All sizes; Programmed Start or Programmed Rapid-Start ballast; ≥ 82CRI; 20,000 hrs Minimum Rated Lamp Life

	Rebate Measure	IOU: PG&E/SCE Rebate/ Fixture or Lamp	IOU: PG&E/SCE Qualifications	IOU: SDG&E Rebate/ Fixture or Lamp	IOU: SDG&E Qualifications	Differences Between PG&E/SCE & SDG&E
Interior Pulse-Start Metal Halide Fixtures	≥ 400 Watt lamp basecase, retrofit fixture ≤ 350 watts	-	Retrofit kits may be used on existing Mercury Vapor, Standard Metal Halide, or High Pressure Sodium fixtures only. New fixtures must not exceed max wattage and change out wattage must be lower than existing fixture. Replacements must be equipped with Pulse-Start Metal Halide lamps and either magnetic or electronic ballasts. Basecase lamp wattages below 175 Watts do not qualify. 400 Watt and greater must be installed above 12' to qualify.	$47.00	Interior, pulse-start metal halide lamps and ballasts ≤ 350 Watts that replace existing standard metal halide lamps and ballasts ≥ 400 Watts qualify for retrofit. In other applications, replacement fixtures must be a one-to-one replacement of existing incandescent or mercury vapor. The HID must have a mean lamp/ballast efficacy of 45 LPW for compact sources (≤100 Watts) and 55 LPW for standard/full size sources (>100 Watts). Fixtures < 400 Watts can use either electronic or electromagnetic ballasts.	SDG&E provides more rebates and a greater breakdown of rebates for Wattages below 400 Watts and provides rebates for basecase lamp Wattages below 175 Watts. SDG&E provides retrofit basecase rebates only for existing mercury vapor while PG&E/SCE provide rebates for Mercury Vapor, Standard Metal Halide, or High Pressure Sodium fixtures.
	>400 Watt lamp basecase, up to 820 Watt replacement fixture (Tier 1)	$100.00		-		
	>400 Watt lamp basecase, up to 821-950 Watt replacement fixture (Tier 2)	$50.00		-		
	400 Watt lamp basecase, up to 400 Watt replacement fixture	$45.00		-		
	400 Watts, incandescent basecase	-		$268.50		
	400 Watts, mercury vapor basecase	-		$204.50		
	176-399 Watt lamp basecase, up to 275 Watt replacement fixture	$40.00		-		
	251-399 Watts, mercury vapor basecase	-		$204.50		
	251-399 Watts, incandescent basecase	-		$268.50		
	176-250 Watts, mercury vapor basecase	-		$73.00		
	176-250 Watts, incandescent basecase	-		$185.50		
	175 Watt lamp basecase, up to 190 Watt replacement fixture	$10.00		-		
	101-175 Watts, mercury vapor basecase	-		$38.00		
	101-175 Watts, incandescent basecase	-		$130.00		
	71-100 Watts, mercury vapor basecase	-		$38.00		
	71-100 Watts, incandescent basecase	-		$76.00		
	36-70 Watts, mercury vapor basecase	-		$18.00		
	36-70 Watts, incandescent basecase	-		$42.50		
	0-35 Watts, mercury vapor basecase	-		$12.50		
	0-35 Watts, incandescent basecase	-		$22.00		

	Rebate Measure	IOU PG&E/SCE Rebate/ Fixture or Lamp	IOU PG&E/SCE Qualifications	IOU SDG&E Rebate/ Fixture or Lamp	IOU SDG&E Qualifications	Differences Between PG&E/SCE & SDG&E
Exterior Pulse-Start Metal Halide Fixtures	>400 Watt lamp basecase, up to 820 Watt replacement fixture (Tier 1)	\$100.00	New fixtures must not exceed max wattage and change out wattage must be lower than existing fixture. Basecase lamp wattages below 175 Watts do not qualify. 400 Watt and greater must be installed above 12' to qualify.	-	The HID must have a mean lamp/ballast efficacy of 45 LPW for compact sources (≤100 Watts) and 55 LPW for standard/full size sources (>100 Watts). Fixtures < 400 Watts can use either electronic or electromagnetic ballasts. Roadway and street lighting do not qualify.	SDG&E provides more rebates and a greater breakdown of rebates for Wattages below 400 Watts and includes rebates for measures below 175 Watts.
	>400 Watt lamp basecase, 821 up to 950 Watt replacement fixture (Tier 2)	\$50.00		-		
	≥ 400 Watts, incandescent basecase	-		\$144.00		
	≥ 400 Watts, incandescent basecase	-		\$62.50		
	400 Watt lamp basecase, up to 400 Watt replacement fixture	\$45.00		-		
	176-399 Watt lamp basecase, up to 275 Watt replacement fixture	\$40.00		-		
	176-399 Watts, incandescent basecase	-		\$144.00		
	176-399 Watts, mercury vapor basecase	-		\$62.50		
	175 Watt lamp basecase, up to 190 Watt replacement fixture	\$10.00		-		
	101-175 Watts, mercury vapor basecase	-		\$46.00		
	101-175 Watts, incandescent basecase	-		\$114.00		
	0-100 Watts, mercury vapor basecase	-		\$37.50		
	0-100 Watts, incandescent basecase	-		\$79.50		
Induction Fixtures	400 Watt lamp basecase, up to 360 Watt replacement fixture	\$100.00	New fixtures must not exceed max wattage and change out wattage must be lower than existing fixture. Fixtures must be equipped with induction lamps and drivers. Existing pulse-start metal halide and exterior installations do not qualify. Only interior installations qualify. 400 Watt and greater must be installed above 12' to qualify.	-	New fixtures ≥ 55 Watts replacing existing incandescent or mercury vapor fixtures qualify. New fixtures must have a mean lamp/ballast efficacy > 50 LPW. Roadway and street lighting do no qualify.	SDG&E specifies a lamp/ballast efficacy.
	176-399 Watt lamp basecase, up to 180 Watt replacement fixture	\$75.00		-		
	101-175 Watt lamp basecase, up to 160 Watt replacement fixture	\$35.00		-		
	> 100 Watt mercury vapor basecase	-		\$85.00		
	100 Watt lamp basecase, up to 95 Watt replacement fixture	\$35.00		-		
	55-100 Watt incandescent basecase	-		\$115.00		

	Rebate Measure	IOU: PG&E/SCE Rebate/ Fixture or Lamp	IOU: PG&E/SCE Qualifications	IOU: SDG&E Rebate/ Fixture or Lamp	IOU: SDG&E Qualifications	Differences Between PG&E/SCE & SDG&E
CFL Fixtures	Interior > 400 Watt lamp basecase, up to 390 Watt replacement fixture	$45.00	New fixtures qualify and must not exceed max wattage and change out wattage must be lower than existing fixture. Electronic ballasts and CFL lamps must accompany fixture. Exterior installations ≤ 100 Watts qualify, existing pulse-start metal halides do not qualify. Ballasts must be Programmed-Start or Programmed Rapid-Start with PF ≥ .90 and a THD of ≤ 20%. Interior installations qualify.	-	New fixtures or modular retrofits with hardwired electronic ballasts replacing an incandescent or mercury vapor fixture qualify. To qualify, fixtures must meet minimum efficacy requirements. Ballasts must be Programmed-Start or Programmed Rapid-Start with PF ≥ .90 and a THD of ≤ 20%.	SDG&E provides more rebates and a greater breakdown of rebates for Wattages below 100 Watts.
	Interior 176-399 Watt lamp basecase, up to 275 Watt replacement fixture	$20.00		-		
	Interior 101-175 Watt lamp basecase, up to 160 Watt replacement fixture	$20.00		-		
	>100 Watts, incandescent basecase	-		$169.00		
	>100 Watts, mercury vapor basecase	-		$74.50		
	Interior < 100 Watt lamp basecase, up to 70 Watt replacement fixture	$17.00		-		
	Exterior < 100 Watt lamp basecase, up to 70 Watt replacement fixture	$17.00		-		
	90-99 Watts, mercury vapor basecase	-		$74.50		
	90-99 Watts, incandescent basecase	-		$169.00		
	66-90 Watts, mercury vapor basecase	-		$51.00		
	66-90 Watts, incandescent basecase	-		$95.00		
	27-65 Watts, mercury vapor basecase	-		$29.50		
	27-65 Watts, incandescent basecase	-		$43.50		
	14-26 Watts, incandescent basecase	-		$21.50		
	5-13 Watts, incandescent basecase	-		$11.00		
Ceramic Metal Halide	Ceramic Metal Halide Directional Lighting Fixtures	$45.00	Eligible integrated ballast ceramic metal halide PAR lamps must have a rated lamp life of 10,500 hours or greater. CMH directional lighting fixtures with a nominal lamp Wattage of 39 Watts or lower qualify.	-	CMH fixture one-to-one replacement of existing incandescent or halogen infrared qualify. Lamps must be < 75 Watts with a mean lamp/ballast efficacy > 55 LPW.	SDG&E and PG&E/SCE offer rebates for different CMH measures.
	Integrated Ballast Ceramic Metal Halide (CMH) Par Lamps	$12.50		-		
	Ceramic Metal Halide (CMH) < 75 Watts	$74.50		$74.50		

APPENDIX C: Utility Program Manager Interview Guides

INTERVIEW GUIDE –
IOU PROGRAM MANAGERS AND ANALYSTS

OBTAIN AND REVIEW PROGRAM DESCRIPTIONS, PROGRAM PLANS, PROGRAM LOGIC MODELS, AND APPLICATION MATERIALS PRIOR TO THE INTERVIEW. ANSWER AS MANY OF THE QUESTIONS BELOW USING THOSE MATERIALS. ONLY REVIEW THOSE QUESTIONS WITH THE RESPONDENT IF THE DOCUMENTS DO NOT PROVIDE CLEAR ANSWERS.

PRIOR TO INTERVIEW, SEND THE RESPONDENT THE LIST OF MEASURE NAMES FROM THE EEGA DATABASE THAT WE BELIEVE DESIGNATE HIGH BAY LIGHTING. VERIFY THAT ALL MEASURES LISTED DO DESIGNATE HIGH BAY LIGHTING AND THAT THE LIST IS COMPLETE.

I. Personnel Roles and Responsibilities

1. Which energy efficiency programs are you working on?
2. What are your responsibilities regarding those Programs? What role do you play, if any, in:
    a. Planning, designing, managing, and administering the Program,
    b. Marketing the Program to customers,
    c. Marketing the Program to distributors and installation contractors,
    d. Managing distributor and installation contractor participation in the Program.
    e. Administering the delivery of financial incentives to customers
    f. Administering the delivery of technical services to customers
    g. Other aspects of the Program?

II. General Program Objectives and Operations: ONLY ASK QUESTIONS 3 – 6 IF NOT CLEARLY ANSWERED PROGRAM MATERIALS

Before proceeding to questions specifically on program activities in regard to High-Bay Lighting, I'd like to make sure I understand the overall goals and operations of the program.

First, could you please describe for me what your understanding of high-bay lighting technologies is?

For the purposes of this interview we define high bay applications as installations in commercial and industrial spaces with ceiling heights of about 15 feet or more.

1. What specific groups of customers does the program target?
    a. **PROBE**: Do the targeted groups include [commercial facilities with high bay lighting such as] schools, warehouses, garages and utility buildings.
    b. **PROBE**: Do the targeted groups include industrial facilities with high bay production, storage, and loading areas?
2. What types of technologies does the program support?
3. What kinds of incentives or assistance are provided to customers?

    PROBE
    a. Financial incentives/rebates for purchase/installation of qualifying equipment
    b. Technical assistance in identifying energy-saving opportunities
    c. Technical assistance in specifying and purchasing energy efficient equipment
    d. Technical assistance in design of installations
4. What kinds of incentives or assistance are provided to distributors and installers?

    PROBE
    a. Financial incentives for promotion or sale of qualifying equipment
    b. Technical assistance in identifying energy-saving opportunities
    c. Technical assistance in specifying and purchasing energy efficient equipment
    d. Technical assistance in design of installations
    e. Advertising or merchandising support
5. **NOTE: ASK THIS ITEM EVEN IF WE HAVE INFORMATION FROM THE PROGRAM DESCRIPTION AND APPLICATION FORMS.** What kinds of incentives and assistance are provided to support customers' decisions to purchase and install efficient fluorescent high-bay lighting?
    PROBE:
    a. Financial incentives/rebates for purchase/installation of qualifying equipment
    b. Technical assistance in identifying energy-saving opportunities
    c. Technical assistance in specifying and purchasing energy efficient equipment
    d. Technical assistance in design of installations
    e. Customer education materials
    f. Training oriented to facility managers or purchasers
6. **NOTE: ASK THIS ITEM EVEN IF WE HAVE INFORMATION FROM THE PROGRAM DESCRIPTION AND APPLICATION FORMS.** What kinds of incentives and assistance are provided to support distributor and contractor efforts to

promote and install efficient fluorescent high-bay lighting?
PROBE:

a. Financial incentives/rebates for purchase/installation of qualifying equipment
b. Technical assistance in identifying energy-saving opportunities
c. Technical assistance in specifying and purchasing energy efficient equipment
d. Technical assistance in design of installations
e. Vendor education materials
f. Training oriented to designers, specifiers, installers?

III. Program Logic

1. Do the goals of the program include the stimulation of long-term changes in …

a. The way distributors promote and sell energy-efficient lighting products?
b. The way that contractors promote, design, and install energy-efficient lighting products?
c. Customers' awareness of efficient lighting products?
d. Customers' understanding of the energy savings and other benefits associated with efficient lighting products?
e. Customers' lighting equipment purchasing practices in the absence of financial incentives?

2. Has a formal logic model been developed for this program?

IF YES: REQUEST A COPY AND ASK ITEM 12.

IF NO: SKIP TO ITEM 14.

3. Which sets of market actors does the program logic model identify as important influences in selection of lighting equipment for retrofit, replacement, or new installations?
PROBE:

a. Customers
b. Manufacturers
c. Distributors
d. Installation Contractors
e. Lighting Designers
f. Architects

4. Based on your experience with the program and in the lighting market, which groups of market actors exercise the greatest influence on high-bay lighting equipment selection.
PROBE:

a. Customers
b. Manufacturers
c. Distributors
d. Installation Contractors
e. Lighting Designers
f. Architects

5. **FOR EACH INFLUENTIAL GROUP NAMED ASK:**
   a. What are the main motivations for this group to purchase/promote energy-efficient high bay lighting?
      PROBE
      i. Energy cost savings
      ii. Lower lifecycle costs
      iii. Lower maintenance costs
      iv. Reduced lumen degradation
      v. Other
   b. What circumstances or conditions inhibit this group from purchasing/promoting energy-efficient high bay lighting?
      PROBE
      i. Cost
      ii. Lack of familiarity with the technology
      iii. Perceptions of performance risk/durability
      iv. Not satisfied with level/quality of light delivered
      v. Physical challenges to installation in existing buildings
      vi. Other
6. How well do you think the program is doing at addressing customer motivations and inhibitions for purchasing efficient fluorescent high-bay lighting?
   PROBE: Why do you say that?
7. Have you noticed any changes in customers' level of awareness of efficient fluorescent high-bay lighting over the past two years?
   PROBE: What kinds of changes have you noticed?
8. Have you noticed any changes in customers' level of understanding of the benefits of efficient fluorescent high-bay lighting over the past two years?
   PROBE: What kinds of changes have you noticed?
9. To your knowledge, has customer demand for efficient high-bay lighting increased over the past two years?

10. How well do you think the program is doing at addressing distributor and contractor motivations and inhibitions for purchasing efficient fluorescent high-bay lighting?
PROBE: Why do you say that?

11. Over the past two years, have you noticed any changes in distributor or contractor level of effort in promoting efficient fluorescent high-bay lighting?
PROBE: What kinds of changes have you noticed?

12. To your knowledge, have sales of efficient high-bay lighting increased, decreased or stayed about the same over the past two years?

13. What sources of information do you use to learn about High Bay Lighting technologies?

- **c.** From within California?
- **d.** What about sources outside of California?

Thank you so much for your time

APPENDIX D: Manufacturer, Distributor and Contractor Interview Guides

HBL MARKET EFFECTS STUDY: LIGHTING DISTRIBUTOR

FINAL INTERVIEW GUIDE

FEBRUARY 2, 2009

Intro

Hi my name is _____________. I'm calling on behalf of the California Public Utilities Commission. We are conducting research on the commercial/industrial lighting market in California [OR SUBSTITUTE OTHER STATE]. May I please speak to the manager or person at your firm most familiar with your sales and installation of commercial lighting products?

ENTER NAME OF CONTACT: _________________________________

IF CONTACT IS NOT AVAILABLE, ASCERTAIN BEST TIME TO CALL.

Lead in for respondent.

Hello, this is _________ calling on behalf of the California Public Utilities Commission. We are conducting research on the commercial/industrial lighting market in California [OR SUBSTITUTE OTHER STATE]. All information we gather will be confidential and will not be linked in any way to you or your company. These questions will take about 15 minutes.

Screening & Firmographics

SC1 First, what is your job title?

Sales Manager 1
President/CEO 2
General Manager 3
Other(Specify)____________________ 4
[Don't Know] 98
[Refused] 99

SC2 Which of the following activities does your company pursue at this location? [*Read list and accept multiple responses*]

SC2a **FOR EACH ACTIVITY NAMED.** Approximately what percent of your total annual revenues comes from [ACTIVITY]?

	SC2	SC2a
Lighting sales to end users	1	%
Lighting sales to OEMs	2	%
Lighting sales to contractors	3	%
Lighting layout and design services	4	%
Lighting installation services	5	%
Lighting maintenance services	6	%
Other (Specify)	7	%
[Don't Know]	98	98
[Refused]	99	99

If responded "Don't Know" find another respondent at this facility.
CONTINUE IF SC2 = 1 OR 3; ELSE TERMINATE

SC3 Approximately how many full-time-equivalent (FTE) staff do you have at this location? [PROBE FOR APPROXIMATE]

ENTER NUMBER...____
[Don't Know]...998
[Refused]...999

SC4 How many locations does your firm have in California [OR SUBSTITUTE OTHER STATE]? [PROBE FOR APPROXIMATE]

ENTER NUMBER...____
[Don't Know]...998
[Refused]...999

SC5 What is the approximate geographic region served by your company at this location? [PROBE AS SPECIFICALLY AS POSSIBLE INCLUDING CITIES AND ZIP CODES]

____

____

____

SC6 Which of the following best characterizes your company's revenue at that location from direct sales to contractors or end-users 2008? [*Read list*]

Less than $1 million...1
$1 million to less than $2 million...2
$2 million to less than $5 million...3
$5 million to less than $10 million...4
$10 million or more...5
[Don't Know]...98
[Refused]...99

If responded "Don't Know" find another respondent at this facility. [OK TO ACCEPT A "ROUGH ESTIMATE"]

Determine whether amount is sufficient to continue (based on size of business and percent of sales that are C/I lighting in California).

Lighting Equipment Sales

Now I am going to ask you about your sales of commercial and industrial lighting equipment for high bay applications. For the purposes of this interview we define high bay applications as sales for commercial and industrial applications with ceiling heights of about 15 feet or more. **Please answer these questions for your sales directly to commercial and industrial end users in California [OR OTHER SUBSTITUTE OTHER STATE].**

Determining knowledge/awareness of High Bay Lighting.

LS1a First, what percentage of your total lighting fixture sales last year was accounted for by the following kinds of lighting equipment? Your best approximation is fine.

LS1b **FOR EACH TYPE OF LIGHTING EQUIPMENT NAMED, ASK:** As best you can tell, what percentage of [TYPE OF LIGHTING EQUIPMENT] is installed in high bay applications? [IF NECESSARY, DEFINE HIGH BAY APPLICATIONS IN TERMS OF CEILING HEIGHT.]

LS1c What kinds of information do you rely on to identify the applications of lighting sold to contractors?

____

____

LS1d Which of the kinds of lighting equipment you mentioned do you consider to be energy-efficient in high bay applications?

	LS1a	**LS1b**	**LS1d**
Fluorescent Tube: T12/Magnetic Ballast	%	%	
Fluorescent Tube: T-8 /Electronic Ballast	%	%	
Fluorescent Tube: T-5/Electronic Ballast	%	%	
High Intensity Discharge: metal halide	%	%	
High Intensity Discharge: pulse start metal halide	%	%	
High Intensity Discharge: low pressurized sodium	%	%	
High Intensity Discharge: high pressure sodium	%	%	
High Intensity Discharge: mercury vapor	%	%	
Other (Specify) ______________________________	%	%	
TOTAL		**100%**	

CONTRACTOR-RELATED QUESTIONS

Now I'd like to ask you some questions regarding your work with contractors.

CR1 Generally speaking, what percent of your sales to contractors would you characterize as follows? Again, approximations are fine.

a. Straight price bid on a detailed specification .... ___
b. Proposal in response to a functional type specification (general use) .... ___
c. Work with the contractor to develop lighting layouts and equipment schedules .... ___
d. Work with the project engineer or architect to develop lighting layouts .... ___
e. Other approach (Specify) ________________ .... ___
[Don't Know] 98
[Refused] 99

CR2 In those contractor sales situations where you have the opportunity, how often do you recommend the energy efficient types of equipment for high bay applications? Would you say it is …?

A. Always .... ____
B. Most of the time .... ____
C. Sometimes .... ____
D. Rarely .... ____
E. Never .... ____
[Don't Know] 998
[Refused] 999

CR2a If respondent answers "Rarely" or "Never", ask WHY

IF CR2<> A, B, OR C, SKIP TO HFL1

CR3 Generally, have you found that contractors are aware of the full range of options for efficient high bay lighting available to them before specifying the lighting system?

Yes .... ___
No .... ___
[Don't Know] 998
[Refused] 999

CR4 Do contractors generally accept your recommendations for efficient high bay lighting for their lighting system?

Yes ....___
No...___
[Don't Know]..998
[Refused]..999

CR5 [FOR ALL CR4 <> YES] Why not?

____

____

____

FLUORESCENT LAMPS [ASK IF RESPONDENT REPORTS SELLING FLUORESCENTS IN HIGH BAY SALES.]

Now I would like to ask about your sales of fluorescent high-bay lighting applications.

HFL1 Over the last three years, have sales of high bay fluorescent lighting, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same3
Not applicable to business [SKIP TO HID1] 4
[Don't Know] 998

[ASK IF HFL1 = 1 OR 2; ELSE SKIP TO HFL4]

HFL2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____

____

____

HFL3 Do you expect this (these) trend(s) to continue? Why or why not?

____

____

____

HFL4 What kinds of feedback have you received from contractors about fluorescent high bay lighting in terms of:

Customer response to the product: __________________________

____

Ease of installation: ______________________________________

____

Commercial advantages/disadvantages v. other products: ___________

____

PULSE START METAL HALIDES [ASK IF RESPONDENT REPORTS SELLING PULSE START METAL HALIDES.]

HID1 Over the past three years, have sales of pulse start metal halides, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same 3
Not applicable to business [SKIP TO HPS1] 4
[Don't Know] 998

[ASK IF HID1 = 1 OR 2; ELSE SKIP TO HID4]

HID2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____

____

____

HID3 Do you expect this (these) trend(s) to continue? Why or why not?

____

____

____

HID4 What kinds of feedback have you received from contractors about pulse-start HID lighting for indoor application in terms of:

Customer response to the product: ______________________________

____

Ease of installation: ____

____

Commercial advantages/disadvantages v. other products: ____________

____

HIGH PRESSURE SODIUM [ASK IF RESPONDENT REPORTS SELLING HIGH PRESSURE SODIUM EQUIPMENT.]

HPS1 Over the past three years, have sales of high pressure sodium lamps, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same3
Not applicable to business [SKIP TO GT1] 4
[Don't Know] 998

[ASK IF HPS = 1 OR 2; ELSE SKIP TO HPS4]

HPS2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____

____

____

HPS3 Do you expect this (these) trend(s) to continue? Why or why not?

____

____

____

HPS4 What kinds of feedback have you received from contractors about high pressure sodium lighting for indoor application in terms of:

Customer response to the product: ________________________________

____

Ease of installation: ____

____

Commercial advantages/disadvantages v. other products: _____________

____

General Market Trends

GT1 About what percentage of your revenues from the sales of commercial/industrial lighting equipment comes from new construction projects, as opposed to replacements and retrofits? [PROBE FOR APPROXIMATE]

ENTER PERCENT NEW CONSTRUCTION .... ____
[Don't Know] 998
[Refused] 999

GT2 To what extent are the trends we've been discussing for the sales of energy-efficient high bay lighting equipment different between new construction and replacements/retrofits?

[PROBE, IF NECESSARY.]

____

____

____

GT2b In what ways are they different? [AND ASK WHY THEY THINK THAT IS]

____

____

____

GT3 Thinking about the overall market, what do you think could be done to increase the installation of energy-efficient high-bay lighting in the commercial and industrial customer sectors?

____

____

____

Marketing Support

MS1 Do you receive marketing support from for energy efficient high bay lighting technologies?

Yes 1
No... 2
Don't know 3

[ASK IF MS1 = 1; ELSE SKIP TO MS8]

MS2 From whom did you receive such marketing support? [DO NOT READ]

1. Manufacturer [SPECIFY]____ 1

____

2. Utility [SPECIFY] ____ 3

____

3. Municipality/Gov't____ 4

____

4. Other [SPECIFY] ____ 5

____

MS3 What kind of marketing support did you receive? [ANSWER FOR ALL POSITVE RESPONSES ABOVE]

____

____

____

MS4 Which technologies are supported?

____

____

____

MS5 Why do you think the sponsor is supporting that particular lighting technology? [ANSWER FOR EACH TECHNOLOGY/SPONSOR COMBINATION SUPPORTED]

MS6 Do you think the marketing support helped you to sell more energy efficient high bay lamps?

Yes 1

No... 2

Don't know 3

MS7 Would you market energy efficient high bay lighting technologies without this support?

Yes 1

No... 2

Don't know 3

[ASK IF MS7 = 1; ELSE SKIP TO PP1]

MS8 What do you do to market high bay lighting technologies? [Probe partnerships with utilities, distributors, manufacturers, etc.]

Program Participation [ask for California firms; else terminate]

[ASK PP1 THROUGH PP3 IF NOT ALREADY ANSWERED]

PP1 Are you aware of any utility incentive programs for businesses to install high bay lighting?

Yes 1

No... 2

Don't know 3

IF PP1 = 1, ASK PP2. ELSE SKIP TO GT1

PP2 Have you supplied equipment to projects that have received incentives from an electric utility [NOT SMUD]?

Yes 1

No... 2

Don't know 3

IF PP2 = 1, ASK PP3; ELSE SKIP TO PP7

PP3 Who was the program's sponsor? If you don't know specifically, please describe it, and what incentives you received and why you received them?

____

____

____

PP4. [THIS NUMBER INTENTIONALLY SKIPPED]

PP5 On a scale of 1 to 10, where 1 is not at all important and 10 is very important, how important was the IOU [not SMUD] program in your firm's decision to increase promotion of energy-efficient lighting equipment?

ENTER 1 – 10, 98 FOR DK, 99 FOR REFUSED .... _____

PP6 Finally, on a scale of 1 to 10, where 1 is no influence and 10 is a great deal of influence, how much influence do you think IOU programs have had on the market share of energy-efficient lighting technologies in your market area?

ENTER 1 – 10, 98 FOR DK, 99 FOR REFUSED _____

PP7 Have you participated in other programs that promote energy efficient technologies for businesses?

Yes 1

No... 2

Don't know 3

PP8 Which ones? If you don't know specifically, please describe it, the sponsor, and what incentives you received and why you received them?

____

____

____

THANK YOU FOR YOUR TIME AND COOPERATION.

CPUC HI BAY LIGHTING MARKET EFFECTS STUDY

MANUFACTURER QUESTIONNAIRE (FINAL)

FEBRUARY 2, 2009

LEAD-IN: Hello, my name is __________________ and I am calling on behalf of the California Public Utilities Commission. We are conducting a study of current market conditions in the commercial and industrial lighting market. We are interviewing a sample of manufacturers to better understand these conditions. The information will be used to help evaluate the effects of utility-sponsored lighting programs. The interview itself will only take about 10 – 15 minutes. All information you provide will be confidential. All responses you provide will only be furnished to the sponsors after they have been aggregated with those of other manufacturers. The results of the study will be made available to all manufacturers who provide information.

[IF RESPONDENT AGRESS TO INTERVIEW]

T1. Our primary interest in speaking with you today is to learn more about the market for high bay lighting technologies for commercial and industrial lighting applications. For the purposes of this interview we define high bay applications as installations in commercial and industrial spaces with ceiling heights of about 15 feet or more. As a starting point, could you please confirm which of the following lamping technologies your company manufactures for high bay lighting applications?

Hi Bay Technology	Manufactures? [Circle Yes/No]	High-efficiency? [Circle Yes/No]
High Intensity Discharge: metal halide	Yes / No	Yes / No
High Intensity Discharge: pulse start metal halide	Yes / No	Yes / No
High Intensity Discharge: pressurized sodium	Yes / No	Yes / No
High Intensity Discharge: high pressure sodium	Yes / No	Yes / No
High Intensity Discharge: mercury vapor	Yes / No	Yes / No
Fluorescent Tubes: T12/Magnetic Ballast	Yes / No	Yes / No
Fluorescent Tubes: T-8 Electronic ballast	Yes / No	Yes / No
Fluorescent Tubes: T-5 Electronic ballast	Yes / No	Yes / No
[OTHER] ____________________		Yes / No
[OTHER] ____________________		Yes / No
[OTHER] ____________________		Yes / No
[OTHER] ____________________		Yes / No

T2. Are there any other lamping technologies that you manufacture for high bay applications that I didn't mention?

____
____
____

T3. Of the technologies you mention above, which do you consider to be "high-efficiency?" [ANSWER IN GRID]

T4. What criteria are you applying to the technologies you mentioned to designate them as energy efficient? [ASK FOR EACH TECHNOLOGY SPECIFIED AS HIGH EFFICIENCY]

____
____
____

T5. What percent of the equipment types discussed above do you sell through the following channels? [ENTER PERCENT]

a. OEMs ....____%

b. Distributors ....____%

c. Direct to contractors and lighting maintenance companies ....____%

d. Direct to customers ....____%

e. Any Other ....____%

Hi Bay Technology	OEMs	Distributors	Direct to Contractors	Direct to Large Customers
High Intensity Discharge: metal halide				
High Intensity Discharge: pulse start metal halide				
High Intensity Discharge: low pressurized sodium				
High Intensity Discharge: high pressure sodium				
High Intensity Discharge: mercury vapor				
Fluorescent Tubes: T12/Magnetic Ballast				
Fluorescent Tubes: T-8 Electronic ballast				
Fluorescent Tubes: T-5 Electronic ballast				
[OTHER] ___________________				

[OTHER] ___________________

[OTHER]___________________

[OTHER] ___________________

ASK IF SALES TO OEMs ARE GREATER THAN ZERO

T6. Can you mention any of the OEMs you sell this equipment to? [ASK FOR CONTACT INFORMATION]

____

____

____

HIGH BAY LIGHTING PENETRATION DATA.

