FINAL DRAFT Scoping Study and Work Plan for a High Bay Lighting Market Effects Study

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Contents

1 Introduction

This document presents a scoping study for an evaluation of the effects of the California investor-owned utilities' (IOUs) 2006 – 2008 energy efficiency programs on the commercial & industrial (C&I) markets for high bay lighting (HBL) products.[1] It presents a preliminary characterization of those markets based upon secondary research, interviews with program staff, and in-depth interviews with small samples of lighting manufacturers, distributors and installation contractors. The scoping study also summarizes the design and accomplishments of the relevant utility programs. We use the summary market and program information as points of reference for the detailed market effects study work plan, which constitutes the final chapter of the report.

1.1.1 Study Objectives

The market effects study, of which this report is the first major deliverable, was commissioned by the California Institute for Energy and Environment through the Request for Proposals (RFP) CP1-006-08 (April 10, 2008). 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 California Public Utilities Commission's (CPUC) 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.

[1] 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.

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.

1.1.2 Methodological Background

The consulting team assembled for this study – KEMA, Inc. supported by Itron, Inc – has relied heavily upon the *California Energy Efficiency Evaluation Protocols*[2] for guidance in conducting this scoping study and in developing the proposed design for the market effects study. The *Protocols* present a definition of 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 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."[3] 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. As the protocol says:

> *The appropriate approach for a market effects study cannot be readily determined without a scoping study to define the market to be studied, develop a market theory to test in the analysis, assess data availability for the market effects study, specify a model of market*

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

[3] 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.

> *change, develop a methodology for data collection and recommend an analysis approach. (p. 149.)*

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.)*

Accordingly, the specific objectives of this scoping study are as follows:

- Describe and lay out a theory and logic model of the California market for HBL technologies
- Describe the utilities' 2006-2008 programs that installed most of the programmatic HBL measures
- Describe and lay out a theory and logic model of the utilities' programs in relation to the market
    - Identify expected outcomes of program efforts
    - Delineate indicators that can be measured in order to establish whether expected outcomes have occurred
    - Recommend alternative hypotheses to test in order to assess whether observed market changes can reasonably be attributed to market forces or actors outside the IOUs' programs
- Develop a plan for data collection and analysis to assess the market effects of the IOUs' programs that support HBL measures

The plans for the data collection and analysis as outlined in this scoping study are subject to revision after a public workshop, as called for in the Market Effects Protocol and the Final Study Plan.

The sources of information for this scoping study are as follows:

- Review of previous market effects studies of California IOUs' programs and other relevant studies outside of California (see Appendix A).

- Review of California IOU program data for High Bay Lighting measures on the Energy Efficiency Groupware Application (EEGA).[4]
- Review of regions in the country that could serve as a possible comparison area to California. The objective was to specify a region without programs supporting accelerated installations of energy efficient high-bay lighting. In consultation with the study's sponsors and advisors, Pennsylvania (excluding Philadelphia), Ohio, and Michigan were originally selected for the preliminary phase of this study.[5]
- 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.
- Interviews with representatives of 11 manufacturers (national and California), 15 distributors (seven in the comparison area), and 16 installation contractors (seven in the comparison area) active in the C&I HBL market.

Appendix A summarizes the key topics from previous studies covering market effects in California and other states. The interview guide used for the IOU program managers and other key staff appears in Appendix B. The interview guide used for contractors, distributors, and manufacturers appears in Appendix C. A summary of small IOU programs (Third-party and partnership programs) claiming savings from HBL measures appears in Appendix D.[6] Appendix E presents a glossary of common technical lighting terminology. Appendix F 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 the full-scale study, for which the states of Michigan, Alabama, Georgia and South Carolina were selected.[7]

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

[5] 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. 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 full-scale study.

[6] 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.

[7] 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 clear history that is free of energy efficiency programs supporting high-bay lighting technologies. As a result of this second review, the MS, AL, GA, and SC region was specified.

2 The HBL Market in California

2.1 Market Theory and Logic

2.1.1 Overview

In this section, we identify the key groups of business establishments in the HBL market, specify their functions in the market, characterize their motivations to promote energy-efficient HBL, and describe the mechanisms by which they have pursued that objective. This market characterization is based upon the literature review and in-depth interviews conducted for this study with program staff, manufacturers, distributors, and installation contractors. 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. The findings and hypotheses generated by the in-depth interviews will be explored further in the large sample surveys.

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 into a broader market system in the non-residential new construction market. Therefore, this study will focus on the retrofit market to define the scope for measurement and assessment. The market theory and logic discussion below, however, does present a limited amount of data on the new construction market because it helps illustrate the market dynamics for retrofit applications by comparison.

The most common and emerging lighting technologies appropriate for HBL applications are summarized in the following table (

Table 1).

Table 1: Common and Emerging Lighting Technologies for High-Bay Lighting Technologies[8]

Lighting Technology	Description
T5 Fluorescent	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. T5 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 T5 or T8 lamps by changing the sockets and ballasts.
T8 Fluorescent	A linear fluorescent lamp that is one inch in diameter.
T12 Fluorescent	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, high pressure sodium, and mercury vapor 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	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.

[8] 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

Another observation of the study team is that few differences, if any, were detected between the market actors' responses in California versus the comparison areas. Any differences detected were subtle.

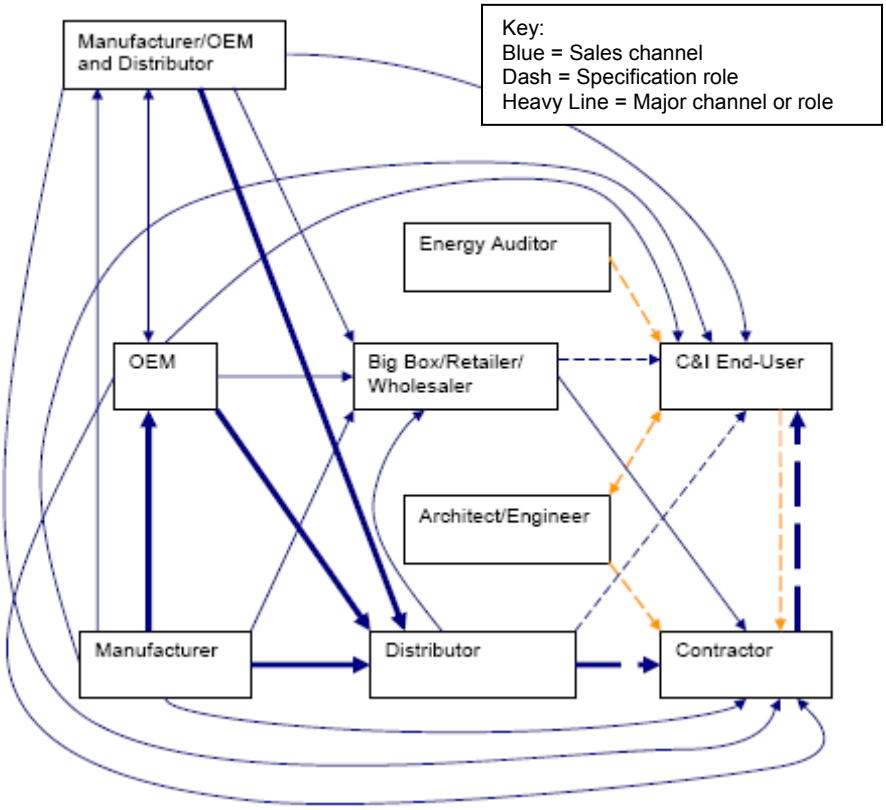
- Manufacturers tend to be national in scope, and target California because it is a large market. Indeed, this was confirmed by all manufacturers interviewed, selling products across the country and even into Canada. Manufacturers showed no regional variation, but recognized that California is a large market for efficient lighting technologies, in general.
- Distributors also tend to be regional or even national in size and organization. Distributors in the comparison area were all regional or national and 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 relatively greater awareness by contractors in California of the full range of energy efficient HBL options than in the comparison area.
- The most significant difference that we identified between California and the comparison areas 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 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. None of the contractors in California raised the issue, however.

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.

2.1.2 Market Structure

Figure 1 below, labeled "The California Market for HBL," reflects utility program staffs' and market actors' views of the market structure and basic mechanisms for installation of lighting for high-bay applications.[9] 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).

Figure 1: The California Market for HBL



[9] 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.

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

Manufacturing

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"[10] 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 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. All of the contractors interviewed both in California and the non-program areas, reported that they received marketing support from manufacturers; most named two or more manufacturers from whom they received such support.

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."

[10] Original Equipment Manufacturer

Distribution

Distributors purchase lighting equipment from manufacturers, warehouse it, and sell on 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 lay-out specification services, usually at no cost to the contractor as a means to promote sales and customer loyalty.