S1. Which areas of the country—either in terms of regions or states—are selling the most energy-efficient high bay lighting equipment? [DO NOT READ; MARK ANY THAT APPLY]:

Pacific Northwest.. 1

California 2

New York... 3

New England.. 4

New Jersey 5

Wisconsin... 6

Other…. 7

.____

____

____

S2. In your opinion, how do you rate market share of energy-efficient high bay lighting in California compared to other states? Is it…

Less most other states
About the same as other states
Above levels in other states
[Don't know]
[Refused]

S3. Which high bay lighting technologies are responsible for most of your high bay lighting sales to California? Why do you think that is?

____

____

____

S4. In your opinion, what is the main factor that contributes to the difference between different regions in the share of energy-efficient high bay lighting technologies? PROBE REBATE PROGRAMS, DIFFERENCES IN INDUSTRIAL ECONOMIC BASE.

S5. What are some of the other factors?

a. Main factor: ____

b. Other Factors: ____

____

____

MANUFACTURER PROMOTION, BARRIERS, MOTIVATION

M1.How does promotion of energy-efficient high bay lighting technologies support your company's overall competitive strategy? PROBE GENERAL POSITIONING IN THE MARKET, APPEAL TO CERTAIN KINDS DISTRIBUTORS OR CUSTOMERS, UNIT MARGIN TARGETS, ETC.

____

____

HIGH BAY FLUORESCENTS [ASK IF RESPONDENT REPORTS SELLING HIGH BAY FLUORESCENTS; OTHERWISE SKIP TO HID SERIES.]

Now I would like to ask about your sales of fluorescent high-bay lighting applications.

HFL1 Since 2006, have sales of high bay fluorescent lighting, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same3
Not applicable to business..4
[Don't Know] 998

[ASK IF HFL1 <> 3; ELSE SKIP TO HID1]

HFL2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____

____

____

HFL3 Do you expect this (these) trend(s) to continue? Why or why not?

____

____

____

PULSE START METAL HALIDES [ASK IF RESPONDENT REPORTS SELLING PULSE START METAL HALIDES; OTHERWISE SKIP TO HPS SERIES.]

HID1 Since 2006, have sales of pulse start metal halides, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same3
Not applicable to business..4
[Don't Know] 998

[ASK IF HID1 <> 3; ELSE SKIP TO HPS1]

HID2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____

____

____

HID3 Do you expect this (these) trend(s) to continue? Why or why not?

____

____

____

HIGH PRESSURE SODIUM [ASK IF RESPONDENT REPORTS SELLING HIGH PRESSURE SODIUM EQUIPMENT; OTHERWISE SKIP TO V SERIES.]

HPS1 Since 2006, have sales of high pressure sodium lamps, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same 3
Not applicable to business 4
[Don't Know] 998

[ASK IF HPS1 <> 3; ELSE SKIP TO LED1]

HPS2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

HPS3 Do you expect this (these) trend(s) to continue? Why or why not?

LED [ASK IF RESPONDENT REPORTS SELLING HIGH BAY LED EQUIPMENT; OTHERWISE SKIP TO V SERIES.]

LED1 Since 2006, have sales of high bay LED lamps, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same3
Not applicable to business 4
[Don't Know] 998

[ASK IF LED1 <> 3; ELSE SKIP TO V0]

LED2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____

____

____

LED3 Do you expect this (these) trend(s) to continue? Why or why not?

____

____

____

VENDOR QUESTIONS

V.0. Please describe any leading strategies you are using for targeting customers?

____

____

____

V.1 How do you promote energy-efficient high bay lighting technologies to distributors? CIRCLE ALL MENTIONED.

- Don’t really promote premiums to vendors 1
- Cooperative advertising 2
- Brochures and other collateral sales materials 3
- Energy savings calculation tools 4
- Discounting and other pricing mechanisms 5
- Web site, e-mail 6
- Other 1(Specify: ______________________________________).......... 7
- Other 2(Specify: ______________________________________).......... 8

IF V.1 =1, SKIP TO V.2. ELSE ASK V.1.a

V.1.a Have your efforts to promote energy-efficient high bay lighting technologies to distributors increased, decreased, or stayed about the same over the past year?

Increased 1

Decreased.. 2

Stayed about the same.. 3

Don't know 4

V.2 What kinds of objections to stocking and promoting energy-efficient high bay lighting do you hear most frequently from distributors?

Costs too much to hold in inventory 1

No demand from customers 2

Not as reliable as standard efficiency 3

Economics don't work for customers 4

Other 1(Specify: _______________________________________).......... 6

Other 2(Specify: _______________________________________).......... 7

V.3 Has the percentage of distributors voicing these kinds of objections increased, decreased, or stayed about the same over the past year?

Increased 1

Decreased.. 2

Stayed about the same.. 3

Don't know 4

V.4 What benefits do distributes see in stocking and promoting energy-efficient high bay lighting technologies?

Offer value-added services to customers 1

Retain customer loyalties.. 2

Access to utility program incentives.. 3

Increased margin per unit.. 4

Generally better performance and materials → customer satisfaction 5

Other 1(Specify: _______________________________________).......... 6

Other 2(Specify: _______________________________________).......... 7

V.5 Has the percentage of distributors identifying these kinds of benefits increased, decreased, or stayed about the same over the past year?

Increased 1

Decreased 2

Stayed about the same 3

Don't know 4

V.6 What kinds of distributors have purchased relatively high numbers or shares of energy-efficient high bay lighting technologies?

____

____

V.7 Are distributors in California more or less active in promoting and selling energy-efficient high bay lighting technologies than those in other parts of the country?

Yes 1

No 2

V.7.a. IF V.7 = YES, PROBE WHAT EVIDENCE THEY HAVE.

____

____

CUSTOMER QUESTIONS

C.0 Please describe any leading strategies you are using for targeting customers?

____

____

____

C.1 How do you promote energy-efficient high bay lighting to customers? CIRCLE ALL MENTIONED.

Don't really promote this equipment to customers 1

Advertising in industry and trade press 2

Trade shows 3

Energy savings calculation tools 4

Discounting and other pricing mechanisms 5

Web site, e-mail 6

Other 1(Specify: ____)........... 7

Other 2(Specify: ____)........... 8

IF C.1 =1, SKIP TO C.2. ELSE ASK C.1.a

C.1.a Have your efforts to promote energy-efficient high bay lighting to customers increased, decreased, or stayed about the same over the past year?

Increased 1

Decreased.. 2

Stayed about the same.. 3

Don’t know 4

C2 Have you gotten any feedback from customers – either those you sell to directly or via distributors – in terms of their response to your energy-efficient high-bay lighting products?

Yes ....ASK C2a

No .... SKIP TO C6

C.2a What kinds of objections to purchasing energy efficient high bay lighting do you hear most frequently from customers?

Cost too much 1

Economics are not sufficiently advantageous.. 2

Not as reliable as standard efficiency 3

Not aware of premium efficiency 4

Other 1(Specify: ____)........... 6

Other 2(Specify: ____)........... 7

C.3 Has the percentage of customers voicing these kinds of objections increased, decreased, or stayed about the same over the past year?

Increased 1

Decreased... 2

Stayed about the same... 3

Don’t know 4

C.4 What benefits do customers see in purchasing energy efficient high bay lighting?

- Lower energy costs 1
- Better materials, longer life.. 2
- Access to utility program incentives.................................. 3
- Other 1(Specify: ________________________________)........... 6
- Other 2(Specify: ________________________________)........... 7

C.5 Has the percentage of customers identifying these kinds of benefits increased, decreased, or stayed about the same over the past year?

- Increased 1
- Decreased.. 2
- Stayed about the same.. 3
- Don't know 4

C.6 What kinds of customers have purchased relatively high numbers or shares of energy-efficient high bay lighting technologies?

____

____

C.7 Do you supply high bay lighting equipment directly to any customers in California

- Yes 1
- No 2
- Don't know 3

IF C.7 = NO OR DK, SKIP TO P.1

C.8 Do you have any supply contracts with end-use customers under which you furnish all or most of their lighting needs to one or more facilities?

- Yes 1
- No 2

IF C.8 = 1, ASK C.9. ELSE SKIP TO P.1.

C.9 Do these contracts generally contain specifications for energy-efficient high bay lighting?

Yes 1

No 2

C.9a [IF C=1] What specifications are those? (Probe technologies and efficiency levels)

____

EFFICIENCY PROGRAMS

P.1 Are you familiar with utility-sponsored programs to promote the sale of energy-efficient high-bay lighting technologies in the following regions? (CIRCLE ALL YES'S.)

Pacific Northwest.. 1

California (IOU) 2

California (non IOU) 3

New York.. 4

New England.. 5

New Jersey 6

Wisconsin.. 7

Other … 8

P1a. [ASK IF P1 = 2] Which utilities in California? [PROBE IOUS; SMUD]

____

____

P.2 Which of these programs have been most effective, in your opinion? (CIRCLE ALL MENTIONED.)

Pacific Northwest.. 1

California (IOU) 2

California (non IOU) 3

New York.. 4

New England.. 5

New Jersey 6

Wisconsin... 7

Other … 8

P.2.a. PROBE REASONS FOR CHOICES, ESPECIALLY CA IOU PROGRAMS; NOT SMUD

____

____

P.3 Generally, do you believe it is more effective to provide financial incentives to customers for the purchase of energy-efficient high-bay lighting technologies, or to the vendor for selling them?

To customer 1

To vendor 2

Neither is effective 3

Both can be effective 4

It depends 5

P.3.a PROBE REASONS FOR ANSWER.

____

____

P.3.b What other elements of these programs have been effective in promoting energy-efficient high bay lighting technologies?

____

____

P.3.c What changes would you make to utility-sponsored programs to make them more effective?

____

____

THANK YOU FOR YOUR TIME AND COOPERATION.

HBL MARKET EFFECTS STUDY: LIGHTING CONTRACTOR

FINAL INTERVIEW GUIDE

FEBRUARY 2, 2009

Intro

Hi my name is Lee Maes. I'm calling on behalf of the California Public Utilities Commission. We are conducting research on the commercial/industrial lighting market in California. [OR SUBSTITUTE OTHER STATE].

May I please speak to the manager or person at your firm most familiar with your sales and installation of commercial lighting products?

ENTER NAME OF CONTACT: ________________________________

IF CONTACT IS NOT AVAILABLE, ASCERTAIN BEST TIME TO CALL.

Lead in for respondent.

Hello, this is _________ calling on behalf of the California Public Utilities Commission. We are conducting research on the commercial/industrial lighting market in California [OR SUBSTITUTE OTHER STATE]. All information we gather will be confidential and will not be linked in any way to you or your company. These questions will take about 15 minutes.

Screening & Firmographics

SC1 First, what is your job title?

- Sales Manager 1
- President/CEO 2
- General Manager 3
- Other (Specify)____________________ 4
- [Don't Know] 98
- [Refused] 99

SC2 Which of the following activities does your company pursue at this location? [*Read list and accept multiple responses*]

SC2a **IF MORE THAN ONE ACTIVITY NAMED ASK:** What percent of your total revenues do you derive from [ACTIVITY]?

	SC2	**SC2a**
Lighting sales to end users	1	%
Lighting installations	2	%
Lighting sales to contractors	3	%
Contracted maintenance services for lighting	4	%
[Don't Know]	98	98
[Refused]	99	99

CONTINUE ONLY IF SC2 = 2; ELSE TERMINATE

SC3 Approximately how many full-time-equivalent (FTE) staff do you have at this location? [PROBE FOR APPROXIMATE]

ENTER NUMBER..____
[Don't Know]..998
[Refused]..999

SC4 How many locations does your firm have in California [OR SUBSTITUTE OTHER STATE]? [PROBE FOR APPROXIMATE]

ENTER NUMBER..____
[Don't Know]..998
[Refused]..999

SC5 Which of the following best characterizes your company's revenue at that location from lighting installations in 2008? [*Read list*]

Less than $1 million..1
$1 million to less than $2 million...2
$2 million to less than $5 million...3
$5 million to less than $10 million...4
$10 million or more...5
[Don't Know]..98
[Refused]..99

SC6 Approximately what percentage of your revenue in the past 12 months was from the installation of lighting equipment in California's [OR SUBSTITUTE OTHER STATE] commercial and industrial sector? [PROBE FOR APPROXIMATE]

ENTER PERCENT...____
[Don't Know]..998
[Refused]..999

If responded "Don't Know" find another respondent at this facility. [OK TO ACCEPT A "ROUGH ESTIMATE"]

Determine whether amount is sufficient to continue (based on size of business and percent of installations that are C/I lighting in California).

Lighting Equipment Installations

Now I am going to ask you about your installations of commercial and industrial lighting equipment for high bay applications. We define high bay applications as installations in commercial and industrial spaces with ceiling heights of about 15 feet or more.

Please answer the following questions for your installations directly to commercial and industrial end users in California [OR OTHER SUBSTITUTE OTHER STATE].

Determining knowledge/awareness of High Bay Lighting.

LS1 First, what percentage of your projects involve high bay applications? Your best approximation is fine.

ENTER PERCENT .... ____
[Don't Know] 998
[Refused] 999

LS2 Overall, what percentage of the fixtures you installed in commercial and industrial projects last year went into high bay applications? An approximation is fine.

ENTER PERCENT .... ____
[Don't Know] 998
[Refused] 999

IF RESPONDENT CAN'T ANSWER IN TERMS OF PERCENT OF FIXTURES, PROBE PERCENT OF SQUARE FEET COVERED OR PERCENT OF TOTAL REVENUES FROM COMMERCIAL AND INDUSTRIAL PROJECTS.

LS3a What types of lighting equipment have you installed in high bay applications over the past year? DO NOT PROMPT. CHECK ALL MENTIONED.

LS3b FOR EACH TYPE OF EQUIPMENT MENTIONED: What percentage of the fixtures installed were accounted for by [EQUIPMENT TYPE]?

LS3c Which of these types of equipment do you consider to be energy-efficient?

	LS3a	**LS3b**	**LS3c**
High Intensity Discharge: metal halide		%	
High Intensity Discharge: pulse start metal halide		%	
High Intensity Discharge: low pressurized sodium		%	
High Intensity Discharge: high pressure sodium		%	
High Intensity Discharge: mercury vapor		%	
Fluorescent Tubes: T12/Magnetic Ballast		%	

Fluorescent Tubes: T-8/Electronic ballast	%
Fluorescent Tubes: T-5/Electronic ballast	%
Compact Fluorescent	%
Incandescent	%
LED Technologies	%
Other (Specify) ______________________________	%
TOTAL	**100%**

LS4 How often do you recommend the energy efficient types of equipment for high bay applications? Would you say it is …?

A. Always...____
B. Most of the time...____
C. Sometimes ....____
D. Rarely ....____
E. Never ....____
[Don't Know]..998
[Refused]...999

LS4a If respondent answers "**Rarel**y" or "**Never**", ask why

IF LS4 <> A, B, OR C, SKIP TO LS8

IF LS4 <> A, B, OR C, SKIP TO LS8

LS5 Generally, have you found that customers are aware of the full range of options for efficient high bay lighting available to them before specifying the lighting system?

Yes ....___
No...___
[Don't Know]..998
[Refused]...999

LS6 Do customers generally accept your recommendations for efficient high bay lighting for their lighting system?

Yes ....___
No...___
[Don't Know]..998
[Refused]...999

LS7 [FOR ALL LS6 <> YES] Why not?

____

____

____

LS8 In what percentage of commercial and industrial lighting projects in the past 12 months where either HID or high bay fluorescents were options did each of the following occur [READ THE 4 OPTIONS] [PROBE FOR APPROXIMATE; TOTAL SHOULD ADD TO 100%; PROBE ANY DISAGREEMENT BETWEEN C AND LS4]

A. Customer requested energy-efficient HID or high bay fluorescents on their own…..____%
B. You recommended energy-efficient HID or high bay fluorescents, customer agreed____%
C. You recommended energy-efficient HID or high bay fluorescents, customer declined . ____%
D. Energy-efficient HID or High bay fluorescents were not discussed…........…____%
[Don't Know]..998
[Refused]..999

FLUORESCENT LAMPS [ASK IF RESPONDENT REPORTS INSTALLING FLUORESCENTS IN HIGH BAY INSTALLATIONS.]

Now I would like to ask about your installations of fluorescent high-bay lighting applications.

HFL1 Over the last three years, have sales of high bay fluorescent lighting, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same3
Not applicable to business..4
[Don't Know]..998

[ASK IF HFL1 <> 3; ELSE SKIP TO HFL3]

HFL2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____

____

____

HFL3 Do you expect this (these) trend(s) to continue? Why or why not?

____

____

____

HFL4 In your experience what benefits do customers perceive in installing fluorescent high bay lighting technologies compared to standard lighting technologies? (Probe: O&M savings, better controls, life-cycle cost savings, improved lighting for retrofits, anything else?)

____

____

____

HFL5 What objections do customers have to installing fluorescent equipment in high bay applications? (Probe: initial costs, lighting quality, supply issues, appearance, lack of information, additional electrical work, anything else?)

____

____

____

HFL6 What business advantages do you perceive in promoting fluorescent technology in high bay applications? What disadvantages?

____

____

____

PULSE START METAL HALIDES [ASK IF RESPONDENT REPORTS INSTALLING PULSE START METAL HALIDES.]

HID1 Over the past three years, have sales of pulse start metal halides, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same 3
Not applicable to business 4
[Don't Know] 998

[ASK IF HID1 <> 3; ELSE SKIP TO HID3]

HID2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____
____
____

HID3 Do you expect this (these) trend(s) to continue? Why or why not?

____
____
____

HID4 In your experience what benefits do customers perceive in installing pulse start halide units compared to standard lighting technologies? (Probe: O&M savings, better controls, life-cycle cost savings, improved lighting for retrofits, anything else?)

____
____
____

HID5 What objections do customers have to installing pulse start units in high bay applications? (Probe: initial costs, lighting quality, supply issues, appearance, lack of information, additional electrical work, anything else?)

____
____
____

HID6 What business advantages do you perceive in promoting pulse start HIDs in high bay applications? What disadvantages?

____

____

____

HIGH PRESSURE SODIUM [ASK IF RESPONDENT REPORTS INSTALLING HIGH PRESSURE SODIUM EQUIPMENT.]

HPS1 Over the past three years, have sales of high pressure sodium lamps, relative to sales of other lighting technologies, for commercial/industrial applications increased, decreased, or stayed about the same?

Increased 1
Decreased 2
Stayed about the same3
Not applicable to business... 4
[Don't Know].. 998

[**ASK IF HID6 <> 3; ELSE SKIP TO HPS3**]

HPS2 What do you think has caused this change? (Probe if necessary: changes in awareness, energy/money concerns, rebates from IOUs, environmental concern, change in costs, changes in technologies, other)

____

____

____

HPS3 Do you expect this (these) trend(s) to continue? Why or why not?

____

____

____

HPS4 What benefits do customers perceive in installing high pressure sodium high bay lighting technologies compared to standard lighting technologies? (Probe: O&M savings, better controls, life-cycle cost savings, improved lighting for retrofits, anything else?)

____

____

____

HPS5 What objections do customers have installing high pressure sodium high bay lighting in high bay applications? (Probe: initial costs, lighting quality, supply issues, appearance, lack of information, additional electrical work, anything else?)

____

____

____

HPS6 What business advantages do you perceive in promoting high pressure sodium in high bay applications? What disadvantages?

____

____

____

Marketing Support

MS1 Do you receive marketing support from for energy-efficient high bay lighting technologies?

Yes 1
No.. 2
Don't know 3

ASK IF MS1 = 1; ELSE SKIP TO MS8

MS2 From whom did you receive such marketing support? [DO NOT READ]

1. Manufacturer [SPECIFY]____ 1
____

2. Distributor [SPECIFY]____ 2
____

3. Utility [SPECIFY] ____ 3
____

4. Municipality/Gov't____ 4
____

5. Other [SPECIFY] ____ 5
____

MS3 What kind of marketing support did you receive? [ANSWER FOR ALL POSITVE RESPONSES ABOVE]

____
____
____

MS4 Which technologies are supported? (e.g., Fluorescent, PSMH, Hi Pressure Sodium)

____
____
____

MS5 Why do you think the sponsor is supporting that particular lighting technology? [ANSWER FOR EACH TECHNOLOGY/SPONSOR COMBINATION SUPPORTED]

____

____

____

MS6 Do you think the marketing support helped you to install more efficient high bay equipment?

Yes 1

No... 2

Don't know 3

MS7 Would you market energy-efficient high bay lighting technologies without this support?

Yes 1

No... 2

Don't know 3

ASK IF MS7 = 1; ELSE SKIP TO PP1

MS8 What do you do to market energy-efficient high bay lighting technologies? [Probe partnerships with utilities, distributors, manufacturers, etc.]

____

____

____

Program Participation [ask for california firms; else skip to 6]

[ASK PP1 THROUGH PP3 IF NOT ALREADY ANSWERED]

PP1 Are you aware of any utility incentive programs for businesses to install energy-efficient high bay lighting?

Yes 1

No... 2

Don't know 3

ASK IF PP1 = 1; ELSE SKIP TO GT1

PP2 Have you participated in projects that have received incentives from an electric utility?

Yes 1

No... 2

Don't know 3

IF PP2 = 1, ASK PP3; ELSE SKIP TO PP7

PP3 Who was the program's sponsor? If you don't know specifically, please describe it, and what incentives you received and why you received them?

____

____

____

PP4 Roughly how many projects that received support from IOU programs [NOT SMUD] did you participate in during the last three years?

ENTER NUMBER OF PROJECTS, CODE 998 FOR DK, 999 FOR REF ____

PP5 On a scale of 1 to 10, where 1 is not at all important and 10 is very important, how important was the IOU program in your firm's decision to increase promotion of energy-efficient lighting equipment?

ENTER 1 – 10, 98 FOR DK, 99 FOR REFUSED .... _____

PP6 Finally, on a scale of 1 to 10, where 1 is no influence and 10 is a great deal of influence, how much influence do you think IOU programs have had on the market share of energy-efficient lighting technologies in your market area?

ENTER 1 – 10, 98 FOR DK, 99 FOR REFUSED _____

General Market Trends

GT1 About what percentage of your revenues from the installation of commercial/industrial lighting equipment in the past 12 months was from new construction projects, as opposed to replacements and retrofits? [PROBE FOR APPROXIMATE]

ENTER PERCENT NEW CONSTRUCTION ....____

[Don't Know]..998

[Refused]...999

GT2 To what extent are the trends we've been discussing for the installation of high bay lighting equipment same between new construction and replacements/retrofits?

[PROBE, IF NECESSARY.]

GT2b In what ways are they different? [AND ASK WHY THEY THINK THAT IS]

GT3 Finally, thinking about the overall market, what do you think could be done to increase the installation of high-bay lighting in the commercial and industrial customer sectors?

THANK YOU FOR YOUR TIME AND COOPERATION.

INTERVIEW GUIDE –

PROGRAM DELIVERY CONTRACTORS

OBTAIN AND REVIEW PROGRAM DESCRIPTIONS, PROGRAM PLANS, PROGRAM LOGIC MODELS, AND APPLICATION MATERIALS PRIOR TO THE INTERVIEW. ANSWER AS MANY OF THE QUESTIONS BELOW USING THOSE MATERIALS. ONLY REVIEW THOSE QUESTIONS WITH THE RESPONDENT IF THE DOCUMENTS DO NOT PROVIDE CLEAR ANSWERS.

Personnel Roles and Responsibilities

1. Which energy efficiency programs are you working on?
2. What are your responsibilities regarding those Programs? What role do you play, if any, in:
    a. Planning, designing, managing, and administering the Program,
    b. Marketing the Program to customers,
    c. Marketing the Program to distributors and installation contractors,
    d. Managing distributor and installation contractor participation in the Program.
    e. Administering the delivery of financial incentives to customers
    f. Administering the delivery of technical services to customers
    g. Other aspects of the Program?

General Program Objectives and Operations

3. **First, could you please describe for me what your understanding of high-bay lighting technologies is?**
4. **NOTE: THIS ITEM FOCUSES DOWN SPECIFICALLY ON HIGH-BAY LIGHTING. ASK THIS ITEM EVEN IF WE HAVE INFORMATION FROM THE PROGRAM DESCRIPTION AND APPLICATION FORMS.**

For the purposes of this interview we define high bay applications as installations in commercial and industrial spaces with ceiling heights of about 15 feet or more. What kinds of incentives and assistance are provided to support customers' decisions to purchase and install efficient fluorescent high-bay lighting?

PROBE:

a. Financial incentives/rebates for purchase/installation of qualifying equipment
b. Technical assistance in identifying energy-saving opportunities
c. Technical assistance in specifying and purchasing energy efficient equipment

    d. Technical assistance in design of installations
    e. Customer education materials
    f. Training oriented to facility managers or purchasers

5. **NOTE: THIS ITEM FOCUSES DOWN SPECIFICALLY ON HIGH-BAY LIGHTING. ASK THIS ITEM EVEN IF WE HAVE INFORMATION FROM THE PROGRAM DESCRIPTION AND APPLICATION FORMS.** What kinds of incentives and assistance are provided to support distributor and contractor efforts to promote and install efficient fluorescent high-bay lighting?
   PROBE:
    a. Financial incentives/rebates for purchase/installation of qualifying equipment
    b. Technical assistance in identifying energy-saving opportunities
    c. Technical assistance in specifying and purchasing energy efficient equipment
    d. Technical assistance in design of installations
    e. Vendor education materials
    f. Training oriented to designers, specifiers, installers?

Program Logic

We are interested in your understanding of the goals of the program and the ways in which the program design and operating procedures support those goals.

6. As you understand them, do the goals of the program include the stimulation of long-term changes in …
    a. The way distributors promote and sell energy-efficient lighting products?
    b. The way that contractors promote, design, and install energy-efficient lighting products?
    c. Customers' awareness of efficient lighting products?
    d. Customers' understanding of the energy savings and other benefits associated with efficient lighting products?
    e. Customers' lighting equipment purchasing practices in the absence of financial incentives?
7. Has a formal logic model been developed for this program?

IF YES: REQUEST A COPY AND ASK ITEM 7.

IF NO: SKIP TO ITEM 9.

8. Which sets of market actors does the program logic model identify as important influences in selection of lighting equipment for retrofit, replacement, or new

installations?
PROBE:

- **a.** Customers
- **b.** Manufacturers
- **c.** Distributors
- **d.** Installation Contractors
- **e.** Lighting Designers
- **f.** Architects

9. FOR EACH INFLUENTIAL GROUP NAMED ASK:

- **a.** What are the main motivations for this group to purchase/promote energy-efficient high bay lighting?
  PROBE
    - **i.** Energy cost savings
    - **ii.** Lower lifecycle costs
    - **iii.** Lower maintenance costs
    - **iv.** Reduced lumen degradation
    - **v.** Other
- **b.** What circumstances or conditions inhibit this group from purchasing/promoting energy-efficient high bay lighting?
  PROBE
    - **i.** Cost
    - **ii.** Lack of familiarity with the technology
    - **iii.** Perceptions of performance risk/durability
    - **iv.** Not satisfied with level/quality of light delivered
    - **v.** Physical challenges to installation in existing buildings
    - **vi.** Other

10. Based on your experience with the program and in the lighting market, which groups of market actors exercise the greatest influence on high-bay lighting equipment selection.
PROBE:

- **a.** Customers
- **b.** Manufacturers
- **c.** Distributors
- **d.** Installation Contractors
- **e.** Lighting Designers
- **f.** Architects

Experience with the Program

11. How well do you think the program is doing at addressing customer motivations and inhibitions for purchasing efficient fluorescent high-bay lighting?
PROBE: Why do you say that?

12. Have you noticed any changes in customers' level of awareness of efficient fluorescent high-bay lighting over the past two years?
PROBE: What kinds of changes have you noticed?

13. Have you noticed any changes in customers' level of understanding of the benefits of efficient fluorescent high-bay lighting over the past two years?
PROBE: What kinds of changes have you noticed?

14. To your knowledge, has customer demand for efficient high-bay lighting increased over the past two years?

15. How well do you think the program is doing at addressing distributor and contractor motivations and inhibitions for purchasing efficient fluorescent high-bay lighting?
PROBE: Why do you say that?

16. Over the past two years, have you noticed any changes in distributor or contractor level of effort in promoting efficient fluorescent high-bay lighting?
PROBE: What kinds of changes have you noticed?

17. Over the past two years, have you noticed any changes in distributors' or contractors' effectiveness in selling efficient fluorescent high-bay lighting?
PROBE: What kinds of changes have you noticed?

18. To your knowledge, have sales of efficient high-bay lighting increased over the past two years?

19. Were you involved in efforts to promote efficient high bay lighting prior to the 2006 – 2008 round of IOU programs?

IF YES:

In what ways has distributor and contractor practices for promoting and delivering this technology changed since then?

In what ways has customer knowledge of and response to the technology changed since then?

20. Do you have any thoughts or suggestions about what the program the program could do to accelerate market acceptance of efficient high-bay lighting?

21. What sources of information do you use to learn about High Bay Lighting technologies?

- **a.** From within California?
- b. What about sources outside of California?

Thank you so much for your time

APPENDIX E: Contractor Survey Data and Survey Instrument

Overview

Key findings from the research conducted on the contractors include the following.