The results of the in-depth interviews suggest that distributors are extremely heterogeneous in terms of what they sell and to whom. Table 2 shows the distribution of distributors who provided in-depth interviews by the kinds of services that they offered. It also shows the range of responses provided to follow-up questions that probed the percentage of total revenue derived from each reported activity. One surprising result was the relatively high level of sales reported as being made directly to end-users. Virtually all distributors interviewed reported selling directly to end-users (versus nine of 12 respondents reporting sales to contractors). The distributor reporting that 95 percent of revenue came from end-users handles lamps exclusively, and his business strategy is to sell directly at discounted prices to large users. Most of the other respondents were general electrical parts distributors, so it makes sense that a significant portion of their revenue derive from sales to facility managers.

Table 2: Reported Distributor Business Activities*

Business Activities	California n = 8	Non-Program Area, n = 4	% of Revenue (Range/Distribution
Lighting sales to end-users	7	4	30% - 95% (evenly distributed)
Lighting sales to OEMs	3	2	0% - 35% (clustered in low range)
Lighting sales to contractors	5	4	2% - 70% (clustered in middle range)
Lighting layout and design services	3	4	No charge
Lighting installation services	1	-	Different division
Sales of other electrical equipment (more than 30 percent of total sales volume)	1	2	10% - 90%

*15 distributor interviews were completed, but 3 respondents refused to answer this sequence of questions.

The distributors interviewed also differed significantly in the manner in which they sell equipment and the degree to which they influence equipment choices of contractors and end-use

customers. The interview guide asked the distributors what percentage of their contractor sales were made under the following arrangements:

- Straight price bid on detailed specifications;
- Proposal in response to a functional type specifications;
- Work with the contractor to develop lighting layouts and equipment schedules;
- Work with the project engineer or architect to develop lighting layouts.

Six of the 10 distributors that answered this question reported that a minimum of 60 percent of their projects was obtained through straight price bids on detailed specifications. Most of this work was in new construction. The other four contractors reported widely varying practices. One never bid on price-only requests, and reported working on lighting layouts with contractors or architects on over two-thirds of his projects. Another reported proposing on functional specifications for 90 percent of his projects.

Although a significant portion of the distributors interviewed reported participating in the specification, most characterized their level of marketing effort and influence on contractor decisions as being fairly low. Only one of the 12 distributors interviewed reported making "special efforts" to market energy-efficient equipment. Those distributors who discussed the issue ascribed greater influence on contractor decisions to manufacturers, utility programs, and general economic conditions.

Manufacturers state that big box stores account for a relatively small portion of total high bay 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 survey.

Contractors

Electrical and lighting contractors specify and install lighting fixtures, controls, and related equipment in C&I facilities. Table 3 shows the range of activities reported by the contractors interviewed. For all but 5 of the 16 contractors interviewed, installation of lighting equipment accounted for one-half or more of total revenues. In most cases, the portion of revenue from installations was over 75 percent. Three of the contractors interviewed concentrated on lighting maintenance contracting, which accounted for 50 to 85 percent of their total revenues. With a few exceptions, lighting equipment sales to end-users or other contractors accounted for little if any revenue, reflecting a common tendency among installers to avoid any risk associated with maintaining inventories of lighting equipment for resale.

Table 3: Reported Contractor Business Activities

Business Activities	**California n = 9**	**Non-Program Area, n = 7**	**% of Revenue (Range/Distribution**
Lighting sales to end-users	4	7	0% - 25% (clustered under 5%)
Lighting equipment installation	9	7	10% - 100% (clustered over 50%)
Lighting sales to other contractors	6	2	8% - 75% (clustered in low range)
Contracted lighting maintenance services	9	7	2% - 85% (clustered in the low range; 3 hi outliers)

Contractors are extremely diverse in terms of size as well as business activities. Table 4 shows the distribution of lighting and general electrical contracting establishments in California by number of employees. Fifty-five percent of the establishments employ fewer than 5 individuals. Most of these are engaged in residential work.

Table 4: 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 2,4991	1	<1%	1,000	3%
Total	**3,616**		**35,314**	

Source: Dun & Bradstreet Selectory Database

Recent studies of the C&I lighting market in states outside of California[11] 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.

[11] 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.

- 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.
- Contractors reported in the in-depth interviews that they specify HBL equipment in 40 – 50 percent of the C&I new construction projects requiring HBL technologies that they worked on, and 60 – 70 percent of the time for HBL retrofit projects in existing buildings. Contractors interviewed for this project reported similar patterns of responsibility for specifications, across regions as well,
- In new construction, contractors identified engineers and designers as the most important influence on equipment selection. In renovation projects, the general contractor was identified as having the greatest influence.
- Surveys of C&I end-use customers conducted for general market characterizations found that contractors were identified as important influences on equipment selection decisions in roughly one-third of projects versus 40 percent for designers. This finding may reflect the fact that facility owners deal directly with specialty contractors in only 50 percent of the lighting projects.

The in-depth interview guide administered to contractors for this study focused more on their perceptions of the technical and business advantages of efficient HBL than on matters of industry structure. However, in response to items concerning their roles in equipment specification, the contractors corroborated findings from other sources on their participation in and influence on the equipment specification process. They also corroborated the reports of manufacturers and distributors interviewed for this study in regard to the level and kinds of marketing support that they received from those groups.

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 high-bay applications. A study of Vermont's industrial facilities found similar levels of overall facility improvement activity and adoption of fluorescent HBL.[12] 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.

2.2 External Factors Affecting HBL Measures

The literature review and in-depth interviews with market actors conducted for this study identified the following external factors which have influenced or which will influence the development of the market for energy-efficient HBL: technology development, codes and standards, voluntary programs, and other external influences.

2.2.1 Technology Development

HBL technology has seen rapid and continuous improvement in efficiency and performance over the past decades, as well as decreases in incremental costs versus older technologies. Pulse-start metal halide technology improves upon the older probe-start technology in the following characteristics:[13]

- Higher light output per unit of electric power;

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

[13] See Appendix E for a Glossary of Technical Lighting Terminology

- Higher light output as lamps age;
- Longer lamp life;
- More stable color rendering as lamps age; [14]
- Quicker startup – pulse-start lamps can reach full brightness in two to four minutes instead of the five to ten minutes needed by probe-start lamps.

According to California's 2005 Database on Energy Efficiency Resources (DEER) database (http://www.deeresources.com), pulse-start technology cost roughly 20 percent more per fixture compared to probe-start technology with comparable light output. As of 2008, the year at which probe-start technology was effectively prohibited by changes to California's building energy efficiency code (Title 24), the incremental cost had decreased considerably.

Development of linear and compact fluorescent technology for high bay applications proceeded in parallel with improvements to pulse-start HID lighting. Manufacturers began developing and selling linear and compact fluorescent fixtures explicitly designed for high bay applications as early as the late 1980s. Since then, lamp and ballast manufacturers moved ahead with the development of T-5 technology, which has proven to be more effective than T-8s in high bay applications due to its intensity, directionality, and good color rendition. Compared to metal halide technologies, high performance fluorescent fixtures offer lower energy consumption per lumen output, lower lumen depreciation rates, better dimming options, faster start-up and restrike, better color rendition, and reduced glare.[15] There are some limitations on the use of fluorescent fixtures in extreme cold and in spaces with ceilings higher than 25 feet. Depending on the specific types of fixtures used and baseline conditions, incremental costs for fluorescent versus HID technologies range from 20 to 30 percent. According to contractors and distributors interviewed for this study, the incremental cost of high performance fluorescent equipment (versus HID technology) is decreasing quickly.

As discussed below, most of the manufacturers, distributors, and contractors that we interviewed were aware of the operational advantages and relative cost-effectiveness of pulse-start HID and high-performance fluorescent technology. Many also reported that they anticipated rapid development of several other technologies that might have high bay application. The first is induction lighting, which generates an electric current through a gas-filled tube without the use of the internal electrodes or filaments used in conventional fluorescent lamps. The absence of the electrode contributes to significantly longer lamp life: 100,000 hours versus the 18,000 – 20,000 associated with fluorescent tubes. In their current state of development, induction systems have somewhat lower efficacy than fluorescent systems and are significantly more

[14] See Appendix E for a Glossary of Technical Lighting Terminology.

[15] Ibid.

expensive. However, where lamp replacement is difficult or dangerous and in cold environments, induction systems may be cost-effective now.

Market actors on the supply side of the HBL market are also keeping a close watch on the development of light-emitting diode (LED) technology. LED technology, supported by over $60 million in federal research, development, and deployment investments and significantly more private sector spending, has made rapid progress in terms of efficacy and cost per lumen. However, HBL is not among the early commercial applications foreseen for the technology.[16]

2.2.2 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.[17] 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 which 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[18] (see sections 131(c), 143(c) and 146 in Title 24). This also helps push designers toward higher efficiency lighting sources like T-5 or T-8 aisle lighter luminaires.

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.[19] 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.

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[16] McCullough, Jeff, Terri Gilbride, Kelly Gordon, Marc Ledbetter, Linda Sandahl, and My Ton, "LED Lighting: Applying Lessons Learned from the CFL Experience," Proceedings of the 2008 ACEEE Summer Study, Vol. 6, pp. 134-146, American Council for an Energy-Efficient Economy, Washington, D.C.

[17] 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.

[18] 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.

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

Industry and Professional Standards. Current ASHRAE/IESNA standards 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.[20] [21]

2.2.3 Voluntary Programs

Voluntary energy efficiency programs operated by utilities and other sponsors nationwide have offered financial incentives and technical support for the installation of pulse-start metal halides and high-performance fluorescent products in high bay 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.

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)

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[20] "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.

[21] "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.

- 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. The following table (Table 5) 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.

Table 5: Level of Support for Energy Efficient HBL in the Contiguous US by State

State	*Level of Support*		
	Active Support	*Partial/Recent Support*	*No Support*
Alabama			X
Arizona	X		
Arkansas			X
California	X		
Colorado	X		
Connecticut	X		
Delaware			X
Florida	X		
Georgia		X	
Idaho	X		
Illinois	X		
Indiana		X	
Iowa	X		
Kansas	X		
Kentucky		X	
Louisiana			X
Maine	X		
Maryland		X	
Massachusetts	X		

State	***Level of Support***		
	Active Support	***Partial/Recent Support***	***No Support***
Michigan		X	
Minnesota	X		
Mississippi			X
Missouri	X		
Montana	X		
Nebraska	X		
Nevada		X	
New Hampshire	X		
New Jersey	X		
New Mexico	X		
New York	X		
North Carolina			X
North Dakota		X	
Ohio		X	
Oklahoma			X
Oregon	X		
Pennsylvania		X	
Rhode Island	X		
South Carolina			X
South Dakota	X		
Tennessee			X
Texas	X		
Utah	X		
Vermont	X		
Virginia			X
Washington	X		
West Virginia			X
Wisconsin	X		
Wyoming	X		
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.

2.2.4 Other External Influences

Almost all of the manufacturers interviewed, as well as many of the distributors, mentioned increased environmental awareness as a driver for observed increases in customer demand for efficient HBL. By contrast, none of the contractors mentioned environmental awareness as a factor affecting high efficiency product market share. Rather, they focused on product advantages for the customer and themselves, including lower labor costs for installation, better lumen maintenance and color rendition, and lower operating costs.

One final finding of interest is that no interviewees on the supply side mentioned the current economic downturn as a potential influence on the purchase of efficient equipment, which still carries a higher first cost than standard equipment.

2.3 Summary of Market Conditions, Market Drivers and Barriers

2.3.1 Overview of Market Conditions

Although the number of interviews was too small to accurately quantify market share, the manufacturers, distributors, and contractors interviewed for this study provided a consistent and consistently up-beat assessment of the market for energy efficient HBL. Some of the key findings from the interviews can be summarized as follows.

- **Trends in sales of energy-efficient HBL.** As Table 6 shows, nearly all manufacturers, distributors, and contractors who felt that they were in a position to judge reported that the market share of high performance fluorescents in the mix of HBL sold increased over the period from 2006 to the present. None reported that the market share had decreased. By contrast, roughly half of the respondents reported that the market share of pulse-start technology had increased, with the remaining respondents split fairly evenly between those who reported that the market share had decreased and those who reported that it had stayed the same. Five of the seven contractors who reported an increased share for pulse-start metal halides were located in non-program areas.
- **Awareness of energy-efficient HBL products.** All of the supply-side actors interviewed, including distributors and contractors in the non-program areas, were aware of pulse-start metal halide and high-performance fluorescent technology applications for HBL. They also recognized that these were energy efficient compared to probe-start metal halide
- **Knowledge of advantages and disadvantages of competing technologies.** Most distributors and contractors were able to give accurate and sometimes exhaustive answers to open-ended questions concerning the relative advantages of high performance

fluorescent, pulse-start HID, and probe-start HID products. Specifically, most contractors identified the advantages of lower operating cost, better color rendition, dimmability, and rapid restart for fluorescent fixtures. Most distributors and contractors in California were also aware of the revisions to Title 24 that prohibited installation of new probe-start HID fixtures. One California contractor believed that fluorescent technology had drawbacks that outweighed its advantages, namely the difficulty of keeping fixtures clean, which effectively hastened lumen degradation. For that reason, he did not recommend fluorescent fixtures to his customers for high bay applications.

Table 6: Trends in HBL Market Share Since 2006

Product/ Trends	**Manufacturers n = 11**	**Distributors n = 15**	**Contractors n = 16**
HP Fluorescent			
Increased	8	14	12
Decreased			
Stayed the Same	1		2
N/A	2	1	2
Pulse Start HIDs			
Increased	2	6	7
Decreased		2	3
Stayed the Same		3	4
N/A	9	4	2

N/A = not applicable, generally because the respondent was not familiar with the topic of the question through his or her own operations.

- **Perceived limits on fluorescent high bay applications.** Contractors identified a number of limitations on the use of fluorescent technology in high bay applications. Several mentioned that HID technology performed more reliably in extreme temperatures.[22] We also asked contractors to identify the maximum ceiling height at which high performance fluorescents will deliver adequate lighting levels. The responses ranged from 20 to 100 feet, with most answers clustering in the low range.
- **Business advantages of promoting fluorescent high bay equipment.** Most of the manufacturers, distributors, and contractors interviewed for this study believed that the

[22] Recent improvements to high-performance fluorescent technology have improved starting performance in cold weather.

commercial advantages of promoting fluorescent high bay technology far outweighed any disadvantages. Most of the respondents began their answers to items related to the business aspects of the market by emphasizing their perceptions of the high customer value offered by fluorescent high bay technology. To them it was clear that they were gaining good will and credibility from customers by specifying this advantageous technology. One manufacturer mentioned that the advantages over HID technology were sufficient to justify the extra costs entailed in retrofitting operating equipment, which in turn facilitated rapid growth in volume of sales.

Most respondents reported that they perceived no serious business disadvantages to promoting energy efficient technologies. There were some differences among the contractors around technical and cost details, specifically:

- Some contractors reported that it was easier and required less labor to install fluorescent fixtures in retrofit situations than it was to install pulse-start ballasts in new or existing fixtures. Others took the opposite view.
- Some contractors reported that it was easier and less expensive to maintain fluorescent lighting compared to HID fixtures, and some took the opposite view.

- **Barriers to further customer acceptance of high bay fluorescent technology.** As mentioned above, most contractors and distributors reported that they perceived few barriers to increased customer acceptance of high bay fluorescent technology, especially if trends in incremental cost and performance continued. In a related question, we asked contractors to identify what could be done to increase customer acceptance. All of those who responded mentioned first that increased customer education by manufacturers, utilities, and government agencies would have the greatest effect on customer acceptance of the technology. Fewer than half mentioned increased rebates.

2.3.2 Summary of Drivers and Barriers

Table 7 summarizes market drivers and barriers for contractors and end-users.[23] This is a preliminary list and will be expanded later during the Phase 1 study

Table 7: Summary of Market Drivers and Barriers for High Bay Fluorescent Technologies

	Driver	Barrier
Contractors	Increased customer satisfaction and retention.*	Some perceptions of performance disadvantages vis-à-vis HID technologies.
	Increased unit sales and revenues.*	Higher first costs.
	Non-energy product advantages that are clear and easy to sell: longer lamp life, better light quality, no restrike issues.*	Lack of consumer awareness of product advantages, at least in some segments.
End Use Customers	Reduction of operating costs.*	Higher first costs.
	Improved lighting levels and control features.*	
	Reduced lighting system maintenance costs.*	Potentially higher maintenance costs compared to HID depending on application.

* Drivers related to any adjacent barriers are both marked with asterisks

[23] For a complete discussion of barriers to energy efficiency market transformation programs in general, see Eto, Joseph, Ralph Prahl, and Jeff Schlegel, *A Scoping Study on Energy Efficiency Market Transformation by California Utility DSM Programs.* Berkeley, CA: Lawrence Berkeley National Laboratory, prepared for the California Demand-Side Measurement Advisory Committee, July 1996.

3 Program Theory and Logic Model

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

The following table (Table 8) 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 investor-owned utilities 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 or 1.7 percent of total ex ante lighting measure savings.

Table 8: 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	4,451,204,468.86	73,717,035	1.17%	70.90%
SCE	5,106,105,779	3,493,443,170.53	48,517,446	0.95%	68.42%
SDGE	989,458,677	689,812,780.66	29,778,173	3.01%	69.72%
Total IOUs	**12,373,826,714**	**8,634,460,420**	**152,012,654**	**1.23%**	**69.78%**

As of June 30, 2008 (Q2), twelve programs had recorded HBL measure installations (see Table 9).[24] This is a report from the second quarter (Q2) of 2008 data before the end of the 2006-2008 funding cycle and will be updated during the Phase 1 study.