- Contractors in the comparison area receive training from manufacturers (64%) more frequently than in CA (26%), which is significant at the 90% confidence level. Only 7% of CA contractors report receiving training from the investor owned utilities (0% reporting for the comparison area). CA contractors receive training on high bay lighting technologies from closer networks including contracting organizations (36%) and trade associations (22%). Comparison area contractors also receive training from other sources for training (27%) with some frequency (27%) but contracting organizations and trade associations fairly infrequently (6% each).
- Contractor reported installations by technology vary between the regions in important ways.
    - Contractors in CA install one of the most efficient options, T-5 fluorescents, in much higher proportion (65% of all fixtures) than in the comparison area (29% of all fixtures). The difference is significant at the 95% confidence level.
    - While proportions are similar for another energy efficient option, T-8 fixtures, at 14% and 16% in CA and the comparison area, respectively, the proportion of installations of the relatively inefficient fluorescent option, T-12 fixtures, is significantly higher (at the 90% confidence level) in the comparison area (11%) than in CA (1%).
    - Contractors in the Southeastern States install pulse-start metal halide fixtures in 31% of installations compared to 14% in CA, significant at the 90% confidence level. This is in spite of the incentive offered for pulse-start metal halide technologies by the CA IOUs.
- Trends in lighting installation technologies vary between the regions:
    - Contractors in both CA and the comparison area report similar perceptions in the trend for fluorescent lighting in high bay applications, with approximately three quarters observing an increase in use, one quarter observing no change and a small percentage (1% to 2%) observing a decrease.
    - Contractors perceive decreasing usage in CA compared to increasing usage in the Southeastern States over the past three years. Over one third (35%) of contractors in the Southeast perceive an increase in pulse-start metal halide usage compared to 5% in CA (significant at the 95% confidence level). Three quarters (75%) of contractors in CA report a decrease in use of pulse-start metal halide fixtures compared to one quarter (26%) in the comparison area (significant at the 95% confidence level). The remainder (19% in CA and 39% in the Southeast region) reports no change over the past three years.
- The differences in perceptions of energy awareness are most striking for the high bay lighting technologies that are supported by the CA IOU programs, probably reflecting overall higher levels of awareness of energy efficiency among CA contractors versus the comparison area.
    - For the energy efficient fluorescent high bay lighting technologies (including induction technologies), contractors in CA more frequently consider those to be energy efficient than in the comparison area. For T-5 fluorescent tubes, 96% of CA contractors believe they are energy efficient compared to 62% in the four

selected Southeastern States (significant at the 95% confidence level). The difference is similar for T-8 technologies, with 88% of CA contractors considering them to be energy efficient compared to 44% of the comparison area contractors (significant at the 95% confidence level). A majority (52%) of CA contractors consider induction lighting technologies to be energy efficient whereas only 5% consider them efficient in the comparison area, possibly reflecting an overall lack of awareness of the technology itself (significant at the 90% confidence level).
    - Perceptions of energy efficiency are reversed, however, for the most prevalent high bay lighting technology, pulse-start metal halides which are also eligible for IOU incentives. Whereas 70% of contractors in the comparison area consider pulse-start metal halides to be energy efficient, only 21% of CA contractors consider them similarly (significantly different at the 90% confidence level), possibly reflecting substantial differences in market evolution between the regions, experience with and knowledge of the technologies, and standards for energy efficient lighting specification.
- For contractors, the tendency to recommend energy efficient types of high bay lighting equipment is higher in CA than in the comparison area. In CA, contractors "always" recommend energy efficient types of equipment 72% of the time, compared to 48% of the time in the Southeastern States.
- Most contractors receive marketing support from distributors (57%) and IOUs (54%). Manufactures (14%). Public/Municipal Utilities (12%) provide support but considerably less frequently. The state government is not mentioned at all.
- When asked about awareness of electric utility incentive programs for energy efficient high bay lighting, a majority (52%) of CA contractors are aware of incentive programs.
- Substantial proportions of contractors received rebate support from the IOUs either paid to them directly (79%) or paid to their customers (82%).
- Most contractors (60%) participated in 50 or fewer HBL projects during the last three years receiving support from the IOUs, and 21% of contractors did not participate in any receiving support.
- CA contractors rate the importance and influence of the IOU programs fairly highly:
    - Contractors rate the importance of IOU programs fairly highly in their firm's decisions to promote energy efficient high bay lighting, with 79% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 13% of contractors rated the importance between 5 and 7 (out of 10).
    - Contractors rate the influence of IOU programs fairly on market shares of energy efficient high bay lighting, with 73% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 21% of contractors rated the importance between 5 and 7 (out of 10).
- In terms of customer acceptance of their recommendations for energy efficient high bay lighting technologies, comparison area contractors are more likely to accept the recommendations than in CA. The contrast between the regions may be a relative comparison based on the heightened awareness of energy-efficient technologies in CA compared to the southeastern United States region (See Table 11). For example, CA contractors may be recommending higher efficiency solutions and more frequently encountering a higher first-cost barrier.

- For 51% of CA contractors, recommendations for energy efficiency high bay lighting are accepted at least "most of the time," compared to 75% of recommendations in the comparison area.
- Recommendations in CA are "rarely" accepted 41% of the time compared to 6% in the comparison area (significant at 95% confidence level).

Baseline Supply Chain Characterization

Annual revenue sources for contractors (Table 1) suggest more specialization toward lighting versus general electrical services in the CA market compared to contractors in the comparison area. For contractors in CA, the highest percentage (39%) of revenues is coming from lighting installations whereas in the comparison area, the highest percentage revenue source is from activities unrelated to lighting (32%). For the second highest revenue sources this is reversed with 26% from lighting installations in the comparison area and 18% of non-lighting related revenue in CA. Revenues from contracted lighting maintenance services are higher in CA, at 18% of revenues compared to 14% of revenues in the comparison area (significant at the 90% confidence level). Lighting sales directly to customers as a source of revenue is similar between the two regions (15% for CA compared to 13%). Lighting sales to other contractors and other lighting services account for relatively similar and small proportions of revenues in both regions.

Table 1

SC2B - Approximate Percentage of Annual Revenue Coming From the Following Activities (All Contractors)

Ratio Estimates	**CA**	**SC-GA-AL-MI**
n	**139**	**93**
Lighting Sales to Customers	13%	15%
Lighting Installations	39%	26%
Lighting Sales to Other Contractors	5%	5%
Contracted Maintenance Services for Lighting	18%	14%*
Other Lighting Services	6%	9%
Other Non-lighting revenue	18%	32%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

As a percentage of revenues from lighting installations, a solid majority (66%) of CA contractors' revenues is derived from installations in the C&I sector compared to 44% in the comparison area (Table 2).

Table 2
SC7 - Approximately what percentage of your revenue [from lighting installations][1] in the past 12 months was from the installation of lighting equipment in your state's commercial and industrial sector?

(All Contractors)

Ratio Estimates	CA	SC-GA-AL-MI
n	**140**	**91**
Percent of C&I revenue in last 12 months	66%	44%

In terms of recent annual lighting installation or replacement volume in the C&I sector, contractors in both regions performed similar numbers of C&I projects, with three quarters of respondents (75% in CA and 76% in the comparison area) performing between 0 and 25 projects annually in the C&I sector (Table 3).

Table 3
SC8 – And approximately how many projects involving installation or replacement of lighting fixtures did your company complete in your States's commercial and industrial sector over the past 12 months?

(All Contractors)

Unweighted frequencies	CA	SC-GA-AL-MI
n	**143**	**93**
0 to 25 Projects	76%	75%
25 to 50	13%	5%
50 to 100	5%	14%
100 to 500	5%	5%

[1] The previous question, SC6, established the value of revenue from lighting installations overall.

As shown in Table 4, the percentages of lighting installed in all C&I projects going into high bay applications in 2008 is similar between regions.

Table 4
LS1 - Approximately what percentage of the lighting installed in all commercial and industrial projects your firm completed in 2008 went into high bay applications?

(All Contractors)

Unweighted Frequencies	**CA**	**SC-GA-AL-MI**
n	**141**	**90**
Zero to Ten Percent	43%	40%
Eleven to Twenty-five Percent	22%	22%
Twenty-six to Fifty Percent	18%	18%
Greater Than Fifty Percent	17%	20%

Table 5 shows that majorities of contractors have never received training for installing high bay lighting technologies. The proportion of contractors in the comparison area not receiving training (54%), however, is considerably smaller (83%) than in CA (significant at the 95% confidence level). The proportion of contractors in the comparison area who report a higher percentage of training received (46%) is higher than in California at 17% (significant at the 95% confidence level).

Table 5
IT2 – Have you ever received training for installing high bay lighting technologies? (All Contractors)

Weighted Frequencies	**CA**	**SC-GA-AL-MI**
n	**143**	**93**
Yes	17%	46%**
No	83%	54%**
Do Not Know	<1%	<1%

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

Table 7 shows where contractors receive training on high bay lighting technologies. Contractors in the comparison area receive training from manufacturers (64%) more frequently than in CA (26%), which is significant at the 90% confidence level. Only 7% of CA contractors report receiving training from the investor owned utilities (0% reporting for the comparison area). CA contractors receive training on high bay lighting technologies from closer networks including contracting organizations (36%) and trade associations (22%). Comparison area contractors also receive training from contracting organizations and trade associations fairly infrequently (6% each). Other sources not listed are also frequently mentioned by contractors in both regions—the most frequent verbatim response is "on the job training."

Table 7
IT3 – From which of the following groups did you receive this training?
(Multiple response; Contractors who received training)

Weighted Frequencies	**CA**	**SC-GA-AL-MI**
n	**45**	**22**
Manufacturers	26%	64%*
Distributors	14%	52%*
Investor-Owned Utilities	7%	<1%
Public/Municipal Utilities	3%	<1%
State Government	1%	<1%
Contracting organizations	36%	6%
Trade Associations	22%	6%
Other sources	42%	27%
Refused	<1%	<1%
Do Not Know	<1%	<1%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

Market Share and Trends

As a percentage of all fixtures installed in high bay situations, the regional differences in technologies used are fairly pronounced, with contractors in CA installing more efficient options than in the comparison area. Contractors in CA install one of the most efficient options, T-5 fluorescents, in much higher proportion (65% of all fixtures) than in the comparison area (29% of all fixtures). The difference is significant at the 95% confidence interval. While proportions are similar for another energy efficient option, T-8 fixtures, at 14% and 16% in CA and the comparison area, respectively, the proportion of installations of the relatively inefficient fluorescent option, T-12 fixtures, is significantly higher (at the 90% confidence level) in the comparison area (11%) than in CA (1%). Contractors in the Southeastern States install pulse-start metal halide fixtures in 31% of installations compared to 14% in CA, significant at the 90% confidence level. This is in spite of the incentive offered for pulse-start metal halide technologies by the CA IOUs. Other technologies are mentioned and installed with much lesser frequency.

Table 8
LS2B - Approximately what percentage of all fixtures used in high bay situations were accounted for by the following technologies?

(Contractors who installed the technology in question)

Ratio Estimates	CA	SC-GA-AL-MI
n	**139**	**93**
Fluorescent Tube: T-5/Electronic Ballast T-5	65%	29%**
Fluorescent Tube: T-8 /Electronic Ballast T-8	14%	16%
Fluorescent Tube: All other, including T12/Magnetic Ballast	1%	11%*
HID: Pulse-start metal halide	14%	31%*
HID: High-pressure sodium	3%	8%
HID: Other HID such as mercury vapor or probe-start metal halide	1%	3%**
Other: technologies such as Induction or LED	2%	2%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

As shown in Table 9, contractors overwhelmingly report an increase in usage of fluorescent technologies in high bay lighting applications. Contractors in both CA and the comparison area report similar perceptions in the trend for fluorescent lighting in high bay applications, with approximately three quarters observing an increase in use, one quarter observing no change and a small percentage (1% to 2%) observing a decrease.

Table 9
HFL1B - In relation to other technologies used in high bay lighting, have fluorescent lighting installations increased, decreased, or stayed about the same over the past three years?

(Contractors who installed fluorescent lighting in high-bay applications)

Weighted Frequencies	**CA**	**SC-GA-AL-MI**
n	**125**	**74**
Increase	72%	76%
Decrease	1%	2%
Stay the same	27%	22%
Don't Know	<1%	1%

By contrast, the observed trends for use of pulse-start metal halide technologies show a difference between regions (Table 10). Contractors perceive decreasing usage in CA compared to increasing usage in the Southeastern States over the past three years. Over one third (35%) of contractors in the Southeast perceive an increase in pulse-start metal halide usage compared to 5% in CA (significant at the 95% confidence level). Three quarters (75%) of contractors in CA report a decrease in use of pulse-start metal halide fixtures compared to one quarter (26%) in the comparison area (significant at the 95% confidence level). The remainder (19% in CA and 39% in the Southeast region) reports no change over the past three years.

Table 10
HID1B - In relation to other technologies used in high bay lighting, have high bay pulse-start metal halide lighting installations increased, decreased, or stayed about the same over the past three years?
(Contractors who installed pulse-start metal halide lighting in high-bay applications)

Weighted Frequencies	**CA**	**SC-GA-AL-MI**
n	**94**	**71**
Increase	5%	35%**
Decrease	75%	26%**
Stay the same	19%	39%
Don't Know	<1%	<1%
Missing	1%	<1%

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

Stocking and Promotion

Contractors' perceptions of energy efficiency in high bay lighting fixtures are predictably similar for more mature technologies but they vary in specific ways. High percentages of contractors in both regions consider LEDs to be energy efficient (78% to 79%). Very few contractors in both regions consider T-12 fluorescent fixtures to be energy efficient (3% to 4%). Most contractors in both regions generally do not consider HID technologies to be energy efficient, with the exception of pulse start metal halides.

Table 11
LS4 - Which of the following kinds of lighting equipment do you consider to be energy efficient in high bay applications?
(Multiple Response; All Contractors)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**143**	**93**
T-5	96%	62%**
T-8	88%	44%**
T-12	3%	4%
HID: Pulse-Start Metal Halide	21%	70%**
HID: Probe Start Metal Halide	14%	18%
HID: High-Pressure Sodium	6%	22%
HID: Low-Pressure Sodium	4%	1%
HID: Mercury Vapor	1%	18%
LED	79%	78%
Induction	52%	5%*
Other	<1%	<1%
Don't Know	1%	0%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

The differences in perceptions of energy awareness are most striking for the high bay lighting technologies that are supported by the CA IOU programs, probably reflecting overall higher levels of awareness of energy efficiency among CA contractors versus the comparison area. For the energy efficient fluorescent high bay lighting technologies (including induction technologies), contractors in CA more frequently consider those to be energy efficient than in the comparison area. For T-5 fluorescent tubes, 96% of CA contractors believe they are energy efficient compared to 62% in the four selected Southeastern States (significant at the 95% confidence level). The difference is similar for T-8 technologies, with 88% of CA contractors considering them to be energy efficient compared to 44% of the comparison area contractors (significant at the 95% confidence level). A majority (52%) of CA contractors consider induction lighting technologies to be energy efficient whereas only 5% consider them efficient in the comparison area, possibly reflecting an overall lack of awareness of the technology itself (significant at the 90% confidence level).

Perceptions of energy efficiency are reversed, however, for the most prevalent high bay lighting technology, pulse-start metal halides which are also eligible for IOU incentives. Whereas 70% of contractors in the comparison area consider pulse-start metal halides to be energy efficient, only 21% of CA contractors consider them similarly (significantly different at the 90% confidence level), possibly reflecting substantial differences in market evolution between the regions, experience with and knowledge of the technologies, and standards for energy efficient lighting specification.

Table 12 shows that for contractors, the tendency to recommend energy efficient types of high bay lighting equipment is higher in CA than in the comparison area. In CA, contractors "always" recommend energy efficient types of equipment 72% of the time, compared to 48% of the time in the Southeastern States.

Table 12
LS5 - How often do you recommend energy efficient types of equipment for high bay applications?
(All Contractors)

Weighted Frequencies	**CA**	**SC-GA-AL-MI**
n	143	93
Always	72%	48%
Most of the Time	8%	29%
Sometimes	18%	6%
Rarely	<1%	3%
Never	1%	7%
Don't Know	<1%	<1%

For contractors who rarely or never recommend energy efficient types of equipment, nine respondents in each region say that is “not our role” or “someone else does that.” Two other CA contractors are public works contractors and do not perform that function (Table 13).

Table 13
LS5a – Why do you rarely or never recommend energy efficient types of equipment for high bay applications?
(Contractors who rarely or never recommend energy efficient types of equipment)

Counts	**CA**	**SC-GA-AL-MI**
Not our role as contractors/Someone else does the engineering	9	9
Depends on height	1	0
Primarily public works contractors	2	0
People never ask	0	1

Table 14 shows where contractors receive marketing support for energy efficient high bay lighting technologies. Most receive their support from distributors (57%) and IOUs (54%). Manufactures (14%), Public/Municipal Utilities (12%) provide support but considerably less frequently. The state government is not mentioned at all.

Table 14
MS2 - Do you receive any kind of marketing support for energy efficient high bay lighting technologies from ____________?
(Multiple response; All CA Contractors)

Weighted Frequencies	**CA**
N	143
Manufacturers	14%
Distributors	57%
Investor-Owned Utilities	54%
Public/Municipal Utilities	12%
State Government	0%

When asked about awareness of electric utility incentive programs for energy efficient high bay lighting, a majority (52%) of CA contractors are aware of incentive programs (see Table 15).

Table 15
PP1 - Are you aware of any electric utility incentive programs for businesses to install energy efficient high bay lighting?
(All CA Contractors)

Weighted Frequencies	**CA**
N	124
Yes	52%
No	18%
Don't Know	30%

When asked which IOUs provided marketing support, most of the support came from SCE (81%) followed by PGE 18% and SDGE 1% (Table 16).

Table 16
MS3C - Which Investor-Owned Utilities gave you marketing support?
(CA Contractors who received IOU marketing support)

Weighted Frequencies	**CA**
N	37
Pacific Gas and Electric (PG&E)	18%
San Diego Gas and Electric (SDG&E)	1%
Southern Cal Edison (SCE)	81%
Other	4%

Table 17 shows that substantial proportions of contractors received rebate support from the IOUs either paid to them directly (79%) or paid to their customers (82%). Also, 91% of contractors received some other type of support; however, other common types of support were hardly received at all.

Table 17
MS4C - What kind of support did you receive from Investor-Owned Utilities for marketing energy-efficient high-bay lighting?
(Multiple response; CA Contractors who received IOU marketing support)

Weighted Frequencies	**CA**
n	37
Literature, Brochures, Fact Sheets	3%
Provided speakers for my seminars, workshops, etc.	1%
Joined me on customer visits	0%
Rebates paid to me	79%
Rebates paid to my customers	82%
Other discounts	<1%
Cooperative advertising	<1%
Tax incentives	<1%
Financing for customers	<1%
Some other type of support	91%
Refused	<1%
Don't Know	<1%

Other responses are provided in Table 18 below, with web site information (5 responses) and classes (4 responses) as the most frequent.

Table 18
MS4C - What kind of support did you receive from Investor-Owned Utilities for marketing energy-efficient high-bay lighting?

Verbatim Counts	**Responses**
Information/help off website	5
Classes	4
Promotion of HBL to our customers	3
Approved/listed us as contractor	3
Product support	3
Hands-on consultation	2
Lend testing equipment	1
Informative program	1
Lighting rebate catalog	1
	23

Table 19 shows that most contractors (60%) participated in 50 or fewer HBL projects during the last three years receiving support from the IOUs, and 21% of contractors did not participate in any receiving support.

Table 19
PP4 - Roughly how many projects that received support from Investor Owned Utility programs, NOT including the Sacramento Municipality Utility District, did you participate during the last three years?
(All CA Contractors)

	CA
n	104
Zero	21%
Between 1 and 10	31%
Between 11 and 25	11%
Between 26 and 50	18%
Between 51 and 75	<1%
Between 76 and 100	7%
Don't Know	12%

As shown in Table 20, contractors rate the importance of IOU programs fairly highly in their firm's decisions to promote energy efficient high bay lighting, with 79% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 13% of contractors rated the importance between 5 and 7 (out of 10).

Table 20

PP5 - On a scale of 1 to 10, where 1 is not at all important and 10 is very important, how important are the utility programs in <u>your firm's</u> decisions about how heavily to promote energy-efficient high-bay lighting equipment?
(CA Contractors who participated in IOU supported HBL installations)

Ratio Estimates	**CA**
n	54
1-4	8%
5-7	13%
8-10	79%

As shown in Table 21, contractors rate the influence of IOU programs fairly on market shares of energy efficient high bay lighting, with 73% of contractors giving a score of 8 or higher (on a scale from 1 to 10). Another 21% of contractors rated the importance between 5 and 7 (out of 10).

Table 21

PP6 - Finally, on a scale of 1 to 10, where 1 is no influence and 10 is a great deal of influence, how much influence do you think utility programs have on the <u>market share</u> of energy-efficient lighting technologies in your market area? That is, how much did the program influence <u>your customers</u>?
(CA Contractors who participated in IOU supported HBL installations)

Ratio Estimates	**CA**
n	54
1-4	6%
5-7	21%
8-10	73%

Perceptions of Customer Awareness and Demand

As shown in Table 22, contractors' recommendations in the comparison area are accepted more frequently than in CA. For CA contractors, 51% of their recommendations for energy efficiency high bay lighting are accepted at least "most of the time," compared to 75% of recommendations in the comparison area. Recommendations in CA are "rarely" accepted 41% of the time compared to 6% in the comparison area (significant at 95% confidence level). The contrast between the regions may be a relative comparison based on the heightened awareness of energy-efficient technologies in CA compared to the southeastern United States region (See Table 11). For example, CA contractors may be recommending higher efficiency solutions and more frequently encountering a higher first-cost barrier.

Table 22
LS6 - In cases where you recommend energy efficient high bay lighting, how often did customers follow this recommendation in 2008?
(Contractors who have recommended energy efficient high bay lighting)

Weighted Frequencies	CA	SC-GA-AL-MI
N	135	83
Always	10%	10%
Most of the Time	41%	65%**
Sometimes	8%	19%
Rarely	41%	6%**
Never	<1%	<1%
Don't Know	1%	<1%

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

According to contractors in both regions, most end users are unaware of the full range of energy efficient high bay lighting options before providing recommendations on their lighting system. Ten percent of contractors say that over 50% of end users are fully aware of their HBL energy efficient solutions, and 17% of contractors say that over end users in the comparison area are fully aware of their energy efficient HBL solutions. These data may be showing relative perceptions of awareness, reflecting the heightened awareness of energy-efficient technologies in CA compared to the southeastern United States region (See Table 11).

Table 23
LS7 - About what percent of your customers are aware of the full range of options for energy-efficient high bay lighting available to them before you provide recommendations about the lighting system?
(All Contractors)

Weighted Frequencies	**CA**	**SC-GA-AL-MI**
n	**139**	**86**
Between 0 and 10	50%	33%
Between 11 and 25	27%	12%
Between 26 and 50	13%	37%
Between 51 and 75	2%	3%
Between 76 and 100	8%	14%
Do Not Know	<1%	1%

HBL Market Effects Study: Lighting Contractor

FINAL Interview Guide

May, 2009

Intro

Hello. This is _____________ calling on behalf of the California Public Utilities Commission and KEMA, an energy consulting company.

We are conducting research on the commercial/industrial lighting market in [STATE RESPONDENT IS IN]. In particular we are focusing on the installation of high bay lighting by contractors. For the purposes of this interview we define high bay applications as installations for commercial and industrial customers with ceiling heights of about 15 feet or more. I want to assure you this is not a sales call and that the information you provide will be kept strictly confidential. This survey should only take about 15 minutes of your time.

May I please speak to someone at your company who is familiar with your sales and installation of commercial lighting products?

ENTER NAME OF CONTACT: ________________________________

IF CONTACT IS NOT AVAILABLE, ASCERTAIN BEST TIME TO CALL.

[REPEAT INTRO AS NEEDED, CONTINUE OR ARRANGE FOR CALLBACK]

[IF NEEDED]

For further questions about this survey, you can contact Kay Hardy of the California Public Utilities Commission. Her phone number is (415) 703-2322. Please make sure that you reference the High Bay Lighting Study.

Screening and Firmographics

SC1 First, what is your job title?

- Sales Manager 1
- President/CEO 2
- Owner / Co-Owner / Partner /Member of LLP 3
- General Manager 4
- Lighting Manager 5
- Other(Specify)_____________________ 6
- [Don't Know] 998
- [Refused] 999

Now, I am going to read some activities that lighting firms like yours perform. For each activity, I would like to know if your firm performs it, and if it does, approximately what fraction of your total annual revenue comes from that activity.

SC2Ax Does your firm do ___________________________?

[*Read list and accept multiple responses*]

Yes.. 1

No .... 2 → **Next Activity**

Other (e.g. "we would but there is no demand for it") (specify__)................. 997 → **Next Activity**

[Don't Know] .... 998 → **Next Activity**

[Refused] .... 999 → **Next Activity**

SC2Bx About what fraction of your annual revenue comes from ______________________?

[*Read list and accept multiple responses*]

ENTER NUMBER... __%

[Don't Know] 998

[Refused] 999

ACTIVITY	SC2A	SC2B
Lighting sales to customers	1	%
Lighting installations	2	%
Lighting sales to other contractors	3	%
Contracted maintenance services for lighting	4	%
Other (Specify:__________)	5	%
		Should sum to 100% unless DK/Ref

CONTINUE IF SCA2=Yes AND SCB2>=5%; ELSE TERMINATE

SC3 Approximately how many full-time-equivalent (FTE) staff do you have at this location? [PROBE FOR APPROXIMATE]

ENTER NUMBER .... ____
[Don't Know] 999998
[Refused] 999999

[POPULATE NEXT WITH RESPONDENT FIRM'S STATE]

SC4 How many locations does your firm have in _____?

[IF NECESSARY: PROBE FOR APPROXIMATE]

ENTER NUMBER .... ____
[Don't Know] 999998
[Refused] 999999

SC4a In which other states does your firm have locations? [DO NOT READ, MULTIPLES ALLOWED]

[Use FIPS codes for state names] .... [FIPS 2-Digit state code]
No Other States 0
[Don't Know] 998
[Refused] 999

SC6 Which of the following best characterizes your company's revenue at that location from lighting installations in 2008? **[READ LIST, OK TO ACCEPT A "ROUGH ESTIMATE"]**

Up to $250,000 1
More than $250,000 to $500,000 2
More than $500,000 to $1 million 3
More than $1 million to $2 million 4
More than $2 million to $5 million 5
More than $5 million to $10 million 6
More than $10 million 7
[Don't Know] 998
[Refused] 999

[POPULATE NEXT WITH RESPONDENT FIRM'S STATE]

SC7 Approximately what percentage of your revenue in the past 12 months was from the installation of lighting equipment in **[STATE]'s** commercial and industrial sector?

ENTER NUMBER [0-100] .... __%
[Don't Know] 998
[Refused] 999

SC8 And approximately how many projects involving installation or replacement of lighting fixtures did your company complete in [STATE]'s commercial and industrial sector over the past 12 months? Your best estimate is fine.

ENTER NUMBER.. ____
[Don't Know] 998
[Refused] 999

Lighting Equipment Installations

Now I am going to ask you about your installation of commercial and industrial lighting equipment for high bay applications. For the purposes of this interview we define high bay applications as installations for commercial and industrial customers with ceiling heights of about 15 feet or more. **Please answer these questions for <u>your installations</u> for commercial and industrial customers in ___________ [INSERT RESPONDENT'S STATE].**

LS1 Approximately what percentage of the lighting installed in all commercial and industrial projects your firm completed in 2008 went into high bay applications**?** **[PROMPT: YOUR BEST ESTIMATE IS FINE.**

ENTER NUMBER [0-100].. __%
[Don't Know] 998
[Refused] 999

Now I am going to ask you about different lighting technologies. I would like to know two things for each technology: 1) Did you install any of that kind of lighting in high-bay applications in 2008; and 2) about what percent of high-bay installations used that kind of lighting.

[USE THE FOLLOWING LIST TO POPULATE THE LS2A AND LS2B SERIES OF QUESTIONS]

LS2A1. Fluorescent Tube: T-5/Electronic Ballast T-5 [ACCEPT ALL VARIETIES]…..1

LS2A2. Fluorescent Tube: T-8 /Electronic Ballast T-8 [ACCEPT ALL VARIETIES]….2

LS2A3. Fluorescent Tube: All other, including T12/Magnetic Ballast…………………..3

LS2A4. HID: Pulse start metal halide…………………………………………………….4

LS2A5. HID: High-pressure sodium………………………………………………………5

LS2A6. HID: Other HID such as mercury vapor or probe-start metal halide……………6

LS2A7. Other: technologies such as Induction or LED……………………………………7

[Don't Know]……………………………………………………………………………….998
[Refused]…………………………………………………………………………………..999

LS2A Did you install any __________ **[Insert technology]** in high-bay applications in 2008**?**

[PROMPT: YOUR BEST ESTIMATE IS FINE]

Yes.. 1
No 2
[Don't Know] 998
[Refused] 999

LS2B **[For each technology mentioned in LS2A]** Approximately what percentage of all fixtures used in high bay situations were accounted for by ________?

[IF NECESSARY, DEFINE HIGH BAY APPLICATIONS AS CEILING HEIGHT AS 15 FT OR MORE.]

[PROMPT: YOUR BEST ESTIMATE IS FINE]

ENTER NUMBER .... ___%
[Don't Know] 998
[Refused] 999

[NOTE: THE 7 DIFFERENT LS2B RESPONSES SHOULD TOTAL between 90% and 105% UNLESS THERE ARE SOME DK/REFUSES. TRY TO FILL IN DK/REF BY ELIMINATION WITH THE RESPONDENT]

LS4 Which of the following kinds of lighting equipment do you consider to be energy-efficient in high bay applications?

[READ LIST, MULTIPLES ACCEPTED]

T5 (all varieties) 1
T-8 (all varieties) 2
T-12 3
Pulse start metal halide (HID)...4
Probe start metal halide (HID) 5
High -pressure sodium (HID)..6
Low-pressure sodium (HID)...7
Mercury vapor (HID) 8
LED..9
Induction 10
Other (Specify) __________ 11
Don't Know 998
Refused 999

LS5 How often do you recommend energy efficient types of equipment for high bay applications? Would you say it is …?

A. Always……………... .1 → **LS6**

B. Most of the time...…………..2 → **LS6**

C. Sometimes .... …….3 → **LS6**

D. Rarely.. 4 **LS5A**

E. Never.. 5 **LS5A**

[Don't Know] .... 998 → **LS6**

[Refused] .... 999 → **LS6**

LS5A Why do you _____ **[INSERT RESPONSE WORD (RARELY OR NEVER) FROM LS5]** recommend energy efficient types of equipment for high bay applications?
[OPEN RESPONSE, 998 DON'T KNOW 999 REFUSED]

____

____

____

LS6 In cases where you recommend energy-efficient high bay lighting, how often did customers follow this recommendation in 2008? Would you say it was …?

A. Always……………..1 → **LS7**
B. Most of the time...…………..2 → **LS7**
C. Sometimes ....…….3 → **LS7**
D. Rarely...4 → **LS7**
E. Never..5 → **LS7**
[Don't Know] ....998 → **LS7**
[Refused] ....999 → **LS7**

LS7 About what percent of your customers are aware of the full range of options for energy-efficient high bay lighting available to them <u>before</u> you provide recommendations about the lighting system?

[Enter number between 0% and 100%] ....……………………………____%
[Don't Know] 998
[Refused] 999

LS9 Does the ceiling height of the installation affect the type of high bay lighting you recommend and install?

Yes	1	**LS9A**
No	2	**HFL1A**
[Don't Know]	998	**HFL1A**
[Refused]	999	**HFL1A**

LS9A What technology do you recommend most often for applications below 25 feet? **DO NOT READ. PROMPT IF NECESSARY.]**

LS9B For applications between 25 and 50 feet?

LS9C For applications higher than 50 feet?

T5 (all varieties)	1
T-8 (all varieties)	2
T-12	3
Pulse start metal halide (HID)	4
Probe start metal halide (HID)	5
High -pressure sodium (HID)	6
Low-pressure sodium (HID)	7
Mercury vapor (HID)	8
LED	9
Induction	10
Other (Specify) __________	11
Don't Know	998
Refused	999

FLUORESCENT LAMPS [ASK ALL RESPONDENTS.]

Now I would like to ask you about your experiences with fluorescent high-bay lighting.