Table 9: 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	42,830,426	39.44%	39.4%	3
SCE2517	Business Incentive Program	MM	40,320,417	37.13%	76.6%	3
SDG&E3020	Small Business Super Saver	MM	11,961,862	11.01%	87.6%	12
SDG&E3012	Express Efficiency	MM	11,562,498	10.65%	98.2%	4
PG&E2027	PG&E Motherlode	LGP	844,932	0.78%	99.0%	1
PG&E2074	Small Business Energy Alliance (SBEA)	3P	694,309	0.64%	99.6%	2
PG&E2049	Wine Industry Efficiency Solutions	3P	148,708	0.14%	99.8%	2
SCE2569	Dept. of General Service Partnership Programs	LGP	71,642	0.07%	99.9%	1
PG&E2015	PG&E ABAG	LGP	50,220	0.05%	99.9%	2
PG&E2077	School Energy Efficiency Program	3P	44,842	0.04%	99.9%	1
SCE2525	SCE San Gabriel	LGP	39,737	0.04%	100.0%	2
SCE2544	California Preschool Energy Efficiency Program	3P	27,058	0.02%	100.0%	1
Totals			108,596,651			

*See text below for definitions of mass market and third party programs.

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

[24] As of the time of this Draft Study, reliable data on the 3P and LGP programs were not available for the remaining two quarters of 2008, but the study team's assessment is that the difference in contributions from the mass market programs is not likely to change from 98%, regardless.

the C&I customer, potentially with the support and assistance of 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 9, 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.

This Scoping Study will focus on the programs—or the 98% of savings—that comprise the savings claims from the mass market. Table 10 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 2006 to 2008 Program Plans posted on the CPUC's website EEGA.[25]

Third party and Local Government Partnership programs are summarized in Appendix D.

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

Table 10: Program Descriptions of IOU Mass Market Programs Claiming Savings from HBL Measures

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.

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
SDGE3012	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.

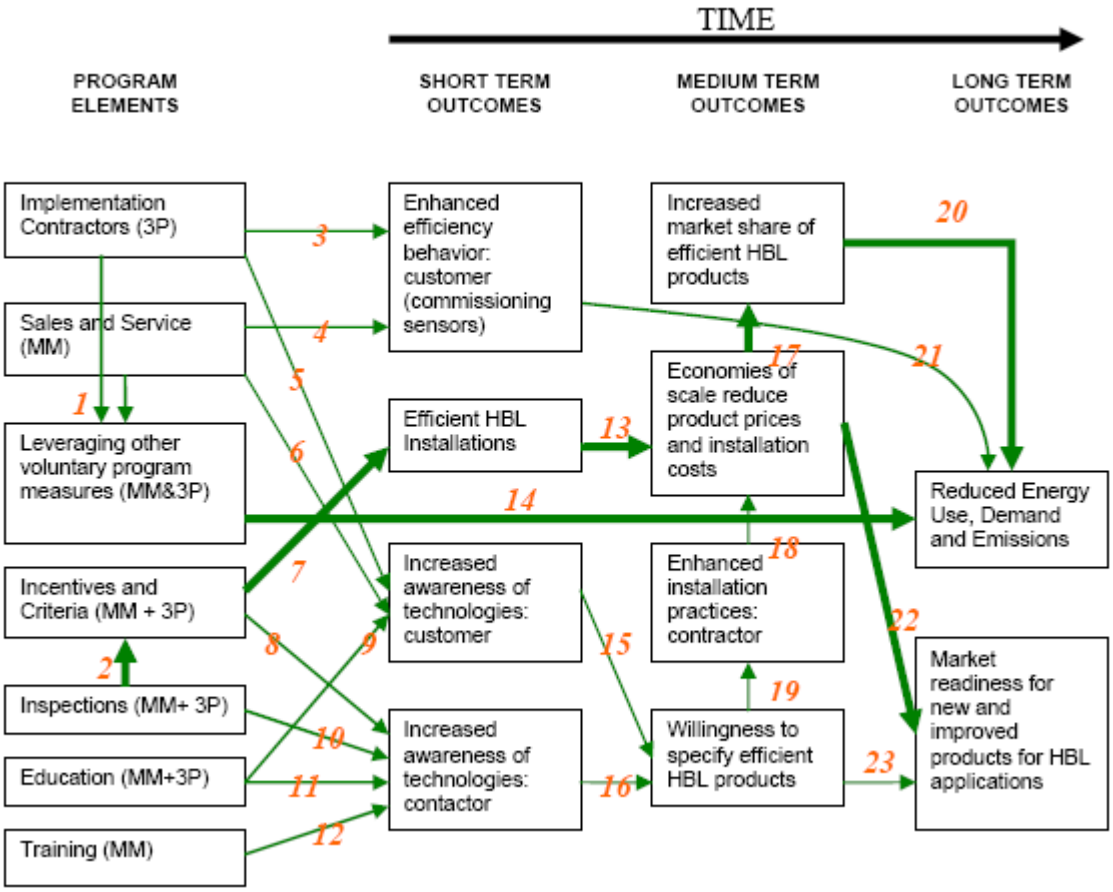
Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
SDGE3020	Small Business Super Saver (SBSS)	• SDGE	SBSS is a local rebate program designed for small commercial or industrial customers. It is a prescriptive rebate program that encourages nonresidential customers to 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	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 direct 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.

3.2 Program Theory and Logic

Figure 2, labeled "Program Logic of HBL Measure Installations through CPUC-Approved Programs," 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. On the left side, the essential program elements are specified, including an indication of whether the element is supported by the MM programs, the 3P 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 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 in which the outcomes are achieved.

Figure 2: Program Logic of HBL Measure Installations through CPUC-Approved 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 through the interviews with program managers. 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 Jordan and McLaughlin.[26]

3.2.1 Program Elements

The key program elements that apply to HBL measures are described further below and how they relate to the short-term outcomes, as shown in Figure 2.

- **Incentives and Criteria (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 contractor is at the center of all decision making and specification of lighting installation decisions, and needs the incentives to specify what the market would otherwise supply at a higher cost.

  The incentives by IOUs for lighting technologies in high bay applications are described in Table 11 below. 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 the measure capacity and not create an incentive that increases overall load through the incentives. This can be challenging when swapping out and replacing different era technologies. The incentives shown in the table below 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 Pulse-start Metal halide 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 (pulse-start metal halides) 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.

[26] 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.

Table 11: 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.

Rebate Measure		IOU				Differences Between PG&E/SCE & SDG&E
		PG&E/SCE		SDG&E		
		Rebate/ Fixture or Lamp	Qualifications	Rebate/ Fixture or Lamp	Qualifications	
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		

	Rebate Measure	IOU				Differences Between PG&E/SCE & SDG&E
		PG&E/SCE		SDG&E		
		Rebate/ Fixture or Lamp	Qualifications	Rebate/ Fixture or Lamp	Qualifications	
T8 or T5 Linear Fluorescent Lamps with Electronic Ballasts	**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				Differences Between PG&E/SCE & SDG&E
		PG&E/SCE		SDG&E		
		Rebate/ Fixture or Lamp	Qualifications	Rebate/ Fixture or Lamp	Qualifications	
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				Differences Between PG&E/SCE & SDG&E
		PG&E/SCE		SDG&E		
		Rebate/ Fixture or Lamp	Qualifications	Rebate/ Fixture or Lamp	Qualifications	
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				Differences Between PG&E/SCE & SDG&E
		PG&E/SCE		SDG&E		
		Rebate/ Fixture or Lamp	Qualifications	Rebate/ Fixture or Lamp	Qualifications	
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		

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 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, and 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.

- **Inspections (Links 2 and 10)**. 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.

  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.

- **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 1, 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 pretty 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 may make it available to customers.

  - 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 as 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; and
  - 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.

- **Education initiatives (Links 9 and 11)** targeting C&I customers and contractors are an ongoing program element, mostly in the form of literature targeting customers and contractors trying to participate 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. Some general marketing materials are available for contractors to use in sales with customers. 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. 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 (Link 12)** are offered to lighting contractors through the MM programs to raise contractor awareness mostly on administrative process issues, but they are fairly irregular. When asked about marketing activities to lighting contractors, one program staff member claimed that the activities were more about technical training rather than marketing. On

occasion, distributors will attend a training event; however, they are not targeted for invitation.

3.2.2 Short-term Outcomes

Key short-term outcomes and how they relate to the medium-term outcomes, as shown in Figure 2, are described below:

- **Increased volume of efficient HBL installations (Link 13)** through program incentives and other support activities are intended to develop economies of scale in the short term, inducing a supply-side response that is the result of reduced 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.
- **Increased awareness by contractors (Link 16)** is a desired outcome in concert with the incentives, because when contractors realize the benefits of efficient HBL measures, it increases their willingness to specify them in the future. 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 than normal when the customer signs over the incentives to the contractor as part of the installation contract.