[IF (LS2A1, LS2A2, LS2A3) ARE ALL (0% OR MISSING OR DK OR REFUSED) THEN ASK HFL1A; ELSE SKIP TO HFL1B]

HFL1A Why doesn't your company install any fluorescent high-bay lighting?

[Do not read, accept multiples]

Customers don't like light quality	1
I (or my firm) don't like light quality	2
Customers say they don't give enough light	3
Customers don't like higher purchase-price of fixtures	4
I (or my firm) don't like higher purchase-price of fixtures	5
Don't last as long as advertised	6
Customers disappointed with savings	7
Cost more to maintain	8
Product does not sell without rebates/incentives/loans	9
Cannot sell in current economy	10
Other (specify:__________)	11
DO NOT GET FEEDBACK FROM CUSTOMERS	12
[Don't Know]	998
[Refused]	999

[SKIP TO LOGIC BEFORE HID1A]

HFL1B In relation to other technologies used in high bay lighting, have fluorescent lighting installations increased, decreased, or stayed about the same over the past three years?

Increased	1	
Decreased	2	
Stayed about the same	3	
[Not applicable to business] [SKIP TO HID1]	4	
[Don't Know]	998	**HFL3**
[Refused]	999	**HFL3**

[Populate with "Increase", "Decrease" or "Remain the same" from HFL1B]

HFL1C Do you expect this market share will continue to **[RESPONSE FROM HFL1B]** in the next two years?

Yes	1
No	2
Don’t know	998
Refused	999

HFL3 In your opinion, what will be the main factors in determining the market share of high-bay fluorescent lights in the next two years?

[Do not read, accept multiples]

Cost of Electricity	1
Lower purchase-price of equipment/new tech	2
Rebates from utility	3
Rebates/Deals from Manufacturer	4
Concern/Awareness of Saving Energy	5
Concern for Environment	6
New technologies give better light	7
New technologies work in more places (temp range, heights, etc.)	8
Easier to maintain/ costs less to replace lamps, maintain	9
Better/More Advertising	10
Changes in building codes, other legal changes	11
Demand from customers	12
Other (Specify:_____________)	13
[Do not know]	998
[Refused]	999

HFL4 What kinds of objections have you heard from customers when you propose installing fluorescent equipment in high bay applications?

[Do not read, accept multiples]

Purchase price / installation cost 1
Light quality (compared to the existing system) 2
Supply issues........ 3
Appearance (of the fixture and tubes) 4
Lack of information 5
Would require additional electrical work 6
Reliability 7
Not as much light as existing system 8
Extreme temperatures rule out HFL 9
Cost more to maintain 10
Other (specify:___________) 11
[NO OBJECTIONS] 12
[Don't Know] 998
[Refused] 999

HFL5 What kinds of feedback have you received from customers who have had high-bay fluorescents installed in their facilities?

[Do not read, accept multiples]

Prefer the light quality (compared to the old system) 1
Dislike the light quality (compared to the old system) 2
Worth the money 3
Not worth the money 4
Like saving money on electricity 5
Disappointed with money savings on electricity........6
Like saving energy........ 7
Disappointed with energy savings 8
Customers like the rebates 9
Customers not satisfied with rebates 10
Harder/costs more to maintain (than old system)........ 11
Easier/costs less to maintain (than old system) 12
Costs too much to change to another technology 13
Likes them, unspecified 14
Disikes them, unspecified 15
Likes the control features
Other (specify:___________) 16
DO NOT GET FEEDBACK FROM CUSTOMERS 17
[Don't Know] 998
[Refused] 999

HFL6 What business advantages do you perceive in promoting fluorescent technology in high bay applications?

[OPEN RESPONSE, 998 DON'T KNOW 999 REFUSED]

____

____

____

HFL7 What business disadvantages do you perceive in promoting fluorescent technology in high bay applications?

[OPEN RESPONSE, 998 DON'T KNOW 999 REFUSED]

____

____

____

PULSE START METAL HALIDES [ASK ALL RESPONDENTS]

Now I would like to ask about your installations of pulse-start metal halide high-bay lighting applications.

[IF LS2A4=0% OR 998 OR 999 THEN ASK HID1A; ELSE SKIP TO HID1B]

HID1A Why doesn't your company install any pulse-start metal halide high-bay lighting?

[Do not read, accept multiples]

Customers don't like light quality 1
I (or my firm) don't like light quality 2
Customers say they don't give enough light 3
Customers don't like higher purchase-price of fixtures 4
I (or my firm) don't like higher purchase-price of fixtures 5
Don't last as long as advertised 6
Customers disappointed with savings 7
Cost more to maintain 8
Product does not sell without rebates/incentives/loans 9
Cannot sell in current economy 10
Other (specify:__________) 11
DO NOT GET FEEDBACK FROM CUSTOMERS 12
[Don't Know] 998
[Refused] 999

SKIP TO MS1

HID1B In relation to other technologies used in high bay lighting, have high bay pulse-start metal halide lighting installations increased, decreased, or stayed about the same over the past three years?

Increased 1
Decreased 2
Stayed about the same.. 3
[Not applicable to business] [SKIP TO MS1].. 4
[Don't Know] .... 998 → **HID3**
[Refused] .... 999 → **HID3**

[Populate with "Increase", "Decrease" or "Remain the same" from HID1B]

HID1C Do you expect this market share will continue to **[RESPONSE FROM HID1B]** in the next two years?

Yes ______________________________ 1
No ______________________________ 2
Don't know ______________________________ 998
Refused ______________________________ 999

HID3 In your opinion, what will be the main factors in determining the market share of high bay pulse-start metal halide lighting in the next two years?

[Do not read, accept multiples]

Cost of Electricity.. 1
Lower purchase-price of equipment/new tech.. 2
Rebates from utility.. 3
Rebates/Deals from Manufacturer 4
Concern/Awareness of Saving Energy.. 5
Concern for Environment.. 6
New technologies give better light.. 7
New technologies work in more places (temp range, heights, etc.).................. 8
Easier to maintain/ costs less to replace lamps, maintain................................ 9
Better/More Advertising.. 10
Changes in building codes, other legal changes.. 11
Other (Specify:_____________) 12
[Do not know].. 998
[Refused] 999

HID4 What kinds of objections have you heard from customers when you propose installing pulse-start metal halide equipment in high bay applications?:

[Do not read, accept multiples]

Purchase price / installation cost 1
Light quality (compared to the existing system) 2
Supply issues 3
Appearance (of the fixture and tubes) 4
Lack of information 5
Would require additional electrical work 6
Reliability 7
Not as much light as existing system 8
Extreme temperatures rule out HFL 9
Cost more to maintain 10
Other (specify:__________) 11
[NO OBJECTIONS] 12
[Don't Know] 998
[Refused] 999

HID5 What kinds of feedback have you received from customers who have had pulse-start metal halide equipment installed in their facilities?

[Do not read, accept multiples]

<u>Prefer</u> the light quality (compared to the old system) 1
<u>Dislike</u> the light quality (compared to the old system) 2
Worth the money 3
<u>Not</u> worth the money 4
Like saving money on electricity 5
Disappointed with money savings on electricity…………………………………6
Like saving energy 7
Disappointed with energy savings 8
Customers like the rebates 9
Customers not satisfied with rebates 10
Harder/costs more to maintain (than old system) 11
Easier/costs less to maintain (than old system) 12
Costs too much to change to another tech 13
Likes them, unspecified 14
Disikes them, unspecified 15
Other (specify:__________) 16
DO NOT GET FEEDBACK FROM CUSTOMERS 17
[Don't Know] 998
[Refused] 999

HID6 What business advantages do you perceive in promoting pulse-start metal halide technology in high bay applications?

[OPEN RESPONSE, 998 DON'T KNOW 999 REFUSED]

HID7 What business disadvantages do you perceive in promoting pulse-start metal halide technology in high bay applications?

[OPEN RESPONSE, 998 DON'T KNOW 999 REFUSED]

Marketing Support

MS1 What activities do you undertake to market energy efficient high bay lighting technologies?

[DO NOT READ LIST, MULTIPLES ACCEPTED, PROMPT IF NECESSARY.]

Talk directly with customers/in-person sales	1
Direct mail/newsletter	2
Telephone advertising	3
Advertise on my company's website	4
Purchase web ads (e.g., Google's Adsense)	5
Advertise on contractor or trade websites	6
Sell over the internet/web	7
Radio advertising	8
Print advertising	9
Showroom, tours	10
Offer classes/workshops	11
Offer special discounts, promotions	12
Notify investor-owned and public utility companies	13
Notify distributors	14
Notify other contractors	15
Other (Specify) __________	16
Don't Know	998
Refused	999

[ASK THE FOLLOWING QUESTION SEQUENCE FOR EACH OF THE MARKET ACTORS:

(A) Manufacturers,

(B) Distributors

(C) Investor-Owned Utilities,

(D) Public/Municipal Utilities,

(E) State Government

THAT IS, ASK IN THIS ORDER:

DO MS2A, MS3A, MS4A, MS5A, MS2B, MS3B, MS4B, MS5B, etc. through MS5E]

MS2 Do you receive any kind of marketing support for energy efficient high bay lighting technologies from ____________?

Yes	1	→ **MS3**
No	2	→ **Next MS2**
[Don't Know]	998	→ **Next MS2**
[Refused]	999	→ **Next MS2**

[IF NONE OF THE MS2 SERIES IS = 1 THEN SKIP TO **LOGIC BEFORE** MS9]

MS3A Which Manufacturers gave you marketing support?

[Accept multiple responses; DO NOT READ]

Lithonia	1
Osram-Sylvania	2
GE	3
TCP (Technical Consumer Products)	4
Philips	5
Grainger	6
Ruud	7
Paragon	8
Cooper	9
Day-Brite	10
Graybar	11
Other (specify:__________)	12
[Don't Know]	998
[Refused]	999

MS3B Which Distributors gave you marketing support**?**

[Accept multiple responses; DO NOT READ]

Yale Electric	1
Grainger	2
Consolidated Electrical Distrs	3
Scott Electric Co	4
ABB	5
McNaughton-Mckay Electric Co	6
Kendall Electric Inc	7
Eaton Electrical	8
Hite	9
Schaedler Yesco Distribution	10
Other (specify:__________)	11
[Don't Know]	998
[Refused]	999

MS3C Which Investor-Owned Utilities gave you marketing support?

[Accept multiple responses; UPDATE FOR STATES; DO NOT READ]

Pacific Gas and Electric (PG&E) 1
San Diego Gas and Electric (SDG&E) 2
Southern Cal Edison (SCE) 3
Other (specify:__________) 4
[Don't Know] 998
[Refused] 999

MS3D Which Public/Municipal Utilities gave you marketing support? [ASK FOR CA ONLY]

[Accept multiple responses; UPDATE FOR SELECTED STATES; DO NOT READ]

Alameda 1
Azusa 2
Burbank 3
Healdsburg 4
Imperial 5
Long Beach 6
Los Angeles (LADWP) 7
Palo Alto 8
Pasadena 9
Sacramento (SMUD) 10
Other (specify:__________) 18
[Don't Know] 998
[Refused] 999

MS3E Which state government gave you marketing support**?**

[Accept multiple responses; DO NOT READ]

California 1
Alabama 2
Georgia 3
Louisiana 4
Mississippi 5
North Carolina 6
South Carolina 7
Other (specify:__________) 8
[Don't Know] 998
[Refused] 999

[ASK THE FOLLOWING QUESTIONS FOR EACH OF THE MARKET ACTORS RECEIVING YES RESPONSE TO MS2:]

(A) Manufacturers,

(B) Distributors

(C) Investor-Owned Utilities,

(D) Public/Municipal Utilities,

(E) State Government

MS4 What kind of support did you receive from ________ for marketing energy-efficient high-bay lighting?

[DO NOT READ, MULTIPLES ACCEPTED]

Literature, Brochures, Fact Sheets	1
Provided speakers for my seminars, workshops, etc.	2
Joined me on customer visits	3
Rebates paid to me	4
Rebates paid to my customers	5
Other discounts	6
Cooperative advertising	7
Tax incentives	8
Financing for customers	9
Other (specify:___________)	10
[Don’t Know]	998
[Refused]	999

MS5 Which high-bay lighting technologies are marketed and/or promoted as energy-efficient?

[DO NOT READ, MULTIPLES ACCEPTED]

T12	1
T-8 (all varieties)	2
T-5 (all varieties)	3
Probe start metal halide (HID)	4
Pulse start metal halide (HID)	5
Low-pressure sodium (HID)	6
High-pressure sodium (HID)	7
Mercury vapor (HID)	8
LED	9
Induction	10
Other (Specify) __________	11
Don't Know	998
Refused	999

[IF NONE OF THE MS2 SERIES IS = 1 THEN SKIP TO **<u>LOGIC BEFORE</u> PP1**]

MS6 Do you think the marketing support helped you to sell more energy efficient high bay lighting?

Yes	1
No	2
Don't Know	998
Refused	999

MS7 Would you market energy efficient high bay lighting technologies without this support?

Yes	1
No	2
Don't Know	998
Refused	999

MS8 Which of the following, if any, do you partner with to market energy-efficient high bay lighting technologies?

Utilities ....1→ **MS8A**
Manufacturers..2→ **MS8A**
Other Contractors ....3→ **MS8A**
Distributors...3→ **MS8A**
Other ....4→ **MS8A**
Don’t Know ....998→ **PP1**
Refused ....999→ **PP1**

MS8A Which ones? [OPEN RESPONSE, 998 DON’T KNOW 999 REFUSED]

____

____

____

Program Participation [ask for california firms; else skip to gt1]

[ASK PP1 THROUGH PP3 IF NOT ALREADY ANSWERED]

PP1 Are you aware of any electric utility incentive programs for businesses to install energy efficient high bay lighting?

Yes 1
No.. 2
Don't Know 998
Refused 999

[IF PP1 = 1, ASK PP2. ELSE SKIP TO GT1]

PP2 Have you participated in projects that have received incentives from an electric utility?

Yes 1
No.. 2
Don't Know 998
Refused 999

[IF PP2 = 1, ASK PP3; ELSE SKIP TO GT1]

PP3 Did those customers get the incentives from the following Investor Owned Utilities…?

[ACCEPT MULTIPLES; PROMPT FOR first three on the list (PG&E, SDG&E, SCE) plus "Any Others?"]

Pacific Gas and Electric (PG&E) 1
San Diego Gas and Electric (SDG&E) 2
Southern Cal Edison (SCE).. 3

Any other utilities? [DO NOT READ THE REST OF THIS LIST BELOW]

[Alameda] 4
[Azusa] 5
[Bear Valley Electric] 6
[Burbank] 7
[Citizens Electric] 8
[Imperial]... 9
[Integrys] 10
[Long Beach] 11
[Los Angeles (LADWP)] 12
[Mountain Utilities] 13
[PacifiCorps] 14
[Palo Alto] 15
[Pasadena] 16
[Sacramento (SMUD)] 17
[Sierra Pacific Power] 18
[Other (specify:__________)] 19
[Don't Know] 998
[Refused] 999

PP4. Roughly how many projects that received support from Investor Owned Utility programs, NOT including the Sacramento Municipality Utility District, did you participate during the last three years?

[PROMPT: YOUR BEST ESTIMATE IS FINE]

ENTER NUMBER .... ______
[Don't Know] 999998
[Refused] 999999

PP5 **[IF PP4 IS NOT DK, REFUSED OR ZERO, ELSE SKIP TO GT1]**

On a scale of 1 to 10, where 1 is not at all important and 10 is very important, how important are the utility programs in **your firm's** decisions about how heavily to promote energy-efficient high-bay lighting equipment?

ENTER 1 – 10, 998 FOR DK, 999 FOR REFUSED .... _____

PP6 Finally, on a scale of 1 to 10, where 1 is no influence and 10 is a great deal of influence, how much influence do you think utility programs have on the **market share** of energy-efficient lighting technologies in your market area? That is, how much did the program influence your customers?

ENTER 1 – 10, 998 FOR DK, 999 FOR REFUSED _____

Lighting Equipment Information and Training

NOW I AM GOING TO ASK YOU HOW YOU LEARN ABOUT COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT FOR HIGH BAY APPLICATIONS. FOR THE PURPOSES OF THIS INTERVIEW WE DEFINE HIGH BAY APPLICATIONS AS INSTALLATIONS FOR COMMERCIAL AND INDUSTRIAL CUSTOMERS WITH CEILING HEIGHTS OF ABOUT 15 FEET OR MORE.

IT 1. Where do you mainly get your information on High Bay Lighting technologies [MULTIPLE RESPONSE; DO NOT READ LIST]:

(A) Manufacturers

(B) Distributors

(C) Investor-Owned Utilities,

(D) Public/Municipal Utilities,

(E) State Government

(F) Other contractors (work colleagues)

(G) Customers

(H) Architects and engineers

(I) Big Box/ Wholesalers/ Retailers

(J) Trade Assocations (specify: ________)

(K) Friends

(L) Conferences/ Workshops/ Meetings

(M) Other (specify:___________)

(N) Don't know

(P) Refused

IT2. Have you ever received training for installing high bay lighting technologies?

(A) Yes
(B) No (SKIP TO GT1)
(C) DK/refused (SKIP TO GT1)

IT 3. From which of the following groups did you receive this training [ACCEPT MULTIPLE RESPONSE; DO NOT READ]:

(A) Manufacturers

(B) Distributors

(C) Investor-Owned Utilities,

(D) Public/Municipal Utilities,

(E) State Government

(F) Contracting organizations

(H) Trade Associations (specify:___________)

(I) Other (specify:___________)

General Market Trends

GT1 About what percentage of your revenues from the installation of commercial/industrial lighting equipment comes from new construction projects, as opposed to replacements and retrofits? **[PROBE FOR APPROXIMATE]**

ENTER PERCENT NEW CONSTRUCTION.. ____%
[Don't Know] 998
[Refused] 999

IF GT1 > 20% ASK GT2. ELSE SKIP TO GT4

GT2 Are you more likely, less likely, or equally likely to install energy-efficient high-bay lighting for new construction projects versus existing buildings?

More likely...1
Less likely 2
Equally likely 3
Don't Know...998
Refused...999

[IF GT2 = 1 OR 2, ASK GT3. ELSE SKIP TO GT4]

GT3 What are the main reasons you are **[POPULATE FROM GT2]** likely to install energy efficient equipment in new construction versus existing buildings?

[OPEN RESPONSE, 998 DON'T KNOW 999 REFUSED]

____

____

____

GT4 Thinking about the overall market, what do you think could be done to increase the installation of energy-efficient high-bay lighting in the commercial and industrial sectors?

[ACCEPT MULTIPLES; DO NOT READ]

Lower prices overall	1
Quality standards for equipment (low-Q deters customers)	2
Fluorescents not good enough yet	3
Education for contractors/architects/owners	4
Building code requirements	5
It will change when induction is cost-effective	6
It will change when LEDs are cost-effective	7
More/bigger utility rebates	8
More/bigger tax breaks from state	9
More/bigger tax breaks from federal government	10
Innovative Pricing Schemes (leasing rather than buying, etc.)	11
Low-cost loans	12
EE light quality must improve	13
EE durability/maintenance must improve	14
Other (specify:__________)	15
[Don't Know]	998
[Refused]	999

THANK YOU FOR YOUR TIME AND COOPERATION.

APPENDIX F: Distributor Survey Data and Survey Instrument

Overview

Key findings from the research conducted on the distributors include the following.

- As is the case with contractors, installations of the most efficient technology, T-5 fluorescents, are greater in CA (35% of all fixtures) than in the comparison area (30%), but to a lesser degree. Also in accordance with the contractors, the proportion of installations of the relatively inefficient fluorescent option, T-12 fixtures, is significantly higher (at the 95% confidence level) in the comparison area (18%) than in CA (4%). In contrast to the contractors, the installation of T-8s in both regions are reportedly higher overall, and the comparison area (38%) represents a statistically greater (at the 95% confidence level) percentage of all fixtures than T8s in CA (22%).
- Distributors in CA also report a significantly greater percentage of pulse-start metal halide fixture installations (16% of all fixtures) compared to the comparison area (8%). This difference is statistically significant at the 95% confidence level.
- Distributors report in similar proportions that they observed an increase in installations of fluorescent high bay lighting technologies over the past three years (77% in CA and 83% in the comparison area).
- Perceived trends in the market by distributors for pulse start metal halides are different than for fluorescent technologies. A lower percentage of CA distributors (37%) report an increase over the past few years, compared to 45% in the four Southeastern States. Accordingly, 32% of CA distributors perceive a decrease versus 14% in the comparison area, a statistically significant difference at the 95% confidence level.
- Perceptions of energy efficiency among distributors reflects some regional differences with generally higher levels of awareness in CA of the highest efficiency products.
    - Nearly all (99%) distributors in CA consider T-5 fluorescents to be energy efficient versus 88% in the comparison area (significant at the 95% confidence level).
    - Nearly all (85%) distributors in CA consider LED technologies to be energy efficient compared to 39% in the Southeastern States (significant at the 90% confidence level).
    - A much lesser, but statistically significant (at the 95% confidence level), proportion of CA distributors (44%) include induction technologies compared to 34% in the Southeast.
    - T-8s are considered energy efficient by nearly all (84%) distributors in the comparison area compared to 68% in CA, but not significantly different.
    - Nearly three quarters (74%) of CA distributors consider pulse-start metal halides to be energy efficient compared to 36% in the four Southeastern States, but the difference is also not significantly different.
- IOU programs' influence on market share and the importance of programs to CA distributors is fairly high; IOU programs' marketing support is less noteworthy than from manufacturers.
    - For distributors representing over a majority (53%) of HBL sales in CA, IOU programs are considered very important (score of 8 or above on a scale from 1 to 10) to their firm's decisions about how to promote energy-efficient HBL equipment. When including all responses above 5 (out of a 1 to 10 scale), over three-quarters (79%) of distributors' sales are represented.

    - When asked what influence the CA IOU programs have on the market share for energy-efficient lighting technologies, distributors in CA representing 61% of sales claim the programs have been very influential, rating the influence at 8 or higher (on a scale of 1 to 10). When including all responses above 5 (out of a 1 to 10 scale), 91% of distributors' sales are represented.
    - In terms of marketing support, Table 13 shows that CA distributors cite manufacturers most frequently (67%) with some support from the IOUs (25%), followed by public/municipal utilities (14%) and the state government (1%).
- As shown in Table 15, in terms of the kinds of marketing support provided by the IOUs, CA distributors most frequently report receiving paid rebates either directly (56%) and/or to their customers (21%). While signing the rebates from the customer to the installer is the most common practice, how the distributor could be directly compensated is unclear. Some possibilities could include additional creative financing terms in which the contractor signs over the customers' incentives to the distributor, or the distributor receives the rebates from the end user as a contracted design service or through direct sales.
- In terms of distributor sales to contractors, distributors describe similar sales processes between the regions, with most of the sales in each region being specified by the contractor. The most common sales process is where contractors provide a list of their needs and request a quote (34% of sales in CA and 33% in the comparison area). A similar percent of sales (33%) in the Southeastern States are completed by contractors interacting generally with the distributors compared to 23% in CA. Sales situations in which distributors actually perform specification services account for 34% of CA sales and 24% of comparison area sales. None of the values compared between the regions differ significantly.
- When asked what percent of customers are aware of the full range of energy efficient HBL options prior to making any recommendations, over half (52%) of CA distributors report that a majority (50% or greater) of their customers are aware of the full range of options versus 43% in the comparison area. The contrast between the regions is especially relevant in light of the heightened awareness of energy-efficient technologies in CA compared to the southeastern United States region (See Table 7).

Baseline Supply Chain Characterization

The annual revenue sources for distributors (Table 1) suggest more specialization toward lighting versus general electrical supplies in the CA market compared to the distributors in the comparison area. The highest percentage of revenues for distributors in CA comes from lighting sales to contractors (44%). This is higher than sales to contractors in the comparison area (19%) and significant at the 95% confidence level. For lighting business activities, direct lighting sales to customers are second highest in both the comparison area (27%) and CA (14%). In the comparison area, the overall highest percentage of revenues is from some other source (41%) unrelated to lighting, which is the second highest source of revenue (21%) in CA. Lighting sales to retailers, lighting layout and design services, as well as lighting installation and maintenance services are relatively small percentages of distributors' revenues in both CA and the comparison area.

Table 1

SC2B - Approximate Percentage of Annual Revenue Coming From the Following Activities (All Distributors)

Ratio Estimates	CA	SC-GA-AL-MI
n	**114**	**73**
Lighting Sales to Customers	14%	27%
Lighting Sales to Original Equipment Manufacturers (OEMs)	4%	3%
Lighting Sales to Contractors	44%	19%**
Lighting sales to retailers	5%	7%
Lighting layout and design services	3%	2%
Lighting installation services	5%	1%
Lighting maintenance services	4%	<1%*
Other	21%	41%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

Table 2 shows that a majority of distributors have never received training for installing high bay lighting technologies in both regions. The proportions are similar and particularly high for distributors in CA (77%) and in the comparison area (79%).

Table 2
IT2 – Have you ever received training for installing high bay lighting technologies? (All Distributors)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**141**	**77**
Yes	23%	19%
No	77%	79%
Do Not Know	<1%	1%

For distributors who had received training, both regions report that manufacturers are by far their primary training resource. Both regions report training received from manufacturers with high frequency (88% each). Training resources are deeper in CA than in the comparison area, with manufacturers being nearly the only source in the comparison area, and trade associations (16% in the comparison area and 19% in CA) as another, albeit less frequently cited, source. Distributors in CA also report receiving some training from contracting organizations (22%) compared to none in the comparison area. Other organizations are mentioned with considerably less frequency. In CA, investor-owned and public/municipal utilities are mentioned 19% and 13% of the time, respectively, compared to 6% and 0% in the comparison area.

Table 3
IT3 – From which of the following groups did you receive this training? (Multiple Response; Distributors who had received training)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**58**	**17**
Manufacturers	88%	88%
Investor-Owned Utilities	19%	6%
Public/Municipal Utilities	13%	<1%
State Government	3%	<1%

Contracting organizations	22%	<1%
Trade Associations	19%	16%
Other	19%	11%
Refused	<1%	<1%
Do Not Know	<1%	<1%

Market Share and Trends

For the majority of technologies installed, distributors cite different proportions between the two regions. As is the case with contractors, installations of the most efficient technology, T-5 fluorescents, are greater in CA (35% of all fixtures) than in the comparison area (30%), but to a lesser degree. Also in accordance with the contractors, the proportion of installations of the relatively inefficient fluorescent option, T-12 fixtures, is significantly higher (at the 95% confidence level) in the comparison area (18%) than in CA (4%). In contrast to the contractors, the installation of T-8s in both regions are reportedly higher overall, and the comparison area (38%) represents a statistically greater (at the 95% confidence level) percentage of all fixtures than T8s in CA (22%). Distributors in CA also report a significantly greater percentage of pulse-start metal halide fixture installations (16% of all fixtures) compared to the comparison area (8%). This difference is statistically significant at the 95% confidence level. This most likely reflects the effects of incentives offered for pulse-start metal halide technologies by the CA IOUs. Other technologies mentioned and installed by distributors in both areas with lesser frequency, include high-pressure sodium, other HID, and other technologies. The latter two account for a significantly greater percentage of CA fixtures (5% and 7%, respectively) than those in the comparison group (1% for both) at the 95% confidence level.

Table 4
LS2B - Approximately what percentage of all fixtures used in high bay situations were accounted for by the following technologies?
(Distributors who sold the technology in question)

Ratio Estimates	CA	SC-GA-AL-MI
n	111	62
Fluorescent Tube: T-5/Electronic Ballast T-5	35%	30%
Fluorescent Tube: T-8 /Electronic Ballast T-8	22%	38%**
Fluorescent Tube: All other, including T12/Magnetic Ballast	4%	18%**
HID: Pulse-start metal halide	16%	8%**
HID: High-pressure sodium	11%	4%
HID: Other HID such as mercury vapor or probe-start metal halide	5%	1%**
Other: technologies such as Induction or LED	7%	1%**

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

As shown in Table 5, distributors report in similar proportions that they observed an increase in installations of fluorescent high bay lighting technologies over the past three years (77% in CA and 83% in the comparison area), followed by no change (16% and 12%, respectively), and a decrease by a small percentage (7% and 5% respectively).

Table 5
HFL1B - In relation to other technologies used in high bay lighting, have fluorescent lighting installations increased, decreased, or stayed about the same over the past three years?
(Distributors who sold fluorescent lighting installations)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**134**	**74**
Increase	77%	83%
Decrease	7%	5%
Stay the same	16%	12%
Don't Know	<1%	<1%

Perceived trends in the market by distributors for pulse start metal halides are different than for fluorescent technologies. A lower percentage of CA distributors (37%) report an increase over the past few years, compared to 45% in the four Southeastern States. Accordingly, 32% of CA distributors perceive a decrease versus 14% in the comparison area, a statistically significant difference at the 95% confidence level. A small proportion in each group report no change at 26% in CA and 37% in the comparison area.

Table 6
HID1B - In relation to other technologies used in high bay lighting, have high bay pulse-start metal halide lighting installations increased, decreased, or stayed about the same over the past three years?
(Distributors who sold high bay pulse-start metal halide lighting installations)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**117**	**54**
Increase	37%	45%
Decrease	32%	14%**
Stay the same	26%	37%
None	<1%	4%

Refused	1%	<1%
Don't Know	4%	<1%

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

Stocking and Promotion

As shown in Table 7, perceptions of energy efficiency among distributors reflects some regional differences with generally higher levels of awareness in CA of the highest efficiency products. Nearly all (99%) distributors in CA consider T-5 fluorescents to be energy efficient versus 88% in the comparison area (significant at the 95% confidence level). Nearly all (85%) distributors in CA consider LED technologies to be energy efficient compared to 39% in the Southeastern States (significant at the 90% confidence level). A much lesser, but statistically significant (at the 95% confidence level), proportion of CA distributors (44%) include induction technologies compared to 34% in the Southeast. T-8s are considered energy efficient by nearly all (84%) distributors in the comparison area compared to 68% in CA, but not significantly different. Nearly three quarters (74%) of CA distributors consider pulse-start metal halides to be energy efficient compared to 36% in the four Southeastern States, but the difference is also not significantly different. Other technologies are mentioned less frequently with little or no real difference in the responses.

Table 7
LS4 - Which of the following kinds of lighting equipment do you consider to be energy efficient in high bay applications?
(Multiple Response; All Distributors)

Weighted Frequencies	CA	SC-GA-AL-MI
n	**142**	**77**
T-5	99%	88%**
T-8	68%	84%
T-12	9%	<1%
HID: Pulse-Start Metal Halide	74%	36%
HID: Probe Start Metal Halide	11%	4%
HID: High-Pressure Sodium	20%	32%
HID: Low-Pressure Sodium	7%	9%
HID: Mercury Vapor	2%	<1%
LED	85%	39%*
Induction	44%	34%**
Other	<1%	<1%
Don't Know	1%	<1%

* Significantly different from the comparison area at the 90% confidence level (p<=0.1).

** Significantly different from the comparison area at the 95% confidence level (p<=0.05).

Table 8 shows that the tendency for distributors to recommend energy efficient types of high bay lighting equipment is high in both regions, but distributors who “always” recommend energy efficient types of equipment is slightly higher (78%) in CA than in the comparison area (63%).

Table 8
LS5 - How often do you recommend energy efficient types of equipment for high bay applications?
(All Distributors)

Weighted Frequencies	**CA**	**SC-GA-AL-MI**
n	135	74
Always	78%	63%
Most of the Time	16%	27%
Sometimes	5%	1%
Rarely	<1%	1%
Never	<1%	6%
Don't Know	<1%	1%

Table 9 shows verbatim responses for those who rarely or never recommend energy efficient HBL equipment. Most noteworthy, two respondents in CA and five in the comparison claim that making a recommendation is not their role.

Table 9
CR2a – Why do you rarely or never recommend energy efficient types of equipment for high bay applications?
(Distributors who rarely or never recommend energy efficient HBL equipment)

Counts	**CAL**	**SC-GA-AL-MI**
Not our role as distributors/We Don't recommend, we just give customers what they ask for	2	5
Do not deal with HBL enough	1	0
Customer only cares about lower price	1	0

When asked about awareness of electric utility incentive programs for energy efficient high bay lighting, a large majority (81%) of CA distributors say they are aware of incentive programs.

Table 10
PP1 - Are you aware of any electric utility incentive programs for businesses to install energy efficient high bay lighting?
(All CA Distributors)

Weighted Frequencies	CA
n	118
Yes	81%
No	19%
Don't Know	<1%

For distributors representing over a majority (53%) of HBL sales in CA, IOU programs are considered very important (score of 8 or above on a scale from 1 to 10) to their firm's decisions about how to promote energy-efficient HBL equipment. When including all responses above 5 (out of a 1 to 10 scale), over three-quarters (79%) of distributors' sales are represented.

Table 11

PP5 - On a scale of 1 to 10, where 1 is not at all important and 10 is very important, how important are the utility programs in <u>your firm's</u> decisions about how heavily to promote energy-efficient high-bay lighting equipment?
(CA Distributors who participated in IOU supported HBL sales)

Ratio Estimates	CA
n	125
1-4	21%
5-7	26%
8-10	53%

When asked what influence the CA IOU programs have on the market share for energy-efficient lighting technologies, distributors in CA representing 61% of sales claim the programs have been very influential, rating the influence at 8 or higher (on a scale of 1 to 10). When including all responses above 5 (out of a 1 to 10 scale), 91% of distributors' sales are represented.

Table 12

PP6 - Finally, on a scale of 1 to 10, where 1 is no influence and 10 is a great deal of influence, how much influence do you think utility programs have on the market share of energy-efficient lighting technologies in your market area? That is, how much did the program influence your customers?
(CA Distributors who participated in IOU supported HBL sales)

Ratio Estimates	CA
n	123
1-4	9%
5-7	30%
8-10	61%

In terms of marketing support, Table 13 shows that CA distributors cite manufacturers most frequently (67%) with some support from the IOUs (25%), followed by public/municipal utilities (14%) and the state government (1%).

Table 13
MS2 - Do you receive any kind of marketing support for energy efficient high bay lighting technologies from ____________?
(Multiple response; All CA Distributors)

Weighted Frequencies	CA
N	143
Manufacturers	67%
Investor-Owned Utilities	25%
Public/Municipal Utilities	14%
State Government	1%

When asked which IOUs provided the distributors with marketing support, over three-quarters (76%) mention PGE followed by SCE (24%) and the SDG&E (21%).

Table 14
MS3C - Which Investor-Owned Utilities gave you marketing support?
(CA Distributors who received IOU marketing support)

Weighted Frequencies	**CA**
N	43
Pacific Gas and Electric (PG&E)	76%
San Diego Gas and Electric (SDG&E)	21%
Southern Cal Edison (SCE)	24%
Other	6%
Refused	<1%

As shown in Table 15, in terms of the kinds of marketing support provided by the IOUs, CA Distributors most frequently report receiving paid rebates either directly (56%) and/or to their customers (21%). While signing the rebates from the customer to the installer is the most common practice, how the distributor could be directly compensated is unclear. Some possibilities could include additional creative financing terms in which the contractor signs over the customers' incentives to the distributor, or the distributor receives the rebates from the customer as a contracted design service or through customer sales. Distributors also mention literature/brochures/fact sheets and providing speakers for workshops or other assemblies with customers. Distributors frequently describe some other kinds of support as well (35%), including joining them on sales calls, offering classes/training programs, to customers, performing energy audits at customers' sites, IOU representatives working directly with customers, completing paperwork, referring customers, and providing information by email.

Table 15
MS4C - What kind of support did you receive from Investor-Owned Utilities for marketing energy-efficient high-bay lighting?
(Multiple response; CA Distributors who received IOU marketing support)

Weighted Frequencies	**CA**
N	54
Literature, Brochures, Fact Sheets	26%
Provided speakers for my seminars, workshops, etc.	18%
Joined me on customer visits	3%
Rebates paid to me	21%
Rebates paid to my customers	56%
Other discounts	<1%
Cooperative advertising	<1%
Tax incentives	<1%
Financing for customers	<1%
Some other type of support	35%
Refused	<1%
Don't Know	<1%

Perceptions of Customer Awareness and Demand

In terms of distributor sales to contractors, distributors describe similar sales processes between the regions, with most of the sales in each region being specified by the contractor. The most common sales process is where contractors provide a list of their needs and request a quote (34% of sales in CA and 33% in the comparison area). A similar percent of sales (33%) in the Southeastern States are completed by contractors interacting generally with the distributors compared to 23% in CA. Sales situations in which distributors actually perform specification services account for 34% of CA sales and 24% of comparison area sales. None of the values compared between the regions differ significantly.

Table 16
CR1 – What percent of your sales to contractors would you describe as follows?
(All Distributors)

Ratio Estimates	**CA**	**SC-GA-AL-MI**
N	116	73
Contractors come in with a list of what they need and only ask for a price	34%	33%
Contractors come in with a layout and you discuss their options in a general way	23%	33%
You work with contractor to develop lighting layouts and equipment schedules	23%	19%
You work with project engineer or architect to develop lighting layouts	11%	5%
Other approach	9%	10%

Distributors responsible for a larger percentage of sales in CA than in the comparison area are, in turn, more likely to have their recommendations accepted for energy efficient high bay lighting technologies. For 87% of sales in CA, contractors accept distributors' recommendations for energy efficient high bay lighting compared to 67% of distributor sales in the comparison area. For distributors responsible for 21% of high bay lighting sales in the comparison area, they would not make any recommendation, compared to CA distributors making 1% of the sales. None of the values compared between the regions differ significantly. The contrast between the regions is especially relevant in light of the heightened awareness of energy-efficient technologies in CA compared to the southeastern United States region (See Table 7).

Table 17
CR4 – Do contractors generally accept your recommendations for energy efficient high bay lighting for their lighting system?
(All Distributors)

Ratio Estimates	**CA**	**SC-GA-AL-MI**
N	135	74
Yes	87%	67%
No	12%	12%
Would Not Recommend	1%	21%

When asked what percent of customers are aware of the full range of energy efficient HBL options prior to making any recommendations, over half (52%) of CA distributors report that a majority (50% or greater) of their customers are aware of the full range of options versus 43% in the comparison area. The contrast between the regions is especially relevant in light of the heightened awareness of energy-efficient technologies in CA compared to the southeastern United States region (See Table 7).

Table 18
CR3 - About what percent of your customers are aware of the full range of options for energy-efficient high bay lighting available to them before you provide recommendations about the lighting system?
(All Distributors)

Weighted Frequencies	**CA**	**SC-GA-AL-MI**
n	**132**	**68**
Between 0 and 10	8%	9%
Between 11 and 25	13%	11%
Between 26 and 50	27%	37%
Between 51 and 75	20%	15%
Between 76 and 100	32%	28%
Do Not Know	<1%	<1%

HBL MARKET EFFECTS STUDY: LIGHTING DISTRIBUTOR

FINAL INTERVIEW GUIDE

MAY, 2009

Intro

Hello. This is _____________ calling on behalf of the California Public Utilities Commission and KEMA, an energy consulting company.

We are conducting research on the commercial/industrial lighting market in [STATE RESPONDENT IS IN]. In particular we are focusing on sales of high bay lighting by distributors. For the purposes of this interview we define high bay applications as installations for commercial and industrial end-users with ceiling heights of about 15 feet or more. I want to assure you this is not a sales call and that the information you provide will be kept strictly confidential. This survey should only take about 15 minutes of your time.

[IF RESPONDENT ASKS "WHAT ARE END USERS?": "End users include facility managers, users, or owners who either work or live in the lighted space. These can be the customers of contractors."

May I please speak to someone at your company who is familiar with your sales and distribution of commercial lighting products?

ENTER NAME OF CONTACT: ________________________________

IF CONTACT IS NOT AVAILABLE, ASCERTAIN BEST TIME TO CALL.

[REPEAT INTRO AS NEEDED, CONTINUE OR ARRANGE FOR CALLBACK]

[IF NEEDED]

For further questions about this survey, you can contact Kay Hardy of the California Public Utilities Commission. Her phone number is (415) 703-2322. Please make sure that you reference the High Bay Lighting Study.

Initial Screening

IS1 Does your firm, or your division of the firm, sell equipment to the wholesale or retail market? [IF NEEDED, PROMPT: "ARE YOUR CUSTOMERS PRIMARILY CONTRACTORS, ENGINEERS AND END_USERS" and/or "IS YOUR FIRM OR DIVISION A LIGHTING DISTRIBUTOR"]

[IF NOT YES THEN TRY TO FIND THE C&I LIGHTING DIVISION OR THANK AND TERMINATE]

IS2 Does your firm, or your division of the firm, handle distribution of commercial and industrial lighting, including lighting used in high-bay applications? For the purposes of this interview we define high bay applications as installations for commercial and industrial end-users with ceiling heights of about 15 feet or more. [IF NOT YES THEN TRY TO FIND THE C&I LIGHTING DIVISION OR THANK AND TERMINATE]

Screening and Firmographics

SC1 What is your job title?

- Sales Manager 1
- President/CEO 2
- Owner / Co-Owner / Partner /Member of LLP 3
- General Manager 4
- Lighting Manager 5
- Other(Specify)____________________ 6
- [Don't Know] 998
- [Refused] 999

Now, I am going to read some activities that lighting firms perform. For each activity, I would like to know if your firm performs it, and if it does, approximately what fraction of your total annual revenue comes from that activity. Then I'd like to ask you about the different kinds of customers that you serve. [*Populate from table below and accept multiple responses*]

SC2Ax Does your firm do ___________________________?

- Yes 1
- No .... 2→ **Next Activity**
- Other (e.g. "we would but there is no demand for it") (specify__)997→ **Next Activity**
- [Don't Know] .... 998→ **Next Activity**
- [Refused] .... 999→ **Next Activity**

SC2Bx About what fraction of your annual revenue comes from ________________________?

[PROMPT: YOUR BEST ESTIMATE IS FINE]

ENTER NUMBER .... __%
[Don't Know] 998
[Refused] 999

SC2A, SC2B	ACTIVITY	SC2A	SC2B
1	Lighting sales to end users. End users include facility managers, users, or owners who either work or live in the lighted space. These can be the customers of contractors.	1	%
2	Lighting sales to original equipment manufacturers (OEMs)	2	%
3	Lighting sales to contractors	3	%
4	Lighting sales to retailers (showrooms, specialty stores or big-box stores)	4	
5	Lighting layout and design services	5	%
6	Lighting installation services	6	%
7	Lighting maintenance services	7	%
8	Other (Specify)	8	%
			Should sum to between 90% and 105% unless there are any DK/Ref
998	[Don't Know]	998	998
999	[Refused]	999	999

If responded "Don't Know" ask if another respondent at this facility might know.
CONTINUE IF SC2B1 OR SC2B3 AND SC2B4 sum to 5% or more; ELSE TERMINATE

SC3 Approximately how many full-time-equivalent (FTE) staff do you have at this location? [PROBE FOR APPROXIMATE]

ENTER NUMBER .... ____
[Don't Know] 999998
[Refused] 999999

[POPULATE SC4 WITH RESPONDENT FIRM'S STATE]

SC4 How many locations does your firm have in _____? [PROBE FOR APPROXIMATE]

ENTER NUMBER .... ____
[Don't Know] 999998
[Refused] 999999

SC4a In which other states does your firm have locations? [DO NOT READ, MULTIPLES ALLOWED]

[Use FIPS codes for state names]................................[FIPS 2-Digit state code]
No Other States 0
[Don't Know] 998
[Refused] 999

SC5 How would you characterize the location of most of the customers you serve from this location? Would you say it is…. [READ LIST]

Within one hour's drive from location 1
Greater than one hour's drive from the location 2
Statewide 3
Nationwide 4
Internationally 5
Other (specify____) 6
[Don't Know] 998
[Refused] 999

SC6 What is your best estimate of your company's revenue from direct sales of lighting equipment to contractors or commercial and industrial end users in 2008?

ENTER NUMBER.. ________
Don't know 998
Refused 999

IF SC6 = 998 OR 999 ASK SC7. ELSE SKIP TO LS1

SC7 Which of the following ranges best characterizes your company's revenue from direct lighting sales to contractors or commercial and industrial end users in 2008 at this location? [*Read list OK TO ACCEPT A "ROUGH ESTIMATE"*]

Up to $250,000 1
More than $250,000 to $500,000 2
More than $500,000 to $1 million 3
More than $1 million to $2 million 4
More than $2 million to $5 million 5
More than $5 million to $10 million 6
More than $10 million 7
[Don't Know] 998
[Refused] 999

Lighting Equipment Sales

Now I am going to ask you about your sales of commercial and industrial lighting equipment for high bay applications. For the purposes of this interview we define high bay applications as sales for commercial and industrial applications with ceiling heights of about 15 feet or more. **Please answer these questions for your sales directly to commercial and industrial end users and contractors.** In these questions, I will refer to "C&I" meaning "Commercial and Industrial."

I am going to ask you about different lighting technologies, and I would like to know, for each technology, two things: About what percent of your **total 2008 lighting sales revenue** was due to that technology and your sense of about **what fraction of that equipment goes into high-bay applications**. First I will ask about three kinds of fluorescents, then HIDs, then other kinds like LEDs, Induction and so on.

[FOR THE LS1A SERIES OF QUESTIONS, USE THE FOLLOWING WORDING, REPLACING THE EQUIPMENT TYPE AS IN EACH SPECIFIC LIST.]

LS1A Approximately what percentage of your total C & I lighting sales last year was accounted for by [TYPE OF LIGHTING EQUIPMENT]? [Your best approximation is fine. IF NEEDED: Include fixtures, lamps, ballasts and complete systems, whichever is appropriate for your firm.]

ENTER NUMBER [0-100]..__%→ **LS1B series**
[Don't Know] ....998→ **LS2A series**
[Refused] ....999→ **LS2A series**

LS1A1. Fluorescent Tube: T-5/Electronic Ballast T-5 [ALL VARIETIES →**LS2A1 (fluor)**

LS1A2. Fluorescent Tube: T-8 /Electronic Ballast T-8 [ALL VARIETIES]→**LS2A1 (fluor)**

LS1A3. Other fluorescents such as T12 with magnetic ballast ....→**LS2A1 (fluor)**

LS1A4. HID: Pulse start metal halide ....→ **LS2A2 (HID)**

LS1A5. HID: High -pressure sodium ....→ **LS2A2 (HID)**

LS1A6. Other HID such as mercury vapor or probe-start metal halide.→ **LS2A2 (HID)**

LS1A7. Other technologies such as Induction or LED...................... → **LS2A3 (Other)**

LS1B1 About what percentage of those [TYPE OF LIGHTING EQUIPMENT] is installed in high bay applications? [IF NECESSARY, DEFINE HIGH BAY APPLICATIONS AS CEILING HEIGHT GREATER THAN 14 FEET.] [PROMPT: YOUR BEST ESTIMATE IS FINE]

ENTER NUMBER [0-100]...__% → **Next LS1A**
[Don't Know] ....998 → **Next LS1A**
[Refused] ....999 → **Next LS1A**

[IF ANY OF (LS1A1, LS1A2, LS1A3) ARE DK/REF THEN ASK LS2A1; ELSE LS2A1 = SUM (LS1A1, LS1A2, LS1A3)]

LS2A1 Can you tell me about what percentage of your total C & I lighting sales was fluorescent?

ENTER NUMBER .... ___% → **LS2B1**
[Don't Know] .... 998 **Next LS1A**
[Refused] .... 999 **Next LS1A**

[IF ANY OF (LS1A4, LS1A5, LS1A6) ARE DK/REF THEN ASK LS2A2; ELSE LS2A2 = SUM (LS1A4, LS1A5, LS1A6]

LS2A2 Can you tell me about what percentage of your total C & I lighting sales was HID?

ENTER NUMBER .... ___% → **LS2B2**
[Don't Know] .... 998 **Next LS1A**
[Refused] .... 999 **Next LS1A**

[IF ANY OF (LS1A7, LS2A1, LS2A2) ARE DK/REF THEN ASK LS2A3; ELSE LS2A3 = LS1A7]

LS2A3 Can you tell me about what percentage of your total C & I lighting sales was SOMETHING OTHER THAN FLUORESCENT OR HID?

ENTER NUMBER .... ___% → **LS2B3**
[Don't Know] .... 998 **Next LS1A**
[Refused] .... 999 **Next LS1A**

[IF RESPONDENT ANSWERED LS2A SERIES THEN ASK CORRESPONDING LS2B SERIES; ELSE WE WILL COMPUTE IT POST AS A WEIGHTED AVERAGE OF THE LS1B SERIES]

LS2B1 About what percentage of fluorescent equipment is installed in high bay applications? [IF NECESSARY, DEFINE HIGH BAY APPLICATIONS AS CEILINGS WITH HEIGHT OF 15 FEET OR HIGHER.] [PROMPT: YOUR BEST ESTIMATE IS FINE]

ENTER NUMBER .... ___%**Next LS1A**
[Don't Know] .... 998 **Next LS1A**
[Refused] .... 999 **Next LS1A**

LS2B2 About what percentage of HID equipment is installed in high bay applications**? [IF NECESSARY, DEFINE HIGH BAY APPLICATIONS AS CEILING HEIGHT GREATER THAN 14 FEET.] [PROMPT: YOUR BEST ESTIMATE IS FINE]**

ENTER NUMBER .... ___% **Next LS1A**
[Don't Know] .... 998 **Next LS1A**
[Refused] .... 999 **Next LS1A**

LS2B3 About what percentage of those other types of lighting equipment is installed in high bay applications? [IF NECESSARY, DEFINE HIGH BAY APPLICATIONS AS CEILINGS WITH HEIGHT OF 15 FEET OR HIGHER.] [PROMPT: YOUR BEST ESTIMATE IS FINE

ENTER NUMBER..___% **Next LS1A**
[Don't Know] ....998 **Next LS1A**
[Refused] ....999 **Next LS1A**

This table may help to clarify what we're looking for		**LS1a**	**LS1b**
	First, three kinds of fluorescents [some prefer to give a total fluorescent percentage, and then do the breakdown % of fluorescent sales]	**% Lighting Sales**	**Of that technology, what percent goes into High-Bay applications**
LS1A1.	Fluorescent Tube: T-5/Electronic Ballast	%	%
LS1A2.	Fluorescent Tube: T-8 /Electronic Ballast	%	%
LS1A3.	Fluorescent Tube: Other, including T12/Magnetic Ballast	%	%
LS2A1	(all fluorescents)	**Ideally subtotal**	**but ask if it's they don't know the breakdown**
	Next, five kinds of HID technology [some prefer to give a total HID percentage, and then do the breakdown % of HID sales]		
LS1A4.	HID: pulse start metal halide	%	%
LS1A5.	HID: high pressure sodium	%	%
LS1A6.	HID: other	%	%
LS2A2	(all HID)	**Ideally subtotal**	**but ask if it's they don't know the breakdown**
	Next, other technologies:		
LS1A7.	All other than HID or Fluorescent	%	%
LS2A3	(all other)	**Ideally subtotal**	**but ask if it's they don't know the breakdown**
	TOTAL	**Must sum to**	**between 90% and 105%**

LS3 Where do you get the information about where the equipment is used, and whether it goes into High Bay applications?

[DO NOT READ, MULTIPLES ACCEPTED; OKAY TO PROMPT IF NEEDED]

Consulting or talking with contractor before the sale 1
Consulting or talking with end-users before the sale 2
Feedback from contractors after install 3
Feedback from end-users after install 4
Information from Manufacturers and OEMs 5
Information from trade associations (Specify: ___________) 6
"My years of experience in this field" 7
Other Distributors 8
Investor-Owned Utilities, ... 9
Public/Municipal Utilities 10
State Government 11
Architects and engineers 12
Big Box/ Wholesalers/ Retailers 13
Friends 14
Conferences/ Workshops/ Meetings 15
Other (specify________________) 16
Don't Know 998
Refused 999

LS4 Which of the previous kinds of lighting equipment you mentioned do you consider to be energy-efficient in high bay applications?

[READ LIST, MULTIPLES ACCEPTED]

T5 (all varieties) 1
T-8 (all varieties) 2
T-12 3
Pulse start metal halide (HID) 4
Probe start metal halide (HID) 5
High -pressure sodium (HID) 6
Low-pressure sodium (HID) 7
Mercury vapor (HID) 8
LED 9
Induction 10
Other (Specify) __________ 11
Don't Know 998
Refused 999

CONTRACTOR-RELATED QUESTIONS

Now I'd like to ask you some questions regarding your work with contractors.

CR1 Generally speaking, what percent of your sales to contractors would you describe as follows? Again, approximations are fine. [READ LIST, ENTER PERCENT FOR EACH CATEGORY]

a. Contractors come in with a list of what they need and only ask for a price (that is, they don't ask for your input)...___%
b. Contractors come in with a layout and you discuss their options in a general way___%
c. You work with contractor to develop lighting layouts and equipment schedules..___%
d. You work with project engineer or architect to develop lighting layouts ....___%
e. Other approach (Specify) ________________________________ ....___%
[Don't Know]...998
[Refused]..999

[MUST SUM TO between 90% and 105% UNLESS THEY ANSWER DK/REF;]

CR2 In those contractor sales situations where you have the opportunity, how often do you recommend energy efficient types of equipment for high bay applications? Would you say it is …?

A. Always……………...____ → **CR3**
B. Most of the time.. ………….____ → **CR3**
C. Sometimes .... ……. ____ → **CR3**
D. Rarely... ……………………………____ → **CR2A**
E. Never...____→ **CR2A**
[Don't Know] ....998 → **CR3**
[Refused] ....999 → **CR3**

CR2A Why do you ____ **[INSERT RESPONSE WORD (RARELY OR NEVER) FROM CR2]** recommend energy efficient types of equipment for high bay applications?

____

____

CR3 About what percent of contractors are aware of the full range of options for energy-efficient high bay lighting available to them before specifying the lighting system?

[Enter number between 0% and 100%] ....………………………………____%
[Don't Know] 998
[Refused] 999

CR4 Do contractors generally accept your recommendations for energy efficient high bay lighting for their lighting system?

Yes..___→ **HFL1**

No ....____→ **CR5**

[Don’t Know] ....998→ **CR5**

[Refused] ....999→ **CR5**

CR5 [FOR ALL CR4 <> YES] Why not? [Don’t know 998; Refused 999]

____

____

____

FLUORESCENT LAMPS

[READ TO ALL RESPONDENTS.]

Now I would like to ask you about your experiences with fluorescent high-bay lighting

[IF RESPONDENT SAYS "CUSTOMERS," PROBE FOR CONTRACTORS OR END USERS. REPEAT IF NECESSARY: "End users include facility managers, users, or owners who either work or live in the lighted space. These can be the customers of contractors."

[IF LS2A1 =0% OR IS MISSING, DK OR REFUSED THEN ASK HFL1A; ELSE SKIP TO HFL1B]

HFL1A Why doesn't your firm carry any fluorescent high-bay lighting products?

[Do not read, accept multiples]

End-users don't like light quality 1
Contractors don't like light quality 2
I (or my firm) don't like light quality 3
End-users say they don't give enough light 4
Contractors say they don't give enough light 5
End-users don't like higher purchase-price of fixtures 6
Contractors don't like higher purchase-price of fixtures 7
I (or my firm) don't like higher purchase-price of fixtures 8
Don't last as long as advertised 9
End-users disappointed with savings 10
Contractors disappointed with savings 11
Cost more to maintain 12
Product does not sell without rebates/incentives/loans 13
Cannot sell in current economy 14
Other (specify:__________) 15
DO NOT GET FEEDBACK FROM CONTRACTORS 16
[Don't Know] 998
[Refused] 999

[SKIP TO LOGIC BEFORE HID1A]

HFL1B In relation to other technologies used in high bay lighting, have sales of <u>high bay fluorescent lighting</u> increased, decreased, or stayed about the same over the past three years?

Increased 1
Decreased 2
Stayed about the same 3
[Not applicable to business] [SKIP TO HID1] 4

[Don't Know] 998
[Refused] 999

[Populate with "Increase", "Decrease" or "Remain the same" from HFL1B]

HFL2 Do you expect this market share will continue to **[RESPONSE FROM HFL1B]** in the next two years?

Yes ____ 1

No ____ 2

Don't know ____ 998

Refused ____ 999

HFL3 In your opinion, what will be the main factors in determining the market share of high-bay fluorescent lights in the next two years? **[Do not read, accept multiples]**

Cost of Electricity 1
Lower purchase-price of equipment/new tech.. 2
Rebates from utility 3
Rebates/Deals from Manufacturer 4
Concern/Awareness of Saving Energy... 5
Concern for Environment.. 6
New technologies give better light... 7
New technologies work in more places (temp range, heights, etc.)...................... 8
Easier to maintain/ costs less to replace lamps, maintain................................. 9
Better/More Advertising 10
Changes in building codes, other legal changes.. 11
Demand from end users 12
Other (Specify:_____________) 12
[Do not know]... 998
[Refused] 999

HFL4 What do contractors tell you about how their customers respond to the high-bay fluorescents installed in their facilities? **[Do not read, accept multiples]**

<u>Love</u> the light quality (compared to the old system)	1
<u>Hate</u> the light quality (compared to the old system)	2
Worth the money	3
<u>Not</u> worth the money	4
Like saving money on electricity	5
Like saving energy	6
Disappointed with savings	7
End-users like the rebates	8
End-users not satisfied with rebates	9
Harder/costs more to maintain (than old system)	10
Easier/costs less to maintain (than old system)	11
Costs too much to change to another technology	12
Likes them, unspecified	13
Dislikes them, unspecified	14
Ability to control light (dimmers or sensors)	15
Other (specify:	16
DO NOT GET FEEDBACK FROM CONTRACTORS	17
[Don't Know]	998
[Refused]	999

HFL5A Based on feedback you get from contractors, on a scale from one to ten where 1 is "very difficult", and ten is "very easy", how easy is it to <u>install</u> HFLs ?:

ENTER 1 – 10	_____
DO NOT GET FEEDBACK FROM CONTRACTORS	997
[Don't Know]	998
[Refused]	999

HFL5B Based on feedback you get from contractors, on a scale from one to ten where 1 is "very difficult", and ten is "very easy", how easy is it to <u>maintain</u> HFLs ?:

ENTER 1 – 10	_____
DO NOT GET FEEDBACK FROM CONTRACTORS	997
[Don't Know]	998
[Refused]	999

HFL5C What other feedback do contractors give you? ______________________________

____

PULSE START METAL HALIDES

[READ TO ALL RESPONDENTS]

Now I would like to ask you about your experiences with pulse-start metal halide in high-bay applications

[IF LS1A4 >0% AND NOT 998 (DK) OR 999 (REF) OR MISSING THEN ASK HID1A; ELSE SKIP TO HID1B]

[IF RESPONDENT SAYS "CUSTOMERS," PROBE FOR CONTRACTORS OR END USERS. REPEAT IF NECESSARY: "End users include facility managers, users, or owners who either work or live in the lighted space. These can be the customers of contractors."

HID1A Why doesn't your firm carry any pulse-start metal halide high-bay lighting products?

[Do not read, accept multiples]

End-users don't like light quality 1
Contractors don't like light quality 2
I (or my firm) don't like light quality 3
End-users say they don't give enough light 4
Contractors say they don't give enough light 5
End-users don't like higher purchase-price of fixtures 6
Contractors don't like higher purchase-price of fixtures 7
I (or my firm) don't like higher purchase-price of fixtures 8
Don't last as long as advertised 9
End-users disappointed with savings 10
Contractors disappointed with savings 11
Cost more to maintain 12
Product does not sell without rebates/incentives/loans 13
Cannot sell in current economy 14
Other (specify:__________) 15
DO NOT GET FEEDBACK FROM CONTRACTORS 16
[Don't Know] 998
[Refused] 999

[SKIP TO MS1]

HID1B In relation to other technologies used in high bay lighting, have sales of pulse-start metal halides increased, decreased, or stayed about the same over the past three years?

Increased 1
Decreased 2
Stayed about the same.. 3
[Not applicable to business] [SKIP TO MS1].. 4
[Don't Know] 998
[Refused] 999

[Populate with "Increase", "Decrease" or "Remain the same" from HID1B]

HID2 Do you expect this market share will continue to **[RESPONSE FROM HID1B]** in the next two years?