  Through education, training, and other support mechanisms, contractors, empowered to "upsell" the higher efficiency products and coupled with incentives, are more willing to specify the efficient HBL products. Not only do the benefits include a product with features that satisfy their customers, but also they are easier to install as a result of the information, training, inspection, and education efforts of the IOUs. For example, newer, efficient HBL technologies are easier to install (more "plug and play") and offer safety benefits (e.g., less exertion on ladders of scaffolds in high ceiling installations) during the installation process. Contractors also need to overcome consumer reticence to install fluorescents because of the fear of breakage and the resulting released mercury vapor.
- **Increased awareness by customers (Link 15)** also increases their willingness to request 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 which offers higher incentives and more latitude for customer specification.

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 T5 fluorescents which they claim, anecdotally, to have increased installations over the 2006 to 2008 period. The T8 and T5 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. 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.

- **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 building management systems (BMS) or energy management systems (EMS).

3.2.3 Medium-term Outcomes

Key medium-term outcomes and how they relate to the long-term outcomes, as shown in Figure 2, are described below:

- **Willingness to specify efficient products (Links 19 and 23)** results in several other desired outcomes. In the medium term, contractors 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. 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.”

  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.

- **Enhanced installation practices by the contractor (Link 18)** encourages economies of scale 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. Enhanced installation practices should also be reflected in higher penetration rates of efficient HBL technologies and also participation rates by contractors.
- **Economies of scale (Link 17 and 22)** have a powerful effect on the market place both to prepare the market for a new and improved high-efficiency product in the long-term, but most significantly, to increase the market share of efficient HBL products in the medium term. Increased market share is primarily reflected in higher penetration rates of efficient HBL technologies, but also, it is 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 more available vs. things that aren't on the list or not eligible for rebates." Economies of scale reduce the risk to distributors of maintaining inventories for relatively higher-priced, energy-efficient products. 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)** 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 T5 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.

3.2.4 Long-term Outcomes

As shown in Figure 2, the two key long-term outcomes of the IOU programs are reducing energy use, demand and emissions, as well as ensuring the persistence of those measures and new and improved measures by preparing the marketplace for them.

- **Reduced energy use, demand, and emissions** is 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.

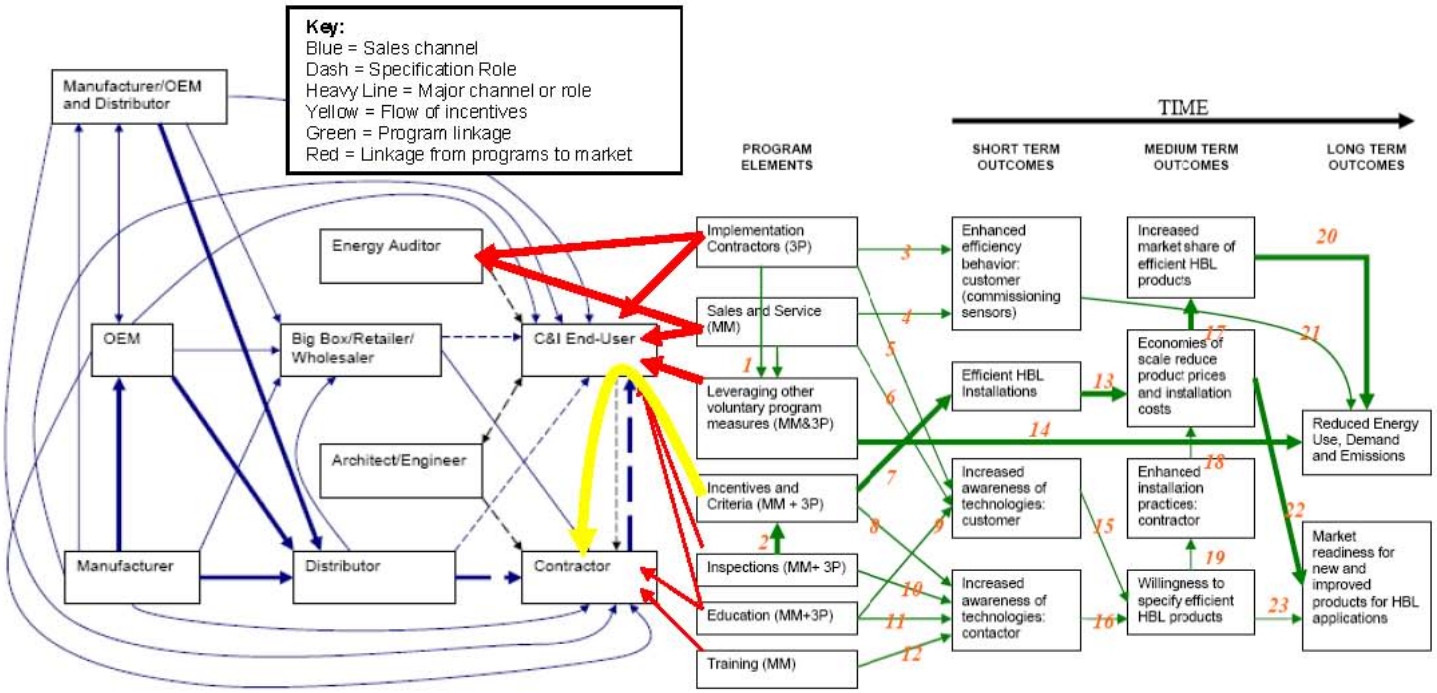
- **Market readiness for new and improved products** is also a significant long-term outcome of the IOU's programs targeting the C&I market. Program managers also emphasize the importance of this outcome. One program manager summarized what others believed: "We're trying to develop an energy efficiency 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.

3.3 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, "Utility Programs with HBL Measures in Relation to the HBL Market," 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. A summary of all of the notation in Figure 3 is as follows:

- 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 which 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 3: 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

3.4 Indicators of Expected Outcomes

The basic elements of the mass market programs are the field support (sales and service teams and implementation contractors), program leveraging, incentives and criteria, inspections, education, and training. The positioning of these elements next to the market elements in Figure 3 indicates that the programs are meant to feed into and leverage activities and relationships that already exist in the market. The links in Table 12 correspond to the numbered arrows in Figure 2 and Figure 3. Please note that there can be more than one indicator of an expected outcome, just as different outcomes can be associated with a single indicator.

Table 12: Logic Model Links, Theory, and Indicators

Link	Program Theory and Indicators
1	**Program Theory: Field 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. **Measurable Indicators** <u>End Users</u>: • Program end-users report that program field support teams influenced them to increase participation in energy efficiency programs and install measures to a greater extent than installation contractors, auditors, or architects/engineers. • Program end-users report that access to efficient HBL was a motivation for program participation.
2	**Program Theory: Inspections** Inspections support the value of the incentives by assuring proper installation practices and use of qualifying equipment. **Measurable Indicators** <u>Contractors</u> • Program contractors report that the inspections caused them to install to high standards with greater frequency than they had previously. • Program contractors report that they use appropriate installation practices (in regard to location, controls, applications) more frequently than non-program contractors.
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. **Measurable Indicators** <u>End-users</u> • Program end-users report other measures taken such as commissioning lighting controls and/or related BMS systems more frequently than non-program end-users.

Link	Program Theory and Indicators
5 & 6	**Program Theory: Information and Advice and Awareness** Information and advice provided by field support teams increases customer awareness of efficient HBL technologies. **Measurable Indicators** <u>End-users</u> • Program end-users report more frequently greater knowledge and understanding of efficient HBL technologies, the energy savings, and the non-energy benefits than non-program end-users; they also report greater change in awareness and knowledge over time. • Program end-users report hearing about efficient HBL technologies from the field support teams more frequently than from other sources.
7	**Program Theory: Incentives and HBL Installation** Incentives and the associated criteria result in greater rates of efficient HBL installations. **Measurable Indicators** <u>End-users/Distributors/Contractors</u> • Program market actors report higher <u>recent</u> market share of efficient HBL installations than non-program market actors. • Program market actors report greater increase in cumulative market share of efficient HBL installations than non-program market actors.
8	**Program Theory: Incentives and Contractor Awareness** Incentives and the associated criteria result in increased contractor awareness of efficient HBL technologies. **Measurable Indicators** <u>Contractors</u> • Program contractors report that program incentives and the associated criteria increased their awareness and knowledge of efficient HBL technologies • Program contractors perceive greater customer and business benefits from efficient HBL installations than non-program contractors. • Program contractors recommend and promote efficient HBL technologies more frequently than non-program contractors.
9	**Program Theory: Education and Awareness** IOU's education strategy increases customer awareness of efficient HBL technologies. **Measurable Indicators** <u>End-users</u> • Program end-users report more frequently a greater knowledge and understanding of efficient HBL technologies, the energy savings, and the non-energy benefits than non-program end-users; they also report greater change in awareness and knowledge.

Link	Program Theory and Indicators
10	**Program Theory: Inspections and Contractor Knowledge and Awareness** IOU's inspection program increases installation contractor knowledge and awareness of efficient HBL technologies. **Measurable Indicators** <u>Contractors</u> • Program contractors report that the inspections caused them to install to safety and application standards (code, ASHRAE, etc.) with greater frequency than they had previously. • Program contractors using appropriate installation practices (in regard to location, controls, applications) more frequently than non-program contractors.
11	**Program Theory: Education and Contractor Knowledge and Awareness** IOU's education strategy increases contractor knowledge and awareness of efficient HBL technologies. **Measurable Indicators** <u>Contractors</u> • Program contractors report that program education components increased their awareness and knowledge of efficient HBL technologies • Program contractors perceive greater customer and business benefits from efficient HBL installations than non-program contractors. • Program contractors recommend and promote efficient HBL technologies more frequently than non-program contractors.
12	**Program Theory: Training and Contractor Knowledge and Awareness** IOU's training strategy increases contractor knowledge and awareness of efficient HBL technologies. **Measurable Indicators** <u>Contractors</u> • Program contractors report that program training components increased their awareness and knowledge of efficient HBL technologies. • Program contractors perceive greater customer and business benefits from efficient HBL installations than non-program contractors. • Program contractors recommend and promote efficient HBL technologies more frequently than non-program contractors.
13	**Program Theory: Installations and Economies of Scale** HBL installations increase in volume and lead to economies of scale. **Measurable Indicators** <u>Distributors/Contractors</u> • Program market actors report higher <u>recent</u> market share of efficient HBL installations than non-program market actors.

Link	Program Theory and Indicators
	• Program market actors report greater increase in cumulative market share of efficient HBL installations than non-program market actors. • Distributors and contractors report costs for efficient HBL equipment decreased relative to competing technologies over the period from 2006 to 2008. • Potential corroboration of cost trends from DEER.
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. **Measurable Indicators** <u>Program End-Users</u>: • End-users report that program field support teams influenced them to increase their participation in energy efficiency programs and install measures to a greater extent than installation contractors, auditors, or architects/engineers.
15	**Program Theory: Customer Awareness and Specification** Increased customer awareness increases their willingness to specify efficient HBL products. **Measurable Indicators** <u>End-Users</u> • Program end-users report more frequently an increased knowledge and understanding of efficient HBL technologies, energy savings, and non-energy benefits than non-program end-users. • Program end users rank efficiency highly on a list of product attributes more frequently than non-program end-users. • Program end-users are more willing to pay the incremental costs of the efficient HBL technologies than non-program end-users..
16	**Program Theory: Contractor Awareness and Specification** Increased contractor awareness increases their willingness to specify efficient HBL products and market efficient products. **Measurable Indicators** <u>Contractors</u> • Program contractors say that they increased their awareness and knowledge of efficient HBL technologies from the IOU's education strategy. • Program contractors report greater awareness and knowledge of HBL customer and business benefits than non-program contractors. • Program contractors report specifying efficient HBL technologies more frequently than non-program contractors. • Program contractors report being willing to explore new and efficient technologies based on participating in the program.

Link	Program Theory and Indicators
17	**Program Theory: Economies of Scale and Prices and Costs** Economies of scale reduce product prices and installation costs. **Measurable Indicators** <u>Distributors/Contractors</u> • Contractors and distributors report decreases over time in the incremental costs of efficient HBL technologies and installation, helping to decrease incremental costs relative to other HBL technologies. • Distributors report changes in stocking practices to accommodate the greater volume of energy-efficient HBL technologies.
18	**Program Theory: Learning by Doing and Costs and Sales** Learning by doing decreases incremental installation costs and increases purchasing and installation volume. **Measurable Indicators** <u>Contractors</u> • Contractors and distributors report decreases over time in the incremental costs of efficient HBL installation • Contractors in California report that incremental installation costs are less than in previous years and less than in non-program areas.
19	**Program Theory: Willingness to Specify and Installations** End-users and contractors' willingness to specify new and efficient HBL technologies increased adoption of efficient equipment and installation practices. **Measurable Indicators** <u>Contractors</u> • Program contractors report using appropriate installation practices (in regard to location, controls, applications) more frequently than non-program contractors. • Program contractors report specifying efficient HBL equipment more frequently than non-program contractors. <u>End-users/Contractors/Distributors</u> • Program market actors report a higher <u>recent</u> market share of efficient HBL installations than non-program market actors. • Program market actors report a greater increase in cumulative market share of efficient HBL installations than non-program market actors.

Link	Program Theory and Indicators
20	**Program Theory: Market Share and Long-Term Outcomes** Increased market share of efficient HBL technologies delivers reduced energy use, demand, and emissions. **Measurable Indicators** <u>End-users/Contractors</u> • Estimate of net effects of the program on unit sales of efficient HBL technology are based on one or more of the following metrics: – subtracting out program sales adjusted for customer-reported free ridership and spillover from the total market sales; – estimate of net adoptions based on comparison of purchases reported by customers in program and non-programs; – estimate of net adoptions based on comparison of sales reported by contractors or distributors • Unit energy and demand savings from DEER or other sources • GHG reductions per California regulatory procedures
21	**Program Theory: Behavior and Long-Term Outcomes** Enhanced efficiency behavior by end-users delivers reduced energy use, demand, and emissions. **Measurable Indicators** <u>End-users/Contractors</u> • Estimate of net effects of program on adoption of appropriate installation and maintenance practices based on one or more of the following metrics: – self-reports by program and non-program customers; – self-reports by program and non-program contractors. • Energy and demand savings from DEER or other sources related to O&M or behavioral changes • GHG reductions per California regulatory procedures

Link	Program Theory and Indicators
22	**Program Theory: Economies of Scale and New Products** Increased economies of scale for efficient HBL technologies and installation practices prepares marketplace for new and improved products for HBL applications. **Measurable Indicators** <u>End Users/Contractors</u> • Program market actors report lower incremental costs for efficient HBL technologies than non-program market actors. • Program market actors report higher levels of awareness and market share for efficient HBL technologies than non-program market actors. • Program market actors report awareness of and interest in emerging HBL technologies more frequently than non-program market actors.
23	**Program Theory: Specification and Installations** Willingness to specify efficient HBL products prepares marketplace for new and improved products for HBL applications. **Measurable Indicators** <u>End Users/Contractors</u> • Program market actors report higher levels of awareness and market share for efficient HBL technologies than non-program market actors. • Program market actors report awareness of and interest in emerging HBL technologies more frequently than non-program market actors.

4 Plan Overview

This section presents the study plan for estimating the market effects of California's IOU programs for HBL measures. Through a limited number of in-depth interviews with market actors in California, the study team did receive some preliminary indications of spillover. As stated earlier, 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.

4.1 Task 1: Analysis of Market Evolution

Objectives. The objective of this task is to assemble as much historic and current data as possible on HBL sales and other market indicators in California and elsewhere in the nation. Such information can provide valuable background for the interpretation of new primary data collected by this project.

Activities. The principle activities for this task are the following:

- **Conduct and summarize a literature review for relevant studies addressing HBL measures and market effects.** A literature research and review was conducted and a summary in order of the study period is presented in Appendix A. This literature review includes studies of California and elsewhere in the United States, and will be the backbone of our Analysis of Market Evolution for energy-efficient HBL technologies. There may also be some value in reviewing site studies for a small sample of 20-30 large commercial projects reviewed in the evaluations of the Standard Performance Contracting programs over the past six years. This review could yield useful information on the evolution of the baseline and on decision-making factors for larger customers.

- **Obtain and analyze databases from programs, market studies, and evaluations in California.** The study team will obtain the following databases to analyze:

  – **IOU 2006 – 2008 program databases.** The study team will request program databases from contractor teams conducting the small commercial, major commercial, and industrial program impact evaluations. Assuming that these databases are available from the contractors, this approach will reduce the burden on the IOUs. Moreover, the databases that the contractors are developing are likely to be cleaner and more useful for the purposes of this study than the IOUs' operating databases. The study team will process this information for a number of purposes, including: identifying the patterns of participation and installations across user segments defined by building type, industry, and geography. In particular, the study

team will review the following data from Itron's *Participant Gross and Net Impact Study for program years 2006-2008*:

- The Small Commercial Contract Group Generic survey contains questions regarding customer and facility characteristics, and customer attitudes.
- The Small Commercial Contract Group Program survey contains questions regarding the role of contractors, program influence on the decision to install, and participant awareness of the program and other programs.
- The Small Commercial Contract Group Lighting survey contains questions on the type, condition, and quality of both the installed and replaced lighting. This survey also asks a series of questions aimed at evaluating participant spillover. This information could potentially be useful in comparing participant vs. non-participant spillover.
- The Small Commercial Contract Group Other survey contains questions relating to participant spillover for all customers, not only for those that installed lighting. These questions try to gather information about any other equipment that may have been installed besides the rebated equipment.
- The Small Commercial Contract Group Rest survey asks for facility operating hours and equipment operating schedules.
- The Small Commercial Contract Group SRNTG survey asks questions for identifying free ridership.
- Onsite data collection from lighting loggers at 52 different sites of HBL measures.in different C&I building segments.