Yes ____ 1
No ____ 2
Don't know ____ 998
Refused ____ 999

HID3 In your opinion, what will be the main factors in determining the market share of high bay pulse-start metal halide in the next two years? **[Do not read, accept multiples]**

Cost of Electricity.. 1
Lower purchase-price of equipment/new tech.. 2
Rebates from utility.. 3
Rebates/Deals from Manufacturer 4
Concern/Awareness of Saving Energy.. 5
Concern for Environment... 6
New technologies give better light... 7
New technologies work in more places (temp range, heights, etc.)................... 8
Easier to maintain/ costs less to replace lamps, maintain.............................. 9
Better/More Advertising... 10
Changes in building codes, other legal changes.. 11
Demand from end-users.. 12
Other (Specify:_____________) 13
[Do not know]... 998
[Refused] 999

HID4 What do contractors tell you about how their customers respond to the pulse-start metal halides installed in their facilities? **[Do not read, accept multiples]**

<u>Love</u> the light quality (compared to the old system) 1
<u>Hate</u> the light quality (compared to the old system) 2
Worth the money 3
<u>Not</u> worth the money 4
Like saving money on electricity 5
Like saving energy 6
Disappointed with savings 7
End-users like the rebates 8
End-users not satisfied with rebates 9
Harder/costs more to maintain (than old system) 10
Easier/costs less to maintain (than old system) 11
Costs too much to change to another technology 12
Likes them, unspecified 13
Disikes them, unspecified 14
Ability to control light (dimmers or sensors) 15
Other (specify:___________) 16
DO NOT GET FEEDBACK FROM CONTRACTORS 17
[Don't Know] 998
[Refused] 999

HID5A Based on feedback you get from contractors, on a scale from one to ten where 1 is "very difficult", and ten is "very easy", how easy is it to <u>install</u> pulse-start metal halides?:

ENTER 1 – 10 .... ______
DO NOT GET FEEDBACK FROM CONTRACTORS 997
[Don't Know] 998
[Refused] 999

HID5B Based on feedback you get from contractors, on a scale from one to ten where 1 is "very difficult", and ten is "very easy", how easy is it to <u>maintain</u> pulse-start metal halides?:

ENTER 1 – 10 .... ______
DO NOT GET FEEDBACK FROM CONTRACTORS 997
[Don't Know] 998
[Refused] 999

HID5C What other feedback do contractors give you? ___________________________

____

Marketing Support

MS1 What activities do you undertake to market energy-efficient high bay lighting technologies? **[DO NOT READ LIST, MULTIPLES ACCEPTED, PROMPT IF NECESSARY.]**

Talk directly with customers/in-person sales 1
Direct mail/newsletter 2
Telephone advertising 3
Advertise on my company's website 4
Purchase web ads (eg. Google's Adsense) 5
Advertise on contractor or trade websites 6
Sell over the internet/web 7
Radio advertising 8
Print advertising 9
Showroom, tours 10
Offer classes/workshops 11
Offer special discounts, promotions 12
Notify investor-owned and public utility companies 13
Notify other distributors 14
Notify contractors 15
Other (Specify) __________ 16
Don't Know 998
Refused 999

[ASK THE FOLLOWING QUESTION SEQUENCE FOR EACH OF THE MARKET ACTORS:

(A) Manufacturers,

(B) Investor-Owned Utilities,

(C) Public/Municipal Utilities,

(D) State Government

THAT IS, ASK IN THIS ORDER:

DO MS2A, MS3A, MS4A, MS5A, MS2B, MS3B, MS4B, MS5B, etc. through MS5D]

MS2 Do you receive any kind of marketing support for energy efficient high bay lighting technologies from ____________?

Yes .... 1 → **MS3**

No .... 2 → **Next MS2**
[Don't Know] .... 998 → **Next MS2**
[Refused] .... 999 → **Next MS2**

[IF NONE OF THE MS2 SERIES IS = 1 THEN SKIP TO **LOGIC BEFORE** MS9]

MS3A Which Manufacturers gave you marketing support? **[DO NOT READ; MULTIPLES ACCEPTED]**

Lithonia	1
Osram-Sylvania	2
GE	3
TCP (Technical Consumer Products)	4
Philips	5
Grainger	6
Ruud	7
Paragon	8
Cooper	7
Day-Brite	8
Graybar	8
Other (specify:___________)	9
[Don’t Know]	998
[Refused]	999

MS3B Which Investor-Owned Utilities gave you marketing support? **[DO NOT READ; MULTIPLES ACCEPTED]**

Pacific Gas and Electric (PG&E)	**15**
San Diego Gas and Electric (SDG&E)	**18**
Southern Cal Edison (SCE)	**20**
Other (specify:___________)	24
[Don’t Know]	998
[Refused]	999

MS3C Which Public/Municipal Utilities gave you marketing support? **[ASK IF CA ONLY; DO NOT READ; MULTIPLES ACCEPTED]**

Alameda	**1**
Azusa	**2**
Burbank	**3**
Healdsburg	**4**
Imperial	**5**
Long Beach	**6**
Los Angeles	**7**
Palo Alto	**8**
Pasadena	**9**
Sacramento (SMUD)	**10**
Other (specify:___________)	18
[Don’t Know]	998
[Refused]	999

MS3D Which state government gave you marketing support**? [DO NOT READ; MULTIPLES ACCEPTED]**

California	1
Alabama	2
Georgia	3
Louisiana	4
Mississippi	5
North Carolina	6
South Carolina	7
Other (specify:___________)	8
[Don't Know]	998
[Refused]	999

[ASK THE FOLLOWING QUESTIONS FOR EACH OF THE MARKET ACTORS RECEIVING YES RESPONSE TO MS2:]

(A) Manufacturers,

(B) Investor-Owned Utilities,

(C) Public/Municipal Utilities,

(D) State Government.

MS4 What kind of support did you receive from ________ for marketing energy-efficient high-bay lighting?

[DO NOT READ, MULTIPLES ACCEPTED]

Literature, Brochures, Fact Sheets	1
Provided speakers for my seminars, workshops, etc.	2
Joined me on customer visits	3
Rebates paid to me	4
Rebates paid to my customers	5
Other discounts	6
Cooperative advertising	7
Tax incentives	8
Financing for customers	9
Other (specify:___________)	10
[Don't Know]	998
[Refused]	999

MS5 Which energy-efficient high-bay lighting technologies are marketed and/or promoted?

[DO NOT READ, MULTIPLES ACCEPTED]

T12 1
T-8 (all varieties) 2
T-5 (all varieties) 3
Probe start metal halide (HID) 4
Pulse start metal halide (HID) 5
Low-pressure sodium (HID) 6
High-pressure sodium (HID) 7
Mercury vapor (HID) 8
LED 9
Induction 10
Other (Specify) __________ 11
Don't Know 998
Refused 999

[IF NONE OF THE MS2 SERIES IS = 1 THEN SKIP TO **LOGIC BEFORE PP1**]

MS6 Do you think the marketing support helped you to sell more energy efficient high bay lighting?

Yes 1
No 2
Don't know 3

MS7 Would you market energy efficient high bay lighting technologies without this support?

Yes 1
No 2
Don't know 3

MS8 Which of the following, if any, do you partner with to market energy efficient high bay lighting technologies?

- Utilities ....1→ **MS8A**
- Manufacturers...2→ **MS8A**
- Contractors ....3→ **MS8A**
- Other Distributors ....3→ **MS8A**
- Other..4→ **MS8A**
- Don't Know ....998→ **PP1**
- Refused ....999→ **PP1**

MS8A Which ones? [OPEN RESPONSE, 998 DON'T KNOW 999 REFUSED]

____

____

____

Program Participation [ask for California firms; else skip to GT1]

PP1 Are you aware of any <u>electric</u> <u>utility</u> incentive programs for businesses to install high bay lighting?

- Yes 1
- No.. 2
- Don't know 3

[IF PP1 = 1, ASK PP2. ELSE SKIP TO GT1]

PP2 Have you supplied equipment to projects that have received incentives from an electric utility?

- Yes 1
- No.. 2
- Don't know 3

[IF PP2 = 1, ASK PP3; ELSE SKIP TO PP7]

PP3 Did those customers get the incentives from…? **[ACCEPT MULTIPLES;, PROMPT FOR first three on the list (PG&E, SDG&E, SCE) plus "Any Others?"]**

Pacific Gas and Electric (PG&E) 1
San Diego Gas and Electric (SDG&E) 2
Southern Cal Edison (SCE) 3

Any other utilities? **[DO NOT READ THE REST OF THIS LIST BELOW]**

[Alameda] 4
[Azusa] 5
[Bear Valley Electric] 6
[Burbank] 7
[Citizens Electric] 8
[Imperial] 9
[Integrys] 10
[Long Beach] 11
[Los Angeles (LADWP)] 12
[Mountain Utilities] 13
[PacifiCorps] 14
[Palo Alto] 15
[Pasadena] 16
[Sacramento (SMUD)] 17
[Sierra Pacific Power] 18
[Other (specify:__________)] 19
[Don't Know] 998
[Refused] 999

PP4. [THIS NUMBER INTENTIONALLY SKIPPED]

PP5 [IF PP3 IS NOT ONLY SMUD (15), ELSE SKIP TO PP7]

On a scale of 1 to 10, where 1 is not at all important and 10 is very important, how important are the utility programs in **your firm's** decisions about how heavily to promote energy-efficient high-bay lighting equipment?

ENTER 1 – 10, 998 FOR DK, 999 FOR REFUSED .... _____

PP6 Finally, on a scale of 1 to 10, where 1 is no influence and 10 is a great deal of influence, how much influence do you think utility programs have on the **market share** of energy-efficient lighting technologies in your market area? That is, how much did the program influence your customers?

ENTER 1 – 10, 998 FOR DK, 999 FOR REFUSED _____

PP7 Have you participated in other programs that promote energy efficient technologies for businesses?

Yes 1

No.. 2

Don't know 3

PP8 Which ones? If you don't know specifically, please describe it, the sponsor, and what incentives you received and why you received them?

____

____

____

Training

NOW I AM GOING TO ASK YOU HOW YOU LEARN ABOUT COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT FOR HIGH BAY APPLICATIONS. FOR THE PURPOSES OF THIS INTERVIEW WE DEFINE HIGH BAY APPLICATIONS AS INSTALLATIONS FOR COMMERCIAL AND INDUSTRIAL END-USERS WITH CEILING HEIGHTS OF ABOUT 15 FEET OR MORE.

IT1. [INTENTIONALLY BLANK]

IT2. Have you ever received training for installing energy efficient high bay lighting technologies?

(D) Yes
(E) No (SKIP TO GT1)
(F) DK/refused (SKIP TO GT1)

IT 3. From which of the following groups did you receive this training [ACCEPT MULTIPLE RESPONSE; DO NOT READ]:

(A) Manufacturers

(B) [INTENTIONALLY BLANK]

(C) Investor-Owned Utilities,

(D) Public/Municipal Utilities,

(E) State Government

(F) Contracting organizations

(H) Trade Associations (specify:___________)

(I) Other (specify:___________)

General Market Trends

GT1 About what percentage of your revenues from the sales of commercial/industrial lighting equipment comes from new construction projects, as opposed to replacements and retrofits? **[PROBE FOR APPROXIMATE]**

ENTER PERCENT NEW CONSTRUCTION..____%
[Don't Know] 998
[Refused] 999

[IF GT1 > 20% ASK GT2. ELSE SKIP TO GT4]

GT2 Are your customers more likely, less likely or equally likely to install energy-efficient high-bay lighting for new construction than for existing buildings?

More likely...1

Less likely 2

Equally likely 3

Don't Know..998

Refused...999

[IF GT2 = 1 OR 2, ASK GT3. ELSE SKIP TO GT4]

GT3 What are the main reasons you are **[POPULATE FROM GT2]** to install energy efficient equipment in new construction versus existing buildings?

____

____

____

GT4 Thinking about the overall market, what do you think could be done to increase the installation of energy-efficient high-bay lighting in the commercial and industrial customer sectors? [DO NOT READ]

- Lower prices overall 1
- Quality standards for equipment (low-Q deters customers) 2
- Fluorescents not good enough yet 3
- Education for contractors/architects/owners 4
- Building code requirements 5
- It will change when induction is cost-effective 6
- It will change when LEDs are cost-effective 7
- More/bigger utility rebates 8
- More/bigger tax breaks from state 9
- More/bigger tax breaks from federal government 10
- Innovative Pricing Schemes (leasing rather than buying, etc.) 11
- Low-cost loans 12
- EE light quality must improve 13
- EE durability/maintenance must improve 14
- Other (specify:__________) 15
- [Don't Know] 998
- [Refused] 999

THANK YOU FOR YOUR TIME AND COOPERATION.

APPENDIX G: End User Survey Data and Survey Instrument

Overview

From the end user survey responses, the key takeaways are as follows:

- Respondents in both regions were generally unaware of pulse-start metal halide technologies (about 80% not aware in each area) prior to undertaking their HBL installation project(s). Respondents in both territories claim similar awareness of fluorescent technologies (about 50%)—most likely a large proportion recall older T-12 technologies since these awareness levels are higher than for pulse-start metal halides, the predominant HBL technology.
- California end users are more likely to learn about pulse start metal halide high-bay lighting equipment from vendors than in the comparison area (26% versus 3%, significant at the 90% confidence level) whereas they hear about fluorescent technologies from vendors with equal frequency (19% each). From the survey data, we cannot determine awareness channels for specific fluorescent technologies (e.g., T5HO, T8, or T12)
- For the comparison area, end users claim to receive more information on HBL technologies from experiences with past projects than in CA. For pulse start metal halides, 20% of end users rely on previous experience for their information in the comparison area compared to less than 1% in CA. For fluorescent high-bay equipment, 38% of end users rely on previous experience for their information in the comparison area compared to 11% in CA. Both comparisons are significant at the 90% confidence level.
- Most end users' spaces in both regions are served by fluorescent tube fixtures. CA end users' spaces eligible for HBL lighting are served by fluorescent tubes more frequently than in the comparison area (76% versus 55%). By contrast, HBL eligible spaces in the comparison area are more frequently served by HID lamps (36% versus 13%) than in CA. The differences in both cases are significant at the 95% confidence level.
- End user reasons for installing the HBL equipment differs substantially between the regions (Table 18). A majority (52%) of end users in CA replace operable equipment in order to upgrade performance compared to 31% of end users in the comparison area. End user HBL installations from remodeling (21%) and failure (21%) are higher in the comparison area than in CA (9% and 5 % respectively). The differences in both cases are significant at the 95% confidence level.
- More end users' high-bay space in CA is lit by equipment purchased between 2006 and 2008 than in the comparison area. Overall, 75% of CA end users installed high-bay lighting in over half (51% or higher) of the high-bay spaces in their facilities compared to 54% in the comparison area.
- In both regions, end users' primary objectives are most frequently to save energy and save money. In CA, 45% of end users chose their HBL technology to save energy compared to 30% in the comparison area. Likewise in CA, 33% of end users chose their HBL technology to save money compared to 20% in the comparison area (significant at the 90% confidence level). The comparison area end users also selected their specific HBL technologies to improve lighting (19%) more so than those in CA (5%), which is significant at the 95% confidence level. Also, a relatively high number of comparison

area end users (22% versus 8% in CA) offer reasons (verbatim responses from the "other" category) for why they replaced what was previously installed, including five respondents who replaced the same technology and one who upgraded to meet building code. Other objectives for selecting the specific HBL technology, when probed, are similar across the board, we note that "Available Rebates" in CA increased from 4% to 10% as a secondary objective.

- A majority of end users in both regions have individuals outside their organization specify or recommend the type of HBL equipment used in the installation project, but a higher majority exists in CA. Nearly two-thirds (65%) of CA end users have outside individuals specify or recommend equipment whereas in the comparison area this percentage falls to 51%. Additionally, the difference between the regions is significant at the 90% confidence level. By contrast, 38% of comparison area end users do not use outside individuals compared to the 20% of CA end users that do not either. This difference is significant at the 95% confidence level.
- Occupancy or motion sensors were installed in 39% of the CA end user projects compared to 12% in the comparison area (significant at 95% confidence level). For nearly three-quarters (74%) of comparison area end users, simple on/off switches were installed compared to 56% of end users in CA (significant at 95% confidence level).
- A majority (52%) of CA end users are aware of IOU programs to reduce energy use and costs, but few qualifying end users in CA report receiving incentives for the high-bay lighting. We note that respondents were screened for knowledge of the installations and not for understanding of the terms and conditions of the installation contract. Since the IOUs' incentives can be signed over to the lighting installer, how many respondents actually received the incentive without their knowledge is unclear.
- The weighted average of the electricity bills paid for the building stock of the HBL installations is considerably larger in the comparison area ($9,389 versus $11,707 in the comparison area). The weighted average of square footage, however, of the building stock of the HBL installations is considerably larger in CA (203,258 square feet versus 128,880 in the comparison area).

Knowledge, understanding and attitudes regarding the use of high-bay fluorescent lighting.

Tables 1 and 2 show similar response patterns in terms of perceived awareness of HBL technologies, prior to the projects undertaken. Respondents in both regions were generally unaware of pulse-start metal halide technologies (about 80% not aware in each area) prior to undertaking their HBL installation project(s). Respondents in both territories claim similar awareness of fluorescent technologies (about 50%)— most likely a large proportion recall older T-12 technologies since these awareness levels are higher than for pulse-start metal halides, the predominant HBL technology.

Table 1

PL9a. - Had you heard of pulse-start metal halide equipment for indoor use prior to undertaking this project?

(End Users who upgraded HBL with PSMH fixtures)

Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
YES	13%	22%
NO	82%	78%
REFUSED	3%	<1%
DON'T KNOW	2%	<1%

Table 2

PL12a. - Had you heard of fluorescent equipment for high-bay lighting applications prior to undertaking this project?

(End Users who upgraded HBL with HFL fixtures)

Weighted Frequency	CA	SC-GA-AL-MI
n	69	33
YES	47%	53%
NO	50%	43%
DON'T KNOW	3%	4%

Tables 3 and 4 show some differences between the two regions in terms of contrasting higher end-user reliance on lighting vendors in CA versus higher previous experience in the comparison area. For both high efficiency technologies, experience with previous projects is a more common source in the comparison area (20% for pulse-start metal halides and 38% for fluorescent equipment) than in CA (at less than 1% and 11% respectively). The difference for fluorescents is significant at the 90% confidence level. For pulse-start metal halides, CA end-users mentioned lighting vendors more frequently than in the comparison area (26% versus 3%) significantly different at the 90% confidence level. For fluorescent technologies, however, both regions heard from vendors with equal frequency (19%). From the survey data, we cannot determine awareness channels for specific fluorescent technologies (e.g., T5HO, T8, or T12)

Table 3
PL9b. - From what sources had you heard about pulse-start metal halide equipment?

(End Users who upgraded HBL with PSMH fixtures and had heard of PSMH fixtures for indoor use prior to undertaking the project)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	17	17
Lighting vendors	26%	3%*
Trade or industry representatives	22%	17%
We sell or already use it	13%	13%
Family member is an electrical contractor	10%	<1%
Lighting show	9%	<1%**
Internal staff	8%	5%
Electrician	6%	<1%
Architects/Engineers	6%	6%
Internet	3%	<1%
Experience with previous projects	<1%	20%
Colleagues or competitors in the industry	<1%	10%
Utility programs or representatives	<1%	0%
Popular science	<1%	6%
Refused	<1%	0%
Don't Know	6%	21%

* Significantly different from the comparison area at the 90% confidence level.

** Significantly different from the comparison area at the 95% confidence level.

Table 4
PL12b.- From what sources had you heard about fluorescent high-bay equipment?

(End Users who upgraded HBL with HFL fixtures and had heard of HFL fixtures for indoor use prior to undertaking the project)

Weighted Frequency	CA	SC-GA-AL-MI
n	31	18
Lighting vendors	19%	19%
Trade publications	16%	<1%**
Trade or industry representatives	14%	27%
Experience with previous projects	11%	43%**
Colleagues or competitors in the industry	8%	5%
Utility programs or representatives	8%	<1%
Electrician	5%	<1%
Hardware store	4%	<1%
Family member is electrical contractor	3%	<1%
Architects/Engineers	2%	6%
Internal staff	<1%	<1%
Manufacturers	<1%	5%
Other	3%	<1%
Refused	<1%	<1%
Don't Know	<1%	3%

** Significantly different from the comparison area at the 95% confidence level.

For Tables 5 to 7, end users were asked about organizational and corporate energy management issues. The response patterns are very similar between the regions, in terms of who is assigned to manage energy use, where the energy management function is located in the corporate physical structure, and whether there are any energy management goals at the facility of the respondent. For CA, 80% of HBL end users and 74% in the comparison area have energy management goals for their facilities (See Table 7).

Table 5

EP1 - First, is there a person, group, or department in your organization that is assigned by top management to manage energy use and costs?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	122	78
Yes-one person	27%	28%
Yes-a group	10%	11%
Yes-a department	10%	12%
NO ONE	49%	45%
DON'T KNOW	4%	3%

Table 6

EP2 - Is this [EP1: PERSON, GROUP, OR DEPARTMENT] located at your facility, corporate headquarters, or another location?

(End Users with Organizational Environmental Initiatives)

Weighted Frequency	CA	SC-GA-AL-MI
N	52	33
Corporate Headquarters	49%	44%
Respondent's facility	44%	40%
Another facility	6%	10%
Don't Know	<1%	5%

Table 7

EP3 - Does your organization have energy use reduction goals for this facility?

(End Users with Organizational Environmental Initiatives)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	52	33
YES	80%	74%
NO	14%	26%
DON'T KNOW	6%	<1%

In terms of specific energy management tasks, the responses between the two regions are similar but CA end-users exceed the comparison area in two key tasks. For 82% of end users in CA, persons are assigned responsibilities for tracking energy use and costs over time (Table 8) compared to 59% in the comparison area (significant at the 95% confidence level). For 70% of end users in CA, persons are assigned responsibilities for developing policies for purchasing energy efficiency equipment compared to 49% in the comparison area.

Table 8

EP4 - Are there persons in your organization who have been assigned responsibility for the following activities?

(End Users with Organizational Environmental Initiatives)

Tracking energy use and costs over time for the facility as a whole		
Weighted Frequency	CA	SC-GA-AL-MI
n	52	33
YES	82%	59%**
NO	12%	39%**
DON'T KNOW	7%	2%

Developing policies to promote purchase of energy-efficient equipment		
n	52	33
YES	70%	49%**
NO	21%	38%
DON'T KNOW	9%	13%

Monitoring energy use for key building or production systems		
n	52	33
YES	73%	63%
NO	17%	28%
DON'T KNOW	9%	8%

Identifying facility improvements to reduce energy use and costs on an ongoing basis		
n	52	33
YES	83%	77%
NO	11%	20%

DON'T KNOW	6%	3%
Track developments in lighting technology.		
n	52	33
YES	53%	48%
NO	34%	38%
DON'T KNOW	13%	14%

** Significantly different from the comparison area at the 95% confidence level.

HBL end users were asked if their organization had any corporate environmental initiatives, for how long those initiatives have been in place, and whether energy management was part of it (Tables 9 to 11). The responses are similar in both regions. Less than half of end users in both regions claim to have a corporate environmental or sustainability initiative (39% in CA and 49% in the comparison area). Over a majority of end users in both regions have been implementing the initiative for over three years (69% in CA versus 67% in the comparison area). Both CA and comparison area end users frequently include energy management in their initiatives. Very high percentages of both regions include energy management in their organizations' environmental initiative—96% in CA compared to 80% in the comparison area. The difference is significant at the 90% confidence level.

Table 9

EP4AA. - Does your organization have any corporate environmental or sustainability initiatives?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	117	76
YES	39%	49%
NO	49%	41%
REFUSED	2%	<1%
DON'T KNOW	9%	11%

Table 10

EP4BB. - For how long has your organization been implementing this environmental initiative?

(End Users with Organizational Environmental Initiatives)

Weighted Frequency	CA	SC-GA-AL-MI
n	45	38
Less than one year	9%	9%
1 to 2 years	19%	14%
3 to 5 years	30%	23%
More than 5 years	39%	44%
DON'T KNOW	4%	10%

Table 11

EP4CC. - Is energy management part of your corporate environmental or sustainability initiative?

(End Users with Organizational Environmental Initiatives)

Weighted Frequency	CA	SC-GA-AL-MI
n	45	38
YES	96%	80%*
NO	2%	13%
DON'T KNOW	2%	7%

* Significantly different from the comparison area at the 90% confidence level.

In both regions, HBL retrofit projects qualified for organizational environmental initiatives about half the time (53% in CA and 48% in the comparison area) (Table 12).

Table 12

EP4DD. - Did any of the HBL retrofit projects discussed in the survey qualify for your organizations environmental or sustainability initiatives?

(End Users with Organizational Environmental Initiatives)

Weighted Frequency	CA	SC-GA-AL-MI
n	52	33
YES	53%	48%
NO	34%	38%
DON'T KNOW	13%	14%

As shown in Tables 13 and 14, when generally asked about what sources of information are used to learn about different lighting technologies, the responses are very similar with the exception of manufacturers' representatives, cited by 14% of comparison area end users compared to 7% in CA (significant at the 90% confidence level)—but little difference for manufacturers' literature (13% versus 12% in CA). When asked which sources are most useful, 31% of comparison end users said manufacturers' literature compared to 4% in CA (significant at the 95% confidence level). The most frequently cited response for usefulness in CA is trade and industry publications at 29%, compared to 15% in the comparison area.

Table 13

EP5. - What sources of information does your organization use to learn about the performance and application of lighting technologies?

(All End Users)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
N	116	75
Trade or industry publications	17%	21%
Manufacturer's literature	13%	12%
Installation contractor	13%	15%
Distributor	9%	10%
Manufacturer representative	7%	14%*
Colleagues in your own industry	7%	7%
Your industry trade or professional organization	7%	2%
Friends	6%	1%*
Some Other Source	41%	27%**
Don't Know	17%	18%

* Significantly different from the comparison area at the 90% confidence level.

** Significantly different from the comparison area at the 95% confidence level.

Table 14

EP6. - Which of these sources do you find most useful?

(End Users who were aware of information sources)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	27	20

Trade/industry publications	29%	15%
Colleagues in your industry	11%	5%
Manufacturer's representative	10%	18%
Installation contractor	6%	11%
Manufacturer's literature	4%	31%**
Distributors	3%	5%
Friends	<1%	4%
Some Other Source	38%	12%**

** Significantly different from the comparison area at the 95% confidence level.

Inventory of recent installation projects and servicing of HBL equipment.

Table 15 shows that most end users' spaces in both regions are served by fluorescent tube fixtures. CA end users' spaces eligible for HBL lighting are served by fluorescent tubes more frequently than in the comparison area (76% versus 55%) and the difference is significant at the 95% level. By contrast, HBL eligible spaces served by HID lamps in the comparison area are more frequently served than in CA (36% versus 13%). This difference is also significant at the 95% confidence level.

Table 15

SL3 - What percentage of your total high-bay space is served by the following types of lighting equipment?

(All End Users)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	111	75
Fluorescent Tube Fixtures	76%	55%**
High Intensity Discharge Lamps	13%	36%**
Compact Fluorescent Fixtures	4%	3%
Incandescent Fixtures	2%	3%
Other	4%	2%

** Significantly different from the comparison area at the 95% confidence level.

End users in both regions are more likely to maintain lighting equipment by using internal staff than through a service contract. Table 16 shows that 79% of end users in CA and 68% in the comparison area maintain lighting equipment with internal staff, and the relative preference in CA for internal maintenance is significantly different than the comparison area at the 90% confidence level. Although CA end users rarely maintain lighting equipment through service contracts (9%), over one quarter (26%) of comparison area end users do (statistically different at the 95% confidence level).

Table 16

SL4 - Does your organization maintain the lighting equipment at this facility?

(All End Users)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	122	78
By using internal staff	79%	68%*
Through a service contract between you and a contractor	9%	26%**
Some other method-describe	8%	4%
By services provided by the building owner or manager	4%	2%

* Significantly different from the comparison area at the 90% confidence level.

** Significantly different from the comparison area at the 95% confidence level.

For end users having service contractors, Table 17 shows that a majority in both regions (52% in CA and 62%) also include periodic assessment and maintenance of the system's energy efficiency in those service contracts.

Table 17

SC5 - Does the lighting equipment service contract at this facility cover periodic assessment and maintenance of the system's energy efficiency?

(End Users with Service Contracts)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	14	21
YES	52%	62%
NO	35%	33%

DON'T KNOW	13%	5%

When asked where the HBL equipment was recently installed, the responses are very similar between the regions. As shown in Table 18, about three quarters of end users installed the equipment in the "facility I work in" (73% in CA and 79% in the comparison area), and 21% in both regions installed it in multiple other facilities.

Table 18

PL0 - Was the high-bay lighting equipment installed at...?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	122	78
The facility you work in	73%	79%
Multiple other facilities	21%	21%
Another facility	4%	2%
Refused	4%	<1%
Don't Know	<1%	<1%

Table 19 shows minor differences in the timing of the multiple-scale HBL projects between the regions. For those end users with multiple facilities, HBL installations were performed in greater numbers as part of one project in CA (48% versus 41%). Conversely, in the comparison area a greater number were performed as different projects (59% versus 42%).

Table 19

PL0.a. - Was the high-bay lighting equipment installed as part of one project that addressed several facilities or as different projects?

(End Users with HBL Project(s) across Multiple Facilities)

Weighted Frequency	CA	SC-GA-AL-MI
n	26	17
Same project	48%	41%
Different projects	42%	59%

REFUSED	2%	<1%
DON'T KNOW	8%	<1%

Reasons for selection of technologies installed.

End user reasons for installing the HBL equipment differs substantially between the regions (Table 20). A majority (52%) of end users in CA replace operable equipment in order to upgrade performance compared to 31% of end users in the comparison area. End user HBL installations from remodeling (21%) and failure (21%) are higher in the comparison area than in CA (9% and 5% respectively). The differences in both cases are significant at the 95% confidence level.

Table 20

PL1 - Was the installation of high-bay lighting equipment carried out …?

(All End Users)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	122	78
To REPLACE OPERABLE equipment in order to upgrade performance	52%	31%
As part of a NEW Construction project	17%	21%
As part of a project to REMODEL existing	15%	21%**
To REPLACE equipment that had FAILED or was about to fail	9%	21%**
For some Other reason-SPECIFY	5%	6%
DON'T KNOW	3%	<1%

** Significantly different from the comparison area at the 95% confidence level.

In both regions, Table 21 shows that end users' primary objectives are most frequently to save energy and save money. In CA, 45% of end users chose their HBL technology to save energy compared to 30% in the comparison area. Likewise in CA, 33% of end users chose their HBL technology to save money compared to 20% in the comparison area (significant at the 90% confidence level). The comparison area end users also selected their specific HBL technologies to improve lighting (19%) more so than those in CA (5%), which is significant at the 95% confidence level. Also, a relatively high number of comparison area end users (22% versus 8% in CA) offer reasons (verbatim responses from the "other" category) for why they replaced what was previously installed, including five respondents who replaced the same technology and one who upgraded to meet building code.

Table 21

PL1.1a - What was the principal objective for choosing the specific high-bay lighting technologies that you did?

(End Users who installed high bay lighting equipment to replace equipment that had failed, to replace operable equipment, or for some other reason)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	76	39
Save energy	45%	30%
Save money	33%	20%*
Improve lighting quality	5%	19%**
Available rebates	4%	<1%
Corporate environmental initiative/responsibility	3%	1%*
Some other reason	8%	22%*
DON'T KNOW	2%	8%

* Significantly different from the comparison area at the 90% confidence level.

** Significantly different from the comparison area at the 95% confidence level.

Other objectives for selecting the specific HBL technology, when probed, are similar across the board, as shown in Table 22, although we note that "Available Rebates" in CA increased from 4% to 10% as a secondary objective.

Table 22

PL1.1.b - What were your other objectives, if any?

(End Users who installed high bay lighting equipment to replace equipment that had failed, to replace operable equipment, or for some other reason)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	87	35
Improve lighting quality	17%	17%
Save energy	16%	19%
Save money	15%	16%
Corporate environmental initiative/responsibility	3%	3%
Available rebates	10%	<1%
No Other Reason	31%	30%
Other Reasons	10%	4%
DON'T KNOW	5%	<1%

Share of technologies installed in these projects.