– **CEUS Database.** The 2002 – 2003 Commercial Energy Use Survey (CEUS) collected information on the saturation of lighting technologies in a large, well-designed sample of commercial buildings. Itron directed that study, and Itron staff assigned to this project are very familiar with the database and the types of analysis that can be supported. The study team will analyze the CEUS database to estimate the overall size of the California market for HBL, segmentation by building type and region, and the saturation of efficient technologies by building and space type.

– **DEER Measure Cost Database.** The study team will analyze the most recent DEER data on the pricing of HBL standard and efficient technologies. We will also analyze any data for previous DEER measure pricing studies that might enable us to establish trends in the relative price of standard and efficient technologies.

Deliverables. The principal deliverable for this task will consist of the draft Market Evolution section of the Final Report. This task will provide a chronology of the development of the California and national markets for HBL, focusing on the following aspects:

- Changes in technology features and customer values.
- Changes in efficient technology prices over time in relation to prices for standard technologies.
- Changes in reported motivations and barriers to promotion and adoption reported by distributors, contractors, and customers.
- Changes in saturation and market share over time.

4.2 Task 2: Analysis of Market Effects, Part 1

Objectives. The objective of this task is to define and estimate the value of indicators of the hypothesized market effects of the 2006-2008 California IOU programs that promote efficient HBL systems.

Activities. The principal activities for this task are as follows.

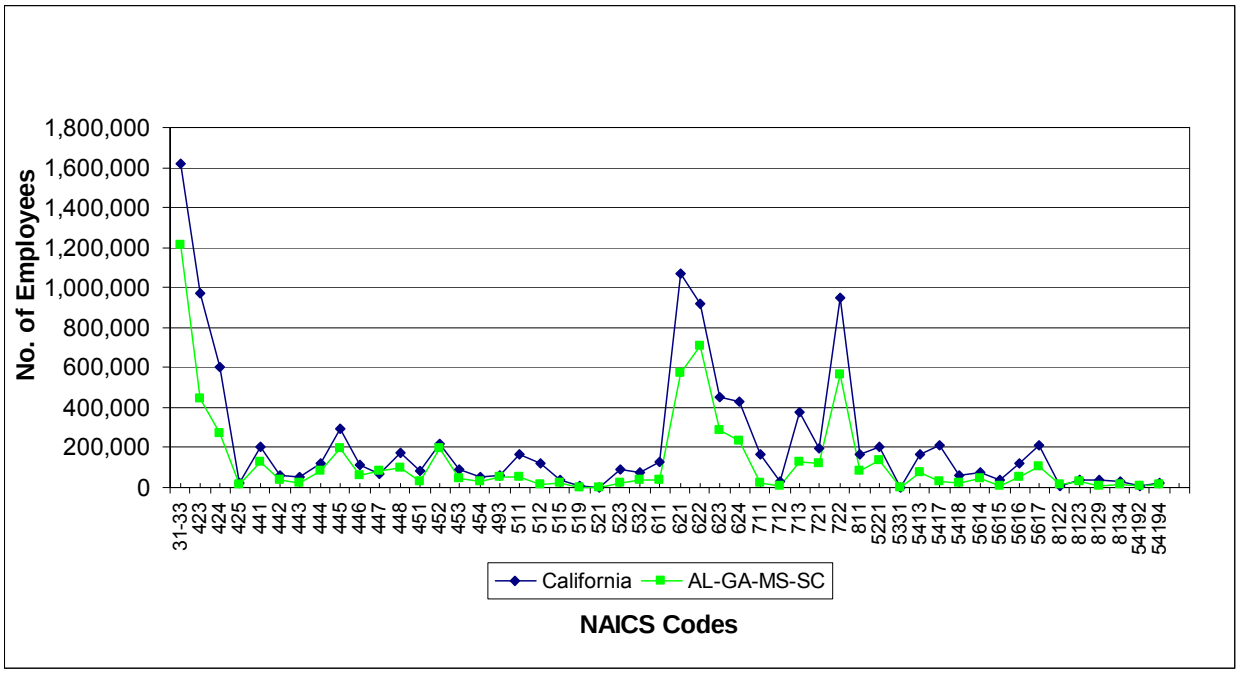
- **Specification of the Comparison Area.** In conducting the in-depth interviews for the comparison area (MI-OH-PA) for the Scoping Study, the study team discovered that this region did not clearly represent a region of market actors without influence of program support for energy efficient HBL technologies. Several interviews revealed the influence of programs in southern Ohio from Duke Energy, and other elevated awareness levels in Pennsylvania from New York. Therefore, in consultation with the study's sponsors, a different comparison area would need to be specified.
    - Criteria for the non-program comparison area selection process were to include a region sufficiently large and diverse as California, but not so large that differences between the areas cannot be measured; and, the region should have no known program activity.
    - A second review of states with no program activity (past or present) supporting energy-efficient HBLs revealed the southeast region of Mississippi, Alabama, Georgia, and South Carolina met the requirements.
    - The study team interviewed Jeff Hirsch[27] regarding DEER specification of building types by C&I activity, and consulted Fred Coito of KEMA who supports

[27] Independent Consultant who supports the California Database of Energy Efficiency Resources (DEER).

that effort, to help determine the potential target market of end users of HBL technologies by NAICS code.

- Based on Mr. Hirsch's recommendations and the study team's experience with other non-residential California projects, including some in support of DEER technical data, the study team relied on a previously specified series of NAICS codes and associated building types for the C&I customer base of the IOUs.
- After sorting the NAICS codes for the building types that could potentially be targets for HBL technologies, the study team collected census data on employee size by NAICS code for that potential end-user market and plotted a graph by NAICS code and total employee size to view a rough comparison of the industrial structure. The study team also relied on data gathered from the in-depth interviews with market actors and program mangers in making assumptions for the relevant target market by NAICS code. Figure 4 shows the plot to match reasonably well between the two areas. Appendix F lists the 2002 NAICS codes, the descriptions, and the employee size data for both areas.

Figure 4: Employee Size by NAICS Codes for Potential End-Users of HBL Technology in California and Four Southeastern States (MI, AL, GA, and SC)



Source: US Census Bureau (2002 Employee Sizes for 2002 NAICS Codes)

- **Develop a sampling plan of contractors and distributors.** In the course of conducting many studies that seek to characterize market conditions through interviews with supply side actors, the study team has developed and refined methods to estimate market shares with relatively high levels of precision using a ratio estimator approach. The basic elements of this approach are as follows.

  – **Sample Development.** We will use the Dun & Bradstreet records contained in the iMarket Database as the sample frame of commercial lighting distributors and contractors. These records identify distributors and contractors by specialty and provide reasonably accurate records of numbers of employees, which is a usable proxy for volume of equipment sold and/or installed. We plan to use a stratified random sampling approach, with number of employees and geographic regions as the stratification variables.

  – **Weighting and computation of survey results.** Distributor and contractor survey responses will be weighted to reflect the number of units of HBL reported as sold or installed by the sample establishment as well as by the population weight of the size stratum from which the firm was drawn. Where the questionnaire seeks responses in the form of a number or percentage—say, the percent of fixtures installed high bay spaces that used efficient technologies—survey responses will be calculated using the combined ratio estimator $\hat{R}_c$:

$$\hat{R}_c = \frac{\sum_h \frac{N_h}{n_h} \sum_i B_{h_i} x_i}{\sum_h \frac{N_h}{n_h} \sum_i x_i},$$

where

i = sample contractor,

N_h = number of contractors in the population in sample stratum h,

n_h = number of contractors in the sample in stratum h,

B_{h_i} = contractor i's response (expressed as a number or percentage),

and

x_i = number of HBL units contractor i reported installed in the evaluation period.

If the question elicits a categorical response (e.g., yes/no), a B_{h_i} will be created for each possible response. For the selected response (responses if choose all that apply), B_{h_i} = 1. For the response/s not selected, B_{h_i} = 0.

This procedure essentially weights responses by the reported number of units sold or installed for each sample firm, thus providing an explicit representation of market share.

- **Precision of estimates.** The use of the combined ratio estimator supports the estimate of a standard deviation and standard error for each variable. The standard errors will be used to calculate appropriate measures of precision for various kinds of results.
- **Alternative estimation methods.** For some variables, we have found it will be more appropriate to use the weighted mean or proportion of the stratified random sample, rather than the ratio estimator. This was the case, for example, in estimating the average number of units installed by contractors in the program and non-program area samples and, from those averages, the total for the population.
- **Sample Design.** As discussed above, the study team will develop stratified random samples of commercial lighting distributors and installation contractors in California and in states in which there have been no active commercial energy efficiency programs to date. The number of employees listed by Dun & Bradstreet (self-reported by the sample firm) will serve as the measure of size for stratification. If we allocate sample points across size categories according to their proportion of total employment in the SIC, we find that the maximum feasible sample size for distributors in California is n = 150 and, for contractors, n = 150. At higher sample sizes, the large and mid-sized strata are exhausted, and the addition of more sample points adds little to the precision of the estimate. For the non-program areas, we recommend samples of 150. Assuming a relatively high error ratio of 0.7, a sample size of 133 will yield estimates of continuous variables, such as market shares, with a 90 percent confidence interval of + 10 percent.

- **Sampling Approach for End-Users Survey.** The objective of the sampling process for the end-user survey is to generate representative random samples of purchasers of HBL in California and in non-program areas identified for the contractor and distributor surveys. The steps in this process will be as follows.
  - **Identify commercial building types and industrial NAICS in which HBL applications are most common.** Figure 4 above shows a reasonably consistent proportional match between California and the preferred comparison region by employee size in 2002 using NAICS 2002 codes. The next step will be to finalize the 2007 NAICS code data by building type and purchase the sample from iMarket,

including employee size data per establishment and state for the NAICS codes specified through DEER and past studies.[28]

- **Develop the sample allocation.** The sample will be segmented by commercial building type/industrial SIC and establishment size. We will develop a measure of size that will serve as a proxy to purchases of HBL. In developing this proxy, we will identify potential indicators contained in the CEUS and the IEUS databases. From these sources, it may be possible to develop indices of lighting wattage per square foot per employee for the targeted industry groups or a similar kind of measure of the quantity of lighting installed. Other potential sources of such information include energy efficiency potential studies, and weights that the study team has used in past studies that rely on DEER inputs and the INFORMS model. Once we have established the feasibility of calculating the index for all building type/industries to be included in the sample frame, we will proceed to populate the sample frame matrix. The sample design will follow the same basic principles laid out for the contractor and distributor surveys.

- **Conduct surveys of distributors and contractors.** We will conduct computer-aided telephone surveys of 300 commercial lighting distributors and 300 installation contractors, with the samples split evenly between California and states in which no major commercial energy efficiency programs have operated for the past 10 years. The focus will be on collecting data to establish the indicators specified in Section 3.4 The key topics to be covered in these surveys will include:
  - Revenues from lighting equipment and service sales (as revealed through the in-depth interviews).
  - Current and recent changes in sales and market share for HBL technologies.
  - Current and recent changes in stocking, promotion, specification, and installation practices for HBL technologies.
  - Perceptions of current and recent changes in customer awareness of and demand for efficient HBL systems.
  - Current and recent changes in business motivations and barriers in regard to stocking and promoting efficient HBL technologies
  - Perceptions of the role of utility programs and California programs in particular in observed market changes.
  - Opinions regarding the likely course of efficient HBL sales and market share in California in the absence of the utility programs.

[28] The segments of interest in this study in the 2007 NAICS code revision are very similar to the 2002 NAICS codes. The 2007 NAICS codes form the basis of the segments commonly used by the study team and DEER

- **Conduct surveys of end users.** We will conduct computer-aided telephone surveys of 600 end-users in C&I market segments that use large quantities of HBL. Half of these surveys will be conducted in California and the other half in non-program areas. The key topics to be covered in these surveys will include:
  - Knowledge, understanding and attitudes regarding the use of high bay fluorescent lighting.
  - Sources of influence in technology selection for the relevant applications.
  - Identification of HBL decision makers.
  - Decision criteria applied to technology selection.
  - Inventory of recent new construction, renovation, replacement, and retrofit projects involving HBL.
  - Share of technologies installed in these projects.
  - Reasons for selection of technologies installed.
  - Changes in building operation due to the enhanced HBL lighting technology.
  - Awareness of and participation in California energy efficiency programs (California sample only).
  - Assessment of program influence on HBL technology choice and estimation of nonparticipant spillover.

- **Analysis of Market Effects.** The analysis of market effects will consist of two major components.
  - The first will be a comparison of the values of market effects indicators developed from the contractor, distributor, and end-user surveys between California and non-program areas.
  - The second will be the development of a narrative of changes in the California and national HBL markets over time, drawing on all of the research and analysis methods described above, including the Analysis of Market Evolution.

  The results of this analysis will be used, to the extent possible, to estimate a net difference in the market share of energy-efficient HBL lighting systems between California and the non-program areas. We will attempt to estimate that difference both for the current period (2006 – 2008) and for previous periods during which the California IOUs promoted efficient HBL technology.

Deliverables. The deliverables for this task will include a memorandum summarizing the final sampling plans for those surveys, and a memorandum summarizing the findings of the analysis of market effects described above.

4.3 Task 3: Assessment of Attribution

Objective. The objective of this task is to assess the extent to which the market changes identified in Part 1 can be attributed to the 2006 – 2008 California IOU programs. In making this assessment, it will be necessary to identify and, to the extent possible, account for independent effects of other factors that likely influenced sales of efficient HBL products. These include changes in manufacturers' competitive strategies in regard to changes in equipment performance and prices, softening economic conditions, changes in electricity prices and other factors affecting customer motivations, and the effects of education, information, and incentive programs offered in other jurisdictions.

Activities. The principal activity of this task will be to sift through the evidence developed in the previous three steps to assess whether observed market effects can be attributed to the current IOU programs and the relative level of program influence versus other potential factors. The types of evidence to be included in this assessment will include the following:

- The size and statistical significance of the differences in indicator values between California and the non-program areas.
- The qualitative strength of the linkage between the observed indicators and differences in market share. For example, differences between areas in contractors' reported installation practices would be considered a stronger indicator than differences in reported levels of customer awareness.
- The quality of the sample and research methods. This criterion will pertain mostly to indicators developed from secondary data and reports.
- The consistency with which market actors identify the subject programs as a key influence on market share and related product development, pricing, stocking, specification, and installation practices.
- The extent to which other factors (such as energy prices or competition among lighting manufacturers) changed in ways that would have increased or decreased customer demand for efficient HBL lighting according to the market theory model.
- The extent to which observed patterns of adoption among vendors and end-users are consistent with the market theory.

Deliverables. The deliverable for this task will be a memorandum summarizing the methods and the findings of the analysis described above. This memorandum will serve as the draft to the corresponding section of the Final Report.

4.4 Task 4: Estimation of Net Energy and Demand Savings

Objectives. The objective of this task is to estimate the energy savings associated with non-participant spillover from the 2006-2008 California IOU programs.

Activities. Our approach is to estimate savings associated with total net efficient HBL lighting sales attributable to the 2006-2008 programs, then to subtract savings estimated by the impact evaluation, which account for net direct impacts and possible participant spillover. The key components of the non-participant spillover estimation will be as follows.

- **Estimate the size of the relevant market for HBL lighting.** In this step we will estimate the annual flow of installations into the relevant California market segments. These segments will be defined by the following factors:
    - **Utility service territory.** Only customers of the three IOUs will be included.
    - **Customer type.** High bay fluorescent is not prevalent in all C&I market segments. We will use the results of the CEUS, market actor interviews, and, to the extent they are available, the IEUS to identify the most relevant sectors.

  Once the market is defined, we will use the information discussed above to estimate the size of the installed stock of HBL lighting. The results of the end-user survey will also be used to support this analysis. Depending on the available data, this may be denominated in terms of total wattage installed or numbers of fixtures. We will then apply estimates of the effective useful life and information from contractors on the extent of retrofit activity to estimate the percentage of the installed stock that turns over each year. We will also consult with the contractors conducting the impact evaluation of non-residential new construction programs to estimate sales into the new construction market.
- **Apply estimates of net market share for efficient HBL attributable to the 2006 – 2008 programs to the estimate of annual sales.** This step will yield an estimate of the net number of fixtures and/or net installed wattage directly attributable to the programs. We will convert fixture data to wattage estimates for use in subsequent steps in the analysis.
- **Estimate energy savings associated with net equipment sales.** We will apply the results of current or recent impact evaluations to convert wattage reduction estimates to annual energy savings. To make this conversion, it will likely be necessary to disaggregate wattage savings by commercial building type and industrial category, because these categories of facilities have different operating schedules.
- **Estimate demand reductions associated with net equipment sales.** We will apply coincidence factors used in program planning and/or developed through recent metering studies to estimate peak demand reductions associated with net equipment sales.

- **Subtract energy and demand savings estimates developed through relevant impact evaluations from totals associated with net equipment sales.** This step will yield an estimate of energy savings and peak demand reductions associated with non-participant spillover.
- **Apply the alternative method to estimate net energy effects, using the results of the end-user survey to estimate nonparticipant turnover in terms of annual units purchased.**
- **Allocate non-participant spillover to utility service territories.** We will use information on the size of the markets in the individual IOU territories to allocate estimated savings to those territories. We may also include in the allocation a factor that reflects the relative effectiveness of those programs, depending on the strength of the evidence of such a difference.
- **Uncertainty analysis.** Each of these efforts has its own uncertainty profile composed of sampling error, potential bias from various sources, and other threats to validity. One useful tool in assessing the uncertainty associated with this analysis is through Monte Carlo simulations.[29] For each source of information, we will identify the sources of uncertainty in the estimates used in the energy savings calculation and characterize the nature and magnitude of that uncertainty. This information will be summarized in a table that will provide the basis of characterization of the error bounds of the energy and demand savings estimates. Prior to proceeding with Monte Carlo simulation