Table 23 shows that more end users' high-bay space in CA is lit by equipment purchased between 2006 and 2008 than in the comparison area. Two thirds (67%) of CA end users installed their HBL solution to cover over three-quarters (76% to 100%) of their high-bay space during the 2006 to 2008 period compared to 50% in the comparison area (significant at 95%). Overall, 75% of CA end users installed high-bay lighting in over half (51% or higher) of the high-bay spaces in their facilities compared to 54% in the comparison area. For lower percentages of high-bay space (1% to 10%) upgraded, only 6% of CA end users installed high bay lighting during the 2006 to 2008 period, compared to 20% of comparison area end users (significant at 95% confidence level).

Table 23

PL1a - Roughly what percentage of the high-bay space in your facility or facilities you manage is lit by the equipment you purchased between 2006 and 2008?

(All End Users)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	110	74
Between 1 and 10	6%	20%**
Between 11 and 25	3%	9%
Between 26 and 50	17%	18%
Between 51 and 75	8%	4%
Between 76 and 100	67%	50%**

** Significantly different from the comparison area at the 95% confidence level.

For end users who installed HID equipment, Table 24 shows few differences between the two regions in terms of the overall mix of technologies. Pulse-start metal halide technologies account for 23% of the installations in CA compared to 14% in the comparison area. Conversely, 36% of comparison area end user installations used (standard) metal halide fixtures compared to 21% of CA installations. The differences for both technologies between the regions are not significant, however. The end users who do not know what type or types of HID equipment they installed are fairly high in both regions (39% in CA and 21% in the comparison area).

Table 24

PL3a. - What type or types of high intensity discharge equipment did you install?

(End Users Who Installed HID Equipment)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	25	25
Pulse-start metal halide	23%	14%
Metal halide	21%	36%
Mercury vapor	7%	10%
High pressure sodium	4%	11%
Pressurized sodium	3%	2%
Other	7%	6%
DON'T KNOW	39%	21%

Table 25 shows very similar responses between the regions in terms of the mix of installed HBL equipment.

Table 25

PL4a. - What type or types of fluorescent tube equipment did you install?

(End Users Who Installed Fluorescent Equipment)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	98	47
T12 with magnetic ballast	14%	17%
T8 with electronic ballast	43%	45%
T5 with electronic ballast	22%	16%

Induction	1%	5%
DON'T KNOW	26%	22%

Identification of HBL decision makers and decision criteria applied to technology selection.

A majority of end users in both regions had individuals outside their organization specify or recommend the type of HBL equipment used in the installation project, but a larger majority exists in CA. Nearly two-thirds (65%) of CA end users have outside individuals specify or recommend equipment whereas in the comparison area this percentage falls to 51%. Additionally, the difference between the regions is significant at the 90% confidence level. By contrast, 38% of comparison area end users do not use outside individuals compared to the 20% of CA end users that do not either. This difference is significant at the 95% confidence level.

Table 26

PL5. - Did a firm or individual outside your organization specify or recommend the type of equipment used in this high-bay lighting installation project?

(All End Users)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	116	75
YES	65%	51%*
NO	20%	38%**
DON'T KNOW	16%	11%

* Significantly different from the comparison area at the 90% confidence level.

** Significantly different from the comparison area at the 95% confidence level.

As shown in Table 27, in both regions a majority of end users mention contractors (either electrical, lighting, or general) as the firm or individual who specified the type of HBL equipment installed. In CA, 53% of end users and 58% of comparison area end users mention contractors. A larger percentage of comparison area end users (32% versus 24% in CA) mention individuals or firms providing design services more exclusively such as distributors, architects/interior designers, and engineers. This difference is significant at the 90% confidence level. Utility support is mentioned by 13% in CA and 5% in the comparison area.

Table 27

PL6a. - What types of firm or individual specified or recommended the type of high-bay lighting equipment you installed?

(Multiple Response; End Users who received a recommendation regarding the high bay lighting equipment from a firm or individual)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	70	37
General Contractor/Electrical Contractor/Lighting Contractor	53%	58%
Architect or interior designer/Engineer/Lighting Distributor	24%	32%*
Utility	13%	5%
Parent Company	5%	<1%
State or Local Government	4%	<1%**
Upper Management/Corporate	2%	<1%
Landlord	2%	<1%
Friend/work colleague	1%	<1%
Lighting Manufacturer	1%	2%
Trade association	<1%	<1%
Other	<1%	<1%
Don't Know	4%	<1%

* Significantly different from the comparison area at the 90% confidence level.

** Significantly different from the comparison area at the 95% confidence level.

In both regions, Tables 28 and 29 show that fluorescent tube or compact fluorescent equipment were the most frequently specified lighting technology by the vendor, contractor, or designer. Table 26 shows that 43% of end users in each region had an alternative to pulse start metal halides specified for them. Pulse-start metal halides were specified for 30% of CA end users and 15% of end users in the comparison area. Vendors, contractors, or designers most frequently specified fluorescent tube or compact fluorescent equipment for 74% of end users in CA and 67% of end users in the comparison group (Table 27).

Table 28

PL8. - Did your lighting vendor, contractor, or designer specify or recommend the use of pulse-start metal halide equipment for your project?

(End Users Who Installed HID Equipment)

Weighted Frequency	CA	SC-GA-AL-MI
n	17	19
YES	30%	15%
NO	43%	43%
DON'T KNOW	27%	42%

Table 29

PL10. - Did your lighting vendor, contractor, or designer specify or recommend the use of fluorescent tube or compact fluorescent equipment for your project?

(End Users Who Installed HFL Equipment)

Weighted Frequency	CA	SC-GA-AL-MI
n	60	22
YES	74%	67%
NO	16%	20%
DON'T KNOW	10%	12%

Table 30 shows that a variety of controls were installed in the CA and comparison area high-bay lighting projects, but occupancy sensors more so in CA than in the comparison area. Occupancy or motion sensors were installed in 39% of the CA end user projects compared to 12% in the comparison area (significant at 95% confidence level). For nearly three-quarters (74%) of comparison area end users, simple on/off switches were installed compared to 56% of end users in CA (significant at 95% confidence level).

Table 30

PL13. - What types of lighting controls were used for this project?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
Simple on/off	56%	74%**
Occupancy or motion sensor	39%	12%**
Time clock	11%	14%
Building or energy management system	7%	5%
Photo sensor	6%	5%
Daylighting controls	2%	3%
None	<1%	<1%
Other	5%	3%
Refused	<1%	<1%
Don't Know	1%	1%

** Significantly different from the comparison area at the 95% confidence level.

Table 31 shows end users' ratings for the importance of a number of lighting features contributing to their selection. The key takeaway is that very little difference can be observed between the two regions, and none of the differences between CA and the comparison area are significant. From a features perspective, without regard to region, energy use is most important overall, followed closely by lighting quality, maintenance cost, installed cost, and then appearance.

Table 31

PL14.- On a scale of 1 to 10 where 1 means "Not at all important" and 10 means "Very important", how important were the following features in your choice of lighting equipment for this project?

(All End Users)

Energy use		
Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Importance (8-10)	75%	67%
Medium Importance (5-7)	15%	27%
Relatively Unimportant (1-4)	4%	4%
Don't Know	6%	3%
Quality of light provided		
Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Importance (8-10)	74%	85%
Medium Importance (5-7)	17%	10%
Relatively Unimportant (1-4)	5%	1%
Don't Know	3%	4%
Cost of maintenance		
Weighted Frequency	CA	SC-GA-AL-MI

n	116	75
High Importance (8-10)	57%	68%
Medium Importance (5-7)	31%	25%
Relatively Unimportant (1-4)	6%	3%
Don't Know	7%	4%

Installed cost		
Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Importance (8-10)	51%	49%
Medium Importance (5-7)	26%	37%
Relatively Unimportant (1-4)	14%	10%
Don't Know	9%	3%

Appearance of the fixtures		
Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Importance (8-10)	26%	32%
Medium Importance (5-7)	35%	38%
Relatively Unimportant (1-4)	36%	26%
Don't Know	3%	4%

Table 32 shows end users' ratings for their satisfaction with a number of lighting features. From a features perspective, without regard to region, end users are most satisfied with lighting quality, followed by the appearance, maintenance cost, energy use, and then installed cost. Overall, satisfaction appears to be similar but the data do show some small differences between the two regions. The regional differences in the high range (8 to 10) of the satisfaction scale seem to favor the comparison area for lighting quality and fixture appearance.

Table 32

PL15. - On a scale of 1 to 10 where 1 means "Not at all satisfied" and 10 means "Very satisfied", how satisfied are you with the following features of the lighting equipment used for this project?

(All End Users)

Quality of light provided		
Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Satisfaction (8-10)	74%	85%
Medium Satisfaction (5-7)	22%	13%
Relatively Unsatisfied (1-4)	4%	2%
Don't Know	<1%	<1%
Appearance of the fixtures		
Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Satisfaction (8-10)	62%	79%
Medium Satisfaction (5-7)	27%	19%
Relatively Unsatisfied (1-4)	10%	1%
Refused	<1%	1%
Don't Know	<1%	<1%
Cost of maintenance		

Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Satisfaction (8-10)	66%	68%
Medium Satisfaction (5-7)	20%	27%
Relatively Unsatisfied (1-4)	7%	2%
Don't Know	7%	2%

Energy use

Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Satisfaction (8-10)	62%	64%
Medium Satisfaction (5-7)	23%	21%
Relatively Unsatisfied (1-4)	3%	8%
Don't Know	12%	8%

Installed cost

Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
High Satisfaction (8-10)	54%	54%
Medium Satisfaction (5-7)	27%	29%
Relatively Unsatisfied (1-4)	8%	5%
Don't Know	11%	12%

Awareness of, influence of, and participation in California energy efficiency programs (California sample only).

As shown in Table 33, a majority (52%) of CA end users are aware of IOU programs to reduce energy use and costs.

Table 33

UT1. - Are you aware of programs that electric investor-owned utilities in California operate to help their commercial and industrial customers reduce energy use and costs?

(All CA End Users)

Weighted Frequency	CA
n	122
YES	52%
NO	46%
DON'T KNOW	2%

Table 34 shows that of the nine CA respondents eligible for incentives and aware of the programs, half received an incentive for the replacement of high-bay lighting equipment. We note that respondents were screened for knowledge of the installations and not for understanding of the terms and conditions of the installation contract. Since the IOUs' incentives can be signed over to the lighting installer, how many respondents actually received the incentive without their knowledge is unclear.

Table 34

UT2. - Did your organization receive a financial incentive from a California electric investor-owned utility to defray a portion of the cost of the high-bay lighting equipment you installed for this project?

(CA End Users who were aware of IOU incentive programs and installed eligible equipment)

Counts	CA
n	9
YES	6
NO	1
DON'T KNOW	2

Table 35 shows that a few end users identified incentives from PGE and SCE specifically.

Table 35

UT3. - What was the name of the investor-owned utility company?

(CA End Users who were aware and received financial incentive from a CA IOU)

Counts	**CA**
n	6
PG&E	2
SCE	1
Other utility-specify	3

Of those who are aware and received an incentive for their HBL installation, one respondent (of six) says it is relatively unlikely that the project would have made the same choice without the incentives.

Table 36

UT4. - On a scale of 1 to 10 where 1 means “Not at all likely” and 10 means “Very Likely”, how likely is it that your organization would have used the energy-efficient high-bay lighting you selected for this project if the financial incentive from your electric investor-owned utility had not been available?

(CA End Users who were aware and received financial incentive from a CA IOU)

Counts	**CA**
N	6
Very Likely (8-10)	1
Medium Likelihood (5-7)	4
Relatively Unlikely (1-4)	1
Don't Know	<1

In Table 37, seven respondents say they had received an incentive from a CA IOU for the HBL equipment installed for other facilities.

Table 37

UT5. - Has your organization received a financial incentive from a California electric investor-owned utility to defray a portion of the cost of energy-efficient high-bay lighting equipment you installed for other projects in this facility or in other facilities your organization may occupy in California?

(CA End Users who installed high bay lighting equipment in multiple facilities and for different projects)

Counts	**CA**
n	7
YES	43%
NO	24%
DON'T KNOW	34%

Of those who installed HBL equipment eligible for IOU incentives in other facilities, only one installed the equipment without the financial incentives.

Table 38

UT8. Has your organization installed pulse-start metal halide or fluorescent high-bay lighting equipment in California facilities without using financial incentives available from investor-owned utility companies?

(CA End Users who installed HBL equipment eligible for IOU incentive in other facilities)

Counts	**CA**
n	7
YES	1
NO	6

Screening and Firmographic Information

The following section presents a series of tables covering screening information and firmographic data collected from all end users in each of the samples.[2] The responses are fairly similar across regions with the following noteworthy exceptions:

- Table 39 shows more facility use for offices in CA (7% versus 1% in the comparison area) and Food Sales in the comparison area (5% versus <1% in CA). Both differences are significant at the 95% confidence level.
- Table 43 shows that the respondent was more frequently the decision maker in the comparison area (41%) compared to CA (31%), significant at the 90% confidence level.
- Table 45 shows that a majority of end users in each region own the space they occupy, over three quarters (78%) of end users in the comparison area own the space they occupy compared to 58% in CA. Conversely, 38% of CA end users lease their space compared to 21% of comparison area and users. The differences in both cases are significant at the 95% confidence level.
- Table 48 shows that the weighted average of the electricity bills paid for the building stock of the HBL installations is considerably larger in the comparison area ($9,389 versus $11,707 in the comparison area).
- Table 49 shows that the vintages of the building stock of the HBL installations tend to be slightly older in the comparison area.
- Table 52 shows that the weighted average of square footage of the building stock of the HBL installations is considerably larger in CA (203,258 square feet versus 128,880 in the comparison area).

[2] Unless otherwise specified, the base of all tables presented in this section are All End Users.

Table 39

SC1 - First, what is the primary use of your facility – for example retail, education, manufacturing, and so forth?

(All End Users)

Weighted Frequency	**CA**	**SC-GA-AL-MI**
n	124	80
Retail	31%	31%
Manufacturing-process	14%	10%
Education	12%	14%
Manufacturing-assembly	11%	13%
Warehouse/Storage	11%	14%
Office	7%	1%**
Other Commercial	4%	4%
Other industrial	3%	3%
Health Care	3%	2%
Services	2%	3%
Public Assembly	2%	<1%
Food sales	<1%	5%**
Food service	<1%	1%

** Significantly different from the comparison area at the 95% confidence level.

Table 40

SC2 - How many employees work at this facility?

(All End Users)

Mean	**CA**	**SC-GA-AL-MI**
n	122	78
Average number of employees	169	161

Table 41

SC3 - Are there any high-bay spaces in this facility or a facility that you manage, that is, indoor spaces with ceiling heights that are fifteen feet or above?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	122	78
YES	100%	100%

Table 42

SC4 - Did your organization install new or replacement lighting fixtures in these high-bay spaces between 2006 and 2008?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	122	78
YES	100%	100%

Table 43

PL7a. - Which individuals in your organization – in terms of job titles – were involved in the selection of the high-bay lighting equipment that was installed?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	116	75
The Respondent	31%	44%*
Owner / Co-Owner / Partner /Member of LLP	15%	15%
Facility Manager	14%	8%
President/CEO	8%	10%
General Manager	6%	2%
Plant Manager	4%	7%
Energy Manager	<1%	2%
Other	33%	28%

Don't Know	11%	11%

* Significantly different from the comparison area at the 90% confidence level.

Table 44

FC1 - First, what is your job title?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	122	78
General Manager	20%	18%
Facility Manager	11%	10%
Owner/Co-owner/Partner/Member of LLP	5%	8%
Plant Manager	3%	7%
Energy Manager	3%	1%
President/CEO	1%	4%
Other -specify	58%	51%
DON'T KNOW	<1%	1%

Table 45

FC2 - Does your organization....

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	122	78
Own the space that you occupy	58%	78%**
Lease the space you occupy or	38%	21%**
Own a part and lease the remainder	3%	<1%
DON'T KNOW	1%	1%

** Significantly different from the comparison area at the 95% confidence level.

Table 46

FC3 - Does your organization pay all electricity bills for this facility directly to the utility?

(End Users whose organization leases all or part of the space it occupies)

Weighted Frequency	CA	SC-GA-AL-MI
n	52	18
YES	87%	88%
NO	4%	2%
DON'T KNOW	9%	10%

Table 47

FC4 - Are all of your electricity costs included in your lease payments, or only a portion of the costs?

(End Users whose organization leases all or part of the space it occupies, and who are not aware of whether their organization pays electric bills directly to utility)

Weighted Frequency	CA	SC-GA-AL-MI
n	5	2
ALL	16%	17%
ONLY A PORTION	13%	<1%
DON'T KNOW	72%	83%

Table 48

FC5 - What is your best estimate of your average monthly electric bills paid by your firm for this location?

(End Users whose organization owns the space it occupies)

Mean	CA	SC-GA-AL-MI
n	75	46
Average monthly electric bill	9389	11707

Table 49

FC6 - In what year did your organization move into this facility?

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	122	78
Since 2000	42%	48%
In the 1990s	25%	12%**
In the 1980s	12%	11%
In the 1970s	6%	13%*
In the 1960s	4%	10%
In the 1950s	6%	5%
In the 1940s	5%	1%*

* Significantly different from the comparison area at the 90% confidence level.

** Significantly different from the comparison area at the 95% confidence level.

Table 50

FC7 - What is the approximate age of the facility?

(All End Users)

Mean	CA	SC-GA-AL-MI
n	101	76
Average Age	31	27

Table 51

FC8 - Is this facility...

(All End Users)

Weighted Frequency	CA	SC-GA-AL-MI
n	122	78
A branch location	47%	47%
Your firm's only location	32%	34%
Your firm's headquarters location	19%	13%
A franchise Location	2%	6%
REFUSED	1%	<1%

Table 52

FC9 - How many square feet of space does your organization occupy in this facility?

(All End Users)

Mean	CA	SC-GA-AL-MI
n	98	67
Average square feet	203258	128880

Table 53

FC10 - What percentage of the entire enclosed space in this facility does your organization occupy?

(All End Users)

Mean	CA	SC-GA-AL-MI
n	122	78
Average percentage of enclosed space	94	95

Table 54

SL1 - Roughly what percentage of your space in this facility has ceiling heights greater of 15 feet or more?

(All End Users)

Mean	CA	SC-GA-AL-MI
n	120	76
Average ceiling height percentage	61	68

Table 55

SL2 - And roughly what percentage of this high-bay space has ceiling heights greater than 25 feet?

(All End Users)

Mean	CA	SC-GA-AL-MI
n	116	76
Average ceiling height percentage	35	30

HBL MARKET EFFECTS STUDY: END USER
DRAFT INTERVIEW GUIDE
AUGUST 2009

UPDATED 11.10.09

Intro

Hello. This is _____________ calling on behalf of the California Public Utilities Commission and KEMA, an energy consulting company.

We are conducting research on the commercial/industrial lighting market in [STATE RESPONDENT IS IN]. In particular we are focusing on the commercial and industrial end-users of high bay lighting. For the purposes of this interview we define high bay applications as installations for commercial and industrial customers with ceiling heights of about 15 feet or more. I want to assure you this is not a sales call and that the information you provide will be kept strictly confidential. This survey should only take about 15 minutes of your time.

May I please speak to someone at your organization who is familiar with your high bay lighting installations?

ENTER NAME OF CONTACT: _________________________________

IF CONTACT IS NOT AVAILABLE, ASCERTAIN BEST TIME TO CALL.

[REPEAT INTRO AS NEEDED, CONTINUE OR ARRANGE FOR CALLBACK]

[IF NEEDED]

For further questions about this survey, you can contact Peter Franzese of the California Public Utilities Commission. His phone number is (415) 703 1926. Please make sure that you reference the High Bay Lighting Study.

Screening

SC1 First, what is the primary use of your facility – for example retail, education, manufacturing, and so forth?

Office	1
Education	2
Food sales	3
Food Service	4
Health Care	5
Lodging	6
Retail	7
Services	8
Public Assembly	9
Warehouse & storage	10
Manufacturing – Assembly	11
Manufacturing – Process	12
Other Commercial	13
Other Industrial	14

IF NONE OF THE ABOVE, RECORD, THANK AND TERMINATE.

SC2 How many employees work at this facility?

Enter Number, 9998 = DK, 9999 =REF.. ______

IF SC2 < 5, RECORD, THANK, AND TERMINATE.

SC3 Are there any high bay spaces in this facility or a facility that you manage, that is, indoor spaces with ceiling heights that are fifteen feet or above?

Yes	1
No	2
Don't know	3

IF SC3 = 2 OR 3, RECORD, THANK, AND TERMINATE.

SC4 Did your organization install new or replacement lighting fixtures in these high bay spaces between 2006 and 2008?

Yes ... 1
No ... 2
Don't know ... 3

IF SC4 = 2 OR 3, RECORD, THANK, AND TERMINATE.

Firmographics and End-User Characteristics

Now, I'd like to get some general information about your organization and this facility.

FC1 First, what is your job title?

Plant Manager ... 1
Facility Manager ... 2
Energy Manager ... 3
President/CEO ... 4
Owner / Co-Owner / Partner /Member of LLP ... 5
General Manager ... 6
Other (Specify)____________________ ... 7
[Don't Know] ... 998
[Refused] ... 999

FC2. Does your organization.....[READ LIST. RECORD ONE RESPONSE.]

Own the space that it occupies in this facility	1
Lease the space that it occupies	2
Own a part and lease the remainder	3
(Don't Know)	98
(Refused)	99

IF FC2 = 2 OR 3, ASK FC3. ELSE SKIP TO FC5.

FC3 Does your organization pay all electricity bills for this facility directly to the utility?

Yes ... 1
No ... 2
Don't know ... 3

IF FC3 = 2 OR 3, ASK FC4. ELSE SKIP TO FC5

FC4 Are all of your electricity costs included in your lease payments, or only a portion of the costs?

All 1
A portion 2
Don't know 3

IF FC4 $\neq$ 1, ASK FC5. ELSE SKIP TO FC6

FC5. What is your best estimate of your average monthly electric bills paid by your firm for this location?

Enter $ per month, 8 = DK, 9 =REF .... _____

FC6 In what year did your organization move into this facility?

Record Approximate Date [Year] .... ______________
[Don't Know] 998
[Refused] 999

FC7 What is the approximate age of the facility?

Record Approximate Age [Years] .... ______________
[Don't Know] 998
[Refused] 999

FC8. Is this facility... [READ LIST. RECORD ONE RESPONSE]

Your firm's only location 1
Your firm's headquarters location 2
A branch location 3
A franchise location 4
Don't know 8
Refused 9

FC9 How many square feet of space does your organization occupy in this facility?

Enter Number in '000s, 9998 = DK, 9999 =REF .... _____

FC10 What percentage of the entire enclosed space in this facility does your organization occupy?

ENTER PERCENT, 998 = DK, 999 = REF .... _____

Saturation of High Bay Lighting

SL1 Roughly what percentage of your space in this facility has ceiling heights greater of 15 feet or more? Your best estimate is fine.

Record Percent.. ______________
[Don't Know] 998
[Refused] 999

SL2 And roughly what percentage of this high bay space has ceiling heights greater than 25 feet? Again, your best estimate is fine.

Record Percent.. ______________
[Don't Know] 998
[Refused] 999

SL3 What percentage of your total high bay space is served by the following types of lighting equipment?

a. High Intensity Discharge Lamps: [READ IF NECESSARY] These are large fixtures consisting of a ballast that generates an arc discharge into a heavy glass bulb that contains pressurized gas, and a reflective housing ...._____

b. Fluorescent Tube Fixtures: [READ IF NECESSARY] These fixtures consist of a ballast, a reflective housing, and 2 to 4 fluorescent tubes that are 4 to 8 feet long and 5/8 to one inch diameter.._____

c. Compact Fluorescent Fixtures: [READ IF NECESSARY.] These fixtures consist of a cluster of compact fluorescent lamps in a reflective housing..........._____

d. Incandescent Fixtures: [READ IF NECESSARY.] These fixtures use standard, high wattage incandescent bulbs. ...._____

e. Other ....___________(open for description)

SC3 a – d SHOULD ADD UP TO AT LEAST 100 PERCENT. COULD ADD TO MORE THAN 100 PERCENT. IF SUM IS < 100%, RECHECK ANSWERS WITH RESPONDENT.

SL4 Does your organization maintain the lighting equipment at this facility

Using internal staff 1
Through a maintenance service contract between you and a contractor 2
Using services provided by the building owner or manager.............................. 3
Don't know 8
Refused 9

IF SL4 = 2, ASK SL5. ELSE SKIP TO PL0.

SC5 Does the lighting equipment service contract at this facility cover periodic assessment and maintenance of the system's energy efficiency?

Yes.. 1
No 2
Don't know 8
Refused 9

Purchase and Installation of High Bay Lighting

Now, turning to your recent purchase and installation of high bay lighting equipment…

PL0 Was the high bay lighting equipment installed at [Read all]:

The facility you work in 1
Another facility 2
Multiple other facilities 3
[Don't Know] 998
[Refused] 999

[Ask if PL0 = 1 and 2, or 1 and 3, or 3.]

PL0.a. Was the high bay lighting equipment installed as part one project that addressed several facilities or as different projects?

Same project 1
Different projects 2
[Don't Know] 998
[Refused] 999

PL1 Was the installation of high bay lighting equipment carried out …

As part of a new construction project 1
As part of a project to remodel existing space 2
To replace equipment that had failed or was about to fail................. 3
To replace operable equipment in order to upgrade performance..... 4
Or for some other reason (Specify) 5
[Don't Know] 998
[Refused] 999

Ask for all PL1 =3 or 4 or 5; else skip.

PL1.1a What was the principal objective for choosing the specific high bay lighting technologies that you did?

1.b What were your other objectives, if any? [DO NOT READ; MULTIPLE RESPONSE]

Save money	1	1	1	
Save energy	2	2	2	
Corporate environmental initiative/responsibility	3	3	3	
Available rebates	4	4	4	
Improve lighting quality	5	5	5	
Or for some other reason (Specify)	6	6	6	Record Open Response
No other objectives		7		
[Don't Know]	998	998	998	
[Refused]	999	999	999	

PL1a Roughly what percentage of the high bay space in your facility or facilities your manage is lit by the equipment you purchased between 2006 and 2008? Your best estimate is fine. [If estimate is given, must record at least 1%]

Record Percent.. _______________
[Don't Know] 998
[Refused] 999

PL2 And roughly what percentage of the equipment installed was accounted for by the following types of equipment.

Record Percent.. _______________
[Don't Know] 998
[Refused] 999

	Equipment Type	**SL2**
a.	High Intensity Discharge	%
b.	Fluorescent Tubes	%
c.	Compact Fluorescent	%
d.	Incandescent	%
e.	Other (Specify) ________________________________	%

IF PL2.a. > 0%, ASK PL3a. ELSE SKIP TO INSTRUCTIONS FOR PL4.

IF PL0.a = 2, say “”Unless otherwise specified, please focus on the first High bay lighting upgrade project you completed…”

PL3a. What type or types of high intensity discharge equipment did you install? PROMPT IF NEEDED. CHECK ALL THAT APPLY.

IF MORE THAN ONE TYPE NAMED, ASK PL3b. ELSE SKIP TO INSTRUCTIONS FOR PL4

PL3b. Which of those technologies accounted for the largest portion of the space served by the installation project? CHECK ONE ONLY.

		PL3a	**PL3b**
1	Metal halide		
2	Pulse start metal halide		
3	Pressurized sodium		
4	High pressure sodium		
5	Mercury vapor		
6	Other (Specify)		

IF PL2.b. > 0%, ASK PL4a. ELSE SKIP TO PL5.

PL4a. What type or types of fluorescent tube equipment did you install? PROMPT IF NEEDED. CHECK ALL THAT APPLY.

IF MORE THAN ONE TYPE NAMED, ASK PL4b. ELSE SKIP TO INSTRUCTIONS FOR PL5.

PL4b. Which of those technologies accounted for the largest portion of the space served by the installation project? CHECK ONE ONLY.

		PL4a	**PL4b**
1	T12 with magnetic ballast		
2	T8 with electronic ballast		
3	T5 with electronic ballast		
4	Induction		

PL5. Did a firm or individual outside your organization specify or recommend the type of equipment used in this high bay lighting installation project?

- Yes 1
- No 2
- Don't know 3

IF PL5 = 1, ASK PL6a. ELSE SKIP TO INSTRUCTIONS FOR PL7.

PL6a. What types of firm or individual specified or recommended the type of high bay lighting equipment you installed? PROMPT IF NEEDED.

IF MORE THAN ONE TYPE NAMED, ASK PL6b. ELSE SKIP TO INSTRUCTIONS FOR PL7a.

PL6b. Which of the firms or individuals you named had the greatest influence on your organization's selection of high bay lighting equipment? CHECK ONE ONLY.

		PL6a	**PL6b**
1	Architect or interior designer		
2	Engineer		
3	Lighting Distributor		
4	General Contractor		
5	Electrical Contractor		
6	Lighting Contractor		
7	Friend/work colleague		
8	Trade association (Specify))		
9	Other (Specify)		
98	[Don't Know]		
99	[Refused]		

PL7a. Which individuals in your organization – in terms of job titles – were involved in the selection of the high bay lighting equipment that was installed? PROMPT IF NEEDED.

IF MORE THAN ONE TYPE NAMED, ASK PL7b. ELSE SKIP TO INSTRUCTIONS FOR PL8

PL7b. Which of these individuals had the greatest influence on your organization's purchase decision? CHECK ONE ONLY.

		PL7a	**PL7b**
0	The Respondent		

1	Plant Manager		
2	Facility Manager		
3	Energy Manager		
4	President/CEO		
5	Owner / Co-Owner / Partner /Member of LLP		
6	General Manager		
7	Other(Specify)____________________		
98	[Don't Know]		
99	[Refused]		

IF PL2a > 0% OR DK, AND THERE IS A RESPONSE TO PL6a ASK PL8. ELSE SKIP TO PL9A

PL8. Did your lighting vendor, contractor, or designer specify or recommend the use of pulse start metal halide equipment for your project?

Yes.. 1
No 2
Don't know 3

IF PL8 = 1 AND PL3a ≠ 2, ASK PL9. ELSE SKIP TO PL9a.

PL9. Why did you choose not to install pulse start metal halide equipment for this project? CHECK ALL THAT APPLY.

Equipment was too expensive.. 1
We did not feel the energy savings justified the additional cost......................... 2
Unsatisfactory experience with pulse start metal halides in other projects........ 3
Too difficult to maintain.. 4
Concerned about quality of light... 5
Other (Specify) 6
Don't know 8
Refused 9

PL9a. Had you heard of pulse start metal halide equipment for indoor use prior to undertaking this project?

Yes.. 1
No 2
Don't know 3

IF PL9a = 1, ASK PL9b. ELSE SKIP TO INSTRUCTIONS FOR PL10.

PL9b. From what sources had you heard about pulse start metal halide equipment?

- Lighting vendors 1
- Architects/Engineers 2
- Internal staff 3
- Experience with previous projects 4
- Colleagues or competitors in the industry 5
- Trade or industry representatives 6
- Utility programs or representatives 7
- Other (specify) 8
- Don't know 98
- Refused 99

If PL2b > 0% OR DK AND THERE IS A RESPONSE TO PL6a ASK PL10. ELSE SKIP TO PL12a.

PL10. Did your lighting vendor, contractor, or designer specify or recommend the use of fluorescent tube or compact fluorescent equipment for your project?

- Yes 1
- No 2
- Don't know 3

IF PL10 = 1 AND IF PL4A ≠ 2 OR 3 OR 4, ASK PL11. ELSE SKIP TO PL12a.

PL11. According to our records when we spoke earlier, we recorded that you did not install any high efficiency fluorescent tubes. Why did you choose not to install high efficiency fluorescent equipment for this project? CHECK ALL THAT APPLY.

- Equipment was too expensive 1
- We did not feel the energy savings justified the additional cost 2
- Unsatisfactory experience with fluorescent equipment in other projects 3
- Too difficult to maintain 4
- Concerned about quality of light 5
- Other (Specify) 6
- Don't know 8
- Refused 9

PL12a. Had you heard of fluorescent equipment for high bay lighting applications prior to undertaking this project?

- Yes 1
- No 2
- Don't know 3

IF PL12a = 1, ASK PL12b. ELSE SKIP TO INSTRUCTIONS FOR PL13.

PL12b. From what sources had you heard about fluorescent high bay equipment?

Lighting vendors 1
Architects/Engineers.. 2
Internal staff 3
Experience with previous projects 4
Colleagues or competitors in the industry 5
Trade or industry representatives.. 6
Utility programs or representatives.. 7
Other (specify) 8
Don’t know 98
Refused 99

PL13. What types of lighting controls were used for this project? PROMPT IF NEEDED. ACCEPT MULTIPLES.

Simple on/off.. 1
Occupancy or motion sensor... 2
Photo sensor.. 3
Time clock... 4
Building or energy management system 5
Daylighting controls 6
Other (Specify) ______________________ 7
None 97
Don’t know 98
Refused 99

PL14. On a scale of 1 to 10 where 1 means “Not at all important” and 10 means “Very important”, how important were the following features in your choice of lighting equipment for this project?

1	Quality of light provided	
2	Appearance of the fixtures	
3	Cost of maintenance	
4	Energy use	
5	Installed cost	

ENTER NUMBER FROM 1 TO 10. 98 = DON’T KNOW; 99 = REFUSED _____

PL15. On a scale of 1 to 10 where 1 means “Not at all satisfied” and 10 means “Very satisfied”, how satisfied are you with following features of the lighting equipment used for this project?

1	Quality of light provided	
2	Appearance of the fixtures	
3	Cost of maintenance	

4	Energy use	
5	Installed cost	

ENTER NUMBER FROM 1 TO 10. 98 = DON'T KNOW; 99 = REFUSED _____

Utility Program Recognition, Participation, Influence

IF RESPONDENT IS IN THE CALIFORNIA SAMPLE ASK UT1. ELSE SKIP TO EP1.

UT1. Are you aware of programs that electric investor-owned utilities in California operate to help their commercial and industrial customers reduce energy use and costs?

Yes... 1
No 2
Don't know 3

IF UT1 = 2 OR 3, SKIP TO EP1.
IF UT1 = 1 AND PL2b > 0% OR PL2c > 0% OR PL3a = 2, ASK UT2. ELSE SKIP TO UT5.

UT2. Did your organization receive a financial incentive from a California electric investor-owned utility to defray a portion of the cost of the high bay lighting equipment you installed for this project?

Yes... 1
No 2
Don't know 3

IF UT2 = 1, ASK UT3. ELSE SKIP TO UT5.

UT3. **What was the name of the investor-owned utility company?**

Pacific Gas & Electric Company (PG&E) 1
Southern California Edison Company (SCE) 2
San Diego Gas and Electric Company (SDG&E)... 3
....
Don't know 4

UT4. On a scale of 1 to 10 where 1 means "Not at all likely" and 10 means "Very Likely", how likely is it that your organization would have used the energy-efficient high-bay lighting you selected for this project if the financial incentive from your electric investor-owned utility had not been available?

ENTER NUMBER FROM 1 TO 10. 98 = DON'T KNOW; 99 = REFUSED _____

Ask for all PL0.a = 2; else skip to EP1.

UT5. Has your organization received a financial incentive from a California electric investor-owned utility to defray a portion of the cost of energy-efficient high bay lighting equipment you installed for other projects in this facility or in other facilities your organization may occupy in California?

Yes... 1
No 2
Don't know 3

IF UT5= 1 AND UT2 = 2, ASK UT6. ELSE SKIP TO UT8.

UT6. What was the name of the investor-owned utility company?

Pacific Gas & Electric Company (PG&E) 1
Southern California Edison Company (SCE) 2
San Diego Gas and Electric Company (SDG&E).. 3
Don't know 4

UT7. On a scale of 1 to 10 where 1 means "Not at all likely" and 10 means "Very Likely", how likely is it that your organization would have used pulse start metal halide or fluorescent high bay fixtures on this project if you had not received financial incentives for that kind of equipment in other projects?

ENTER NUMBER FROM 1 TO 10. 98 = DON'T KNOW; 99 = REFUSED _____

UT8. Has your organization installed pulse start metal halide or fluorescent high bay lighting equipment in California facilities without using financial incentives available from investor-owned utility companies?

Yes... 1
No 2
Don't know 3

IF UT8 = 1, ASK UT9. ELSE SKIP TO EP1.

UT9. On a scale of 1 to 10 where 1 means "Not at all important" and 10 means "Very important", how important was utility program endorsement for pulse start metal halide and fluorescent high bay lighting in your decisions to use this kind of equipment in projects for which you did not seek financial incentives?

ENTER NUMBER FROM 1 TO 10. 98 = DON'T KNOW; 99 = REFUSED _____

Energy Efficiency Practices and Policies

In this final section I'd like to ask you about your organization's policies and practices in regard to energy management.

EP1 First, is there a person, group, or department in your organization that is assigned by top management to manage energy use and costs?

Yes, one person 1

Yes, a group 2

Yes, a department 3

No 4

(Don't know) 98

(Refused) 99

[IF EP1 = 1, 2 OR 3 AND IF FC8 = 2,3, OR 4, ASK EP2. ELSE SKIP TO EP3.]

EP2 Is this [EP1: PERSON, GROUP, OR DEPARTMENT] located at your facility, corporate headquarters, or another location?

Respondent's facility 1

Corporate Headquarters 2

Another Facility 3

None...97

(Don't know) 98

Refused 99

EP3 Does your organization have energy use reduction goals for this facility?

Yes...1

No 2

(Don't know) 98

Refused 99

EP4 Are there persons in your organization who have been assigned responsibility for the following activities? [READ LIST. 1 = YES, 2 = NO, 98 = DK, 99 = REFUSED]

a.	Tracking energy use and costs over time for the facility as a whole	
b.	Monitoring energy use for key building or production systems	
c.	Identifying facility improvements to reduce energy use and costs on an ongoing basis	

d.	Track developments in lighting technology.	
e.	Developing policies to promote purchase of energy-efficient equipment	

If either PL1.1a or PL1.1b does not equal 3, ask EP4AA. Else skip to EP4BB.

EP4AA. Does your organization have any corporate environmental or sustainability initiatives?

Yes 1
No 2
(Don't know) 98
Refused 99

If EP4AA = 1 continue; else skip to EP5.

EP4BB. For how long has your organization been implementing this environmental initiative?

Less than one year 1
1 to 2 years 2
3 to 5 years 3
More than 5 years 4
(Don't know) 98
Refused 99

EP4CC. Is energy management part of your corporate environmental or sustainability intiative?

Yes 1
No 2
(Don't know) 98
Refused 99

If EP4CC = 1 continue; else skip to EP5. IF PL1.1a = 3 then skip.

EP4DD. Did any of the HBL retrofit projects discussed in the survey qualify for your organizations environmental or sustainability initiatives?

Yes 1

No 2
(Don't know) 98
Refused 99

EP5. What sources of information does your organization use to learn about the performance and application of lighting technologies? PROMPT IF NEEDED. ACCEPT MULTIPLES.

IF MORE THAN ONE TYPE NAMED, ASK EP6. ELSE SKIP TO END.

EP6. Which of these sources do you find most useful? CHECK ONE ONLY.

		EP5	**EP6**
1	Manufacturer's literature		
2	Manufacturer representative		
3	Distributor		
4	Installation contractor		
5	Colleagues in your own industry		
6	Your industry trade or professional organization		
7	Trade or industry publications		
8	Friends		
9	Other (Specify)		
98	[Don't Know]		
99	[Refused]		

THANK YOUR FOR YOUR TIME AND COOPERATION.

APPENDIX H: 2002 NAICS Codes of Potential Target Market for HBL End Users and Employee Sizes

Meaning of NAICS economic sector code	2002 NAICS Code	Meaning of 2002 NAICS code	California (Employees)	AL-GA-MS-SC (Employees)
Manufacturing	31-33	Manufacturing	1,616,504	1,209,507
Wholesale trade	423	Durable goods merchant wholesalers	967810	441,496
Wholesale trade	424	Nondurable goods merchant wholesalers	602614	274,190
Wholesale trade	425	Wholesale electronic markets and agents and brokers	26132	13,782
Retail trade	441	Motor vehicle & parts dealers	206057	130,054
Retail trade	442	Furniture & home furnishings stores	62935	37,999
Retail trade	443	Electronics & appliance stores	54254	22,570
Retail trade	444	Building material & garden equipment & supplies dealers	118103	84,114
Retail trade	445	Food & beverage stores	291687	196,029
Retail trade	446	Health & personal care stores	113541	61,896
Retail trade	447	Gasoline stations	64696	79,822
Retail trade	448	Clothing & clothing accessories stores	170997	100,774
Retail trade	451	Sporting goods, hobby, book, & music stores	80539	31,935
Retail trade	452	General merchandise stores	218982	198,363
Retail trade	453	Miscellaneous store retailers	87657	48,319
Retail trade	454	Nonstore retailers	55665	26,923
Ref Warehouse	493	Warehousing & storage	60019	50,117
Information	511	Publishing industries (except Internet)	168096	51,506
Information	512	Motion picture & sound recording industries	117901	11,386
Information	515	Broadcasting (except Internet)	36348	24,914

Meaning of NAICS economic sector code	2002 NAICS Code	Meaning of 2002 NAICS code	California (Employees)	AL-GA-MS-SC (Employees)
Information	519	Other information services	5240	1,935
Finance and insurance	521	Monetary authorities - central bank	1947	1,448
Finance and insurance	523	Securities intermediation & related activities	90024	20,916
Real estate and rental and leasing	532	Rental & leasing services	78514	40,078
Educational services	611	Educational services	125686	37,812
Health care and social assistance	621	Ambulatory health care services	1066160	572,306
Health care and social assistance	622	Hospitals	918074	707,868
Health care and social assistance	623	Nursing & residential care facilities	454376	286,680
Health care and social assistance	624	Social assistance	430348	232,492
Arts, entertainment, and recreation	711	Performing arts, spectator sports, & related industries	168814	24,222
Arts, entertainment, and recreation	712	Museums, historical sites, & similar institutions	26364	9,714
Arts, entertainment, and recreation	713	Amusement, gambling, & recreation industries	379136	126,724
Accommodation and food services	721	Accommodation	194745	120,127
Accommodation and food services	722	Food services & drinking places	950791	563,491
Other services (except public administration)	811	Repair & maintenance	166205	80,815
Finance and insurance	5221	Depository credit intermediation	204841	133,329
Real estate and rental and leasing	5331	Lessors of nonfinancial intangible assets (exc copyrighted works)	3623	1,902
Professional, scientific, and technical services	5413	Architectural, engineering, & related services	162681	75,573

Meaning of NAICS economic sector code	2002 NAICS Code	Meaning of 2002 NAICS code	California (Employees)	AL-GA-MS-SC (Employees)
Professional, scientific, and technical services	5417	Scientific research & development services	211340	28,894
Professional, scientific, and technical services	5418	Advertising & related services	59978	18,868
Administrative and support and waste management and remediation services	5614	Business support services	73566	43,573
Administrative and support and waste management and remediation services	5615	Travel arrangement & reservation services	36912	10,521
Administrative and support and waste management and remediation services	5616	Investigation & security services	121163	49,665
Administrative and support and waste management and remediation services	5617	Services to buildings & dwellings	207321	102,765
Other services (except public administration)	8122	Death care services	11291	11,476
Other services (except public administration)	8123	Drycleaning & laundry services	40068	27,848
Other services (except public administration)	8129	Other personal services	40697	9,830
Other services (except public administration)	8134	Civic & social organizations	28378	14,257
Professional, scientific, and technical services	54192	Photographic services	9470	3,919
Professional, scientific, and technical services	54194	Veterinary services	24733	15,591

APPENDIX I: Mass Market, Third Party and Local Government Partnership Program Summaries

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
PG&E2080	Mass Markets Commercial	• PG&E	• The program delivers a portfolio of energy efficiency, demand response, and distributed generation services. • It includes statewide elements as well as elements specially targeted to the mass market customers in PG&E's service area.	• Commercial and residential renters • Commercial customers who lack information, time and resources for energy efficiency projects.	• PG&E	Provide outreach and marketing as well as direct installation for small businesses to localized portions of the mass market.
SDGE3012	Mass Markets Express Efficiency	• SDGE • Express Efficiency	• Express Efficiency is a statewide prescriptive rebate program that encourages nonresidential customers to retrofit existing equipment with high efficiency equipment. • Rebates are intended to cover a portion of the incremental cost associated with installing higher efficiency equipment.	• Nonresidential customers who have a monthly demand above 100 kW and/or an average monthly gas usage of 4,166 therms and above	• SDGE • Community Based Organizations (CBOs) • Faith Based Organizations (FBOs) • Ethnic organizations • Other stakeholders	• The program will use multiple marketing channels to increase awareness and participation in the program. • Financial incentives may be awarded on comprehensive projects that include more than one measure or that participate in demand response programs.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
SDGE3020	Mass Markets Small Business Super Saver (SBSS)	• SDGE	SBSS is a local rebate program designed for small commercial or industrial customers. It is a prescriptive rebate program that encourages nonresidential customers to retrofit existing equipment with high efficiency equipment. • Rebates are intended to cover a significant portion of the incremental cost associated with installing higher efficiency equipment.	• Small commercial or industrial customers under 100 kW of monthly demand and/or less than 4,166 average monthly therms.	• SDGE • Community Based Organizations (CBOs) • Local governments • Chamber of Commerce	SBSS will work in conjunction with other programs to cross train contractors on the new programs and services available to customers. Customers will be contacted and educated through face-to-face contact by SDGE Energy Program Representatives, CBOs, local governments, Chamber of Commerce, and other selected organizations. • Once informed, customers will be given a list of participating contractors/vendors to contact for participation. Contractors will market directly to customers as well, and will be trained on program information accordingly. • A financial incentive can be paid to contractors in conjunction with the customer rebate for a no-cost installation to customers under 50kW monthly demand, or for a comprehensive retrofit. • Financial incentives are not offered to contractors for CFL installations and delamping as a stand-alone measure or as one of two comprehensive measures.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
SCE2517	Mass Markets Business Incentives & Services Program (BIS)	• SCE	Integration of three previously stand-alone programs: 1) The Standard Performance Contract (SPC) program offers cash incentives for the installation of high efficiency equipment or systems. • Incentives are based on annual kWh savings and paid upon completion and inspection of the project. 2) The Express Efficiency Program is designed to encourage energy efficiency by offering rebates to offset the cost of replacing or upgrading a variety of equipment with new, energy-efficient technology. 3) The Non-residential Audits (NRA) program strategy is a method for delivering energy efficiency information and awareness to business customers, which often results in participation in energy efficiency projects.	<u>SPC</u> • Projects are typically customized equipment or systems for commercial, industrial or agriculture facilities that fall outside the standard offer incentive programs. <u>Express Efficiency</u> • All non-residential customers regardless of size or monthly electric demand. <u>NRA</u> • Business customers	• SCE	<u>Audits: Energy Efficiency Information</u> • For large and medium customers, facility surveys and audits will be conducted by SCE or third party program implementer staff to make the customer aware of opportunities that may exist to implement energy efficiency projects. • For smaller customers, onsite audits may be conducted or information may be provided through mail, email, telephone or other means through the Education, Training and Outreach program. <u>Energy Efficiency Design Assistance</u> • If appropriate, SCE or third party program implementers will provide additional assistance to help a customer or vendor identify and carry out an energy saving project. <u>Financial Incentives</u> Incentives are available to customers or their consultants and contractors with the customers' approval. Project caps will be consistent across both programs as follows: • Customers are eligible to receive up to 75 % of the installed project cost (not to exceed 100% of the incremental cost) or \$1.5M, whichever is less. The customer will have the option of receiving the incentive in the form of a utility bill credit or a check.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
PGE2015	Association of Bay Area Governments (ABAG) Energy Watch	• PGE • Association of Bay Area Governments (ABAG) • Energy Solutions (implementation subcontractor to ABAG)	Promotes reduced energy use and energy savings for local governmental agencies. The 2006-2008 ABAG-EW Partnership is designed to provide technical assistance and information services to assist cities, counties and special districts (local governments) in the ABAG membership areas.	• Local governmental agencies (cities, counties and special districts) in the following counties: Alameda, Contra Costa, Marin (coordinated with the Marin County Energy Watch), Napa, San Mateo, Santa Clara, Solano and Sonoma	• PGE • ABAG • Energy Solutions • Government agencies in the following counties: Alameda, Contra Costa, Marin (coordinated with the Marin County Energy Watch), Napa, San Mateo, Santa Clara, Solano and Sonoma	Facility Services: Provide comprehensive, sustained technical services to help make improvements in public facilities using subcontractors hired by ABAG. Community Energy Services: Offer assistance to local governments in developing energy policies and programs to generate community-wide energy savings for mass markets and other market sectors. Energy Efficiency Education and Information Services: Provide free energy workshops designed for local government decision-makers and facility staff on how to reduce energy bills and operate more energy efficiently. Energy Efficiency Services and Incentives for Municipal Buildings and Street lighting: Survey major energy-consuming systems within public facilities in order to identify potential energy-saving opportunities. • Financial incentives will be available to help support the investment in energy efficiency retrofits at select municipal facilities.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
						Small Facility Direct Install: Provide energy efficient retrofit services for selected small public facilities. • Qualifying customers may gain a number of energy-efficient upgrades for free. Retro-Commissioning (RCx) / Monitoring-Based Commissioning (MBCx): Approach to obtaining savings that combines the expertise of the facility management staff, utility and subcontractor expertise, and the installation of energy monitoring and metering equipment at the building system level.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
PGE2049	Wine Industry Efficiency Solutions (WIES)	• Resource Solutions Group (RSG)	WIES addresses energy efficiency and resource management, and implements a process that will ensure demand and energy savings within this market sector.	• Small and mid-sized wineries in PG&E's service area • Trade allies who provide goods and/or services to the winery market segment	• Resource Solutions Group (RSG) • PGE	• Identifies efficiency improvement opportunities and provides incentives through installation support services and/or rebates for customers who agree to move forward with recommendations.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
PGE2077	School Energy Efficiency Program (SEE)	• Resource Solutions Group (RSG)	SEE provides school facility audits, energy efficiency recommendations, technical services, and cash incentives to encourage the installation of cost-effective energy efficiency measures (EEMs). • SEE is available in 19 counties within PG&E's service area and is provided on a first-come, first-served basis. • School districts, county office of education facilities, and small government facilities who enroll in SEE will receive a comprehensive energy audit of one or more of their facilities.	• Public and private K-12 schools	• Resource Solutions Group (RSG) • PGE	The 2006-08 SEE is designed to encourage and reward participants who implement any of the recommended EEMs outlined in the energy audit report. • Participants who agree to implement the recommendations can receive incentives in three difference forms: 1. Cash Incentives 2. Cash Bonuses 3. Installation Support Services (IS Services), which include the development of project specifications, bid package development and project management services

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
PGE2027	Motherlode Energy Watch (MLEW)	• El Dorado Management	MLEW promotes reduced energy use and energy savings targets for partner cities and counties by providing energy efficiency information and direct installation of energy-efficient equipment free of charge.	• Multifamily residential and small business customers located within designated targeted areas (Vast majority of Sierra Foothills Region)	• El Dorado Management • PGE • Counties: Sierra, Nevada, Placer, El Dorado, Amador and Calaveras • Cities: Nevada City, Grass Valley, Auburn, Placerville, Jackson and Angeles Camp	<u>Multifamily Residential Direct Install:</u> Energy efficiency experts will investigate designated neighborhoods and identify multifamily homes that qualify for the installation of a variety of free energy-efficient measures. <u>Small Business Direct Install</u>: Provide energy efficiency retrofit services to small commercial customers in targeted business districts. • Qualifying customers may gain a number of energy-efficient upgrades free of charge and/or qualify for rebate incentives on applicable energy-efficient equipment. <u>Energy Efficiency Services and Incentives for Municipal Buildings</u>: Survey major energy-consuming systems within city and county facilities in order to identify potential energy-saving opportunities. • Financial incentives may be available to help support the investment in energy efficiency retrofits at select municipal facilities. <u>Energy Efficiency Education and Information Services</u>: Provide energy clinics and classes for residents, community-based organizations and businesses. <u>Codes and Standards Support:</u> Provide Title 24 training and educational

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
						seminars related to energy codes and standards for existing and future building designs to designers, engineers, architects and building officials.
PGE2074	Energy Savers Program—The Energy Alliance Association (TEAA)	• Energy Alliance Association (TEAA) • Small Business Energy Alliance (SBEA)	TEAA / SBEA provide incentives and comprehensive energy efficiency services to the small business sector. • The focus is to reduce peak demand and energy usage through short payback energy efficiency measures.	• Serves small and medium size commercial customers (up to 500 kW) in the non-residential market in the counties of Marin, Sonoma, Mendocino, Lake, Napa, and Solano.	• TEAA • SBEA • PGE	• Offer No-cost energy surveys to eligible small business customers • Offer 100% pre-and post-construction inspections by SBEA project managers • Offer five energy efficiency measures: 1. Comprehensive Lighting 2. HVAC System Tune-Up 3. Vending Machine Controller

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
SCE2525	San Gabriel Valley EE Partnership Program (SGVEWP)	• SCE • Southern California Association of Governments (SCAG)	SGVEWP is a residential and nonresidential partnership between SCE and SCAG. The primary objectives of SGVEEP include: • Provide specialized energy efficiency offerings to San Gabriel Valley local governments, residential and business communities, • Leverage their communication infrastructure to inform their local communities about the wide variety of energy efficiency and demand reduction offerings available to them and encourage participation • Identify opportunities for municipal building retrofits, new construction, commissioning and retro commissioning as well as funnel existing energy programs to the partnership participants	• Cities within the San Gabriel Valley	• SCE • SCAG	• Provide energy education, retrofit assistance, Retro-Commissioning (RCx) as well as design consultation and energy analysis of new construction and renovation project plans.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
SCE2544	CA Preschool Energy Efficiency Program	• Low-Income Investment Fund (LIIF) • California Department of Education's Child Development Division • California Head Start Association • Intergy	CPEEP's primary objectives are to deliver cost-effective energy and demand savings to child care and preschool centers through a comprehensive strategy that includes detailed audits, technical assistance, implementation and verification.	• Child care and preschool centers	• Low-Income Investment Fund (LIIF) • California Department of Education's Child Development Division • California Head Start Association • Intergy • SCE	LIIF will use its channels to increase communication and begin marketing to preschools: • Forms of communication include newsletters, email, and direct mail to center directors, a web site, and conferences and professional development meetings to educate this market sector on the benefits of energy efficiency and the program designed to assist them. • Work with each preschool on a case-by-case basis to determine the incentive that will make the project feasible for the customer.
SCE2569	State of California/IOU EE Partnership Program	• SCE • State of California • The other three IOUs: 1. PG&E 2. SCG 3. SDG&E	Program involves collaboration on a new energy efficiency partnership program to share energy efficiency best practices and to implement energy efficiency projects for immediate and long-term energy savings and peak demand reduction. • The effort will attempt to reduce the amount of energy the state purchases off the electrical grid by 20% by the year 2015.	• State agencies under the executive branch of the state government (Assist compliance with Executive Order S20-04 Green Building Initiative)	• SCE • State of California • The other three IOUs: 1. PG&E 2. SCG 3. SDG&E	• Utilize custom incentives and core programs for projects implemented in California's state owned and leased buildings and IOU services for education and training activities. The activities will achieve cost effective energy savings through energy efficiency retro-commissioning, equipment retrofits, new construction and demand response programs. • Seek opportunities to integrate utility incentives with state financing through the Energy $mart program to increase program participation in the partnership effort.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
PGE2066	Energy Smart Grocer—Portland Energy Conservation Inc. (PECI)	• EnergySmart Grocer (ESG)	ESG provides grocers with energy audits, rebates and information about energy efficient technology and operations. ESG promotes energy efficient lighting, HVAC (Heating, Ventilation and Air Conditioning), and refrigeration systems. Specific services include: • No cost energy audit • Estimated Energy Savings Report • Contractor enrollment • Technical consultation • Financial rebates and rebate application assistance	• Grocery stores in PG&E's service area with a demand of 70 kW or greater	• ESG • PGE	**The program will use the following methods to obtain outcomes:** • Enroll Customers: Program managers will talk with corporate decision makers to discuss the program and confirm enrollment. • Perform Audits: The program provides detailed, site specific audits. • Present the Audit Results: A report shows the installed measures' costs, savings and simple payback, so that an energy expert can show the return on investment for each recommended retrofit. • Seal the Leaks: Door gaskets and strip curtains will be installed as part of the controls package • Coordinate Contractors: The energy expert recommends a qualified controls contractor and coordinates the work with the stores' existing contractors if necessary. • Monitor Pre- and Post- Installation: The program collects pre- and post-installation data. Pre- and post-installation data are compared to verify the controls are operational.

APPENDIX I: Glossary of Technical Lighting Terminology

Definitions in this Appendix are either adapted or verbatim definitions from the Rensselaer Polytechnic Institute National Lighting Product Information Program Glossary[3].

ballast -

A device used by electric-discharge light sources, such as fluorescent or high intensity discharge (HID) lamps, to regulate voltage and current supplied to the lamp during start and throughout operation.

color rendering-

A general expression for the effect of a light source on the color appearance of objects in conscious or subconscious comparison with their color appearance under a reference light source.

diffuser –

Diffusers scatter the light from a luminaire in all directions. Most diffusers are made of plastic, usually acrylic or polycarbonate. Other materials include glass and alabaster.

directionality –

The directionality of light is defined as the balance between the diffuse and directional components of light within an environment. It is an indicator about the spatial distribution of light flow onto an element or into a space.

footcandle –

A measure of illuminance in lumens per square foot. One footcandle equals 10.76 lux (lumens/square meter), although for convenience 10 lux is commonly used as the equivalent.

[3] Rensselaer Polytechnic Institute Lighting Research Center. (2009). National Lighting Product Information Program (NLPIP) Glossary. Retrieved May 19, 2009, from http://www.lrc.rpi.edu/programs/nlpip/glossary.asp

high intensity discharge (HID) lamp -

An electric lamp that produces light directly from an arc discharge under high pressure.

Metal halide, high pressure sodium, and mercury vapor are types of HID lamps.

high pressure sodium (HPS) lamp –

A high-intensity discharge lamp type that uses sodium under high pressure as the primary light-producing element. HPS lamps are among the most efficacious light sources, with efficacies as high as 150 lumens per watt.

illuminance-

The amount of light incident on a surface area. Illuminance is measured in footcandles (lumens/square foot) or lux (lumens/square meter).

initial light output-

A lamp's light output, in lumens, after 100 hours of seasoning.

intensity (luminous intensity) –

Total luminous flux within a given solid angle, in units of candelas, or lumens per steradian.

lamp efficacy-

The ratio of the light output of a lamp (lumens) to its active power (watts), expressed as lumens per watt (LPW).

lumen-

A unit measurement of the rate at which a lamp produces light. A lamp's light output rating expresses the total amount of light emitted in all directions per unit time. Ratings of initial light output provided by manufacturers express the total light output after 100 hours of operation.

lumen depreciation –

The decrease in lumen output that occurs as a lamp is operated, until failure.

luminaire –

A complete lighting unit consisting of a lamp or lamps and the parts designed to distribute the light, to position and protect the lamp(s), and to connect the lamp(s) to the power supply. (Also referred to as fixture.)

luminous flux-

The rate of flow of light, measured in lumens. The overall light output of a lamp.

lux -

A measure of illuminance in lumens per square meter. One lux equals 0.093 footcandle.

probe-start technology –

Probe-start technology is used in traditional metal halide lamps. Three electrodes are present in the arc tube of a probe-start lamp: a starter electrode and two operating electrodes. To start the lamp, a discharge is created across a small gap between the starter electrode and the operating electrode. Electrons then jump across the arc tube to the other operating electrode to start the lamp. Once the lamp is started, a bi-metal switch removes the starting probe electrode from the circuit. Each time a MH lamp is turned on, tungsten sputters from the electrodes. Over the lamp life, this tungsten can cause the arc tube wall to blacken, thus reducing performance of the lamp.

pulse-start technology –

Pulse-start metal halide lamps do not have a starter electrode. Instead, they have a high-voltage ignitor that works with the ballast to start the lamp using a series of high-voltage pulses. Using an ignitor with a lamp reduces tungsten sputtering (see *probe-start technology*). Warm-up time and heat loss are also reduced.

restrike time -

The time required for a lamp to restrike, or start, and to return to 90% of its initial light output after the lamp is extinguished. Normally, HID lamps need to cool before they can be restarted.

steridian-

A unit of measure equal to the solid angle subtended at the center of a sphere by an area on the surface of the sphere equal to the square of the sphere radius.

APPENDIX H: Response to Public Comments from May 17, 2010 Presentation

The California Public Utilities Commission posted a draft version of this report on its web site and hosted a webinar presentation of key methods, findings, and recommendations on May 17, 2010. Members of the public were invited to offer comments at the end of the webinar presentation and/or to file them on the web site. The Commission received several comments from members of the public as part of the webinar. These comments and our response are shown in Table A below. The Commission received no comments from the public on its web site.

Public Comments and Responses

Comment/Question	Response
What percentage of the high bay lighting projects identified through the California end-user survey would have required permits under Title 24?	Title 24 requires that a permit be obtained for renovation projects that involve the replacement of 50 percent or more of the lighting fixtures in the affected space. According to the results of the end user survey, 59 percent (+/- 3.6 percent) of the projects reported by sample end-user customers met this threshold.
Did you identify any differences between different kinds of end-use customers in terms of high bay lighting project specifications or technology choices?	The end user sample was not sufficiently large to provide resolution on this issue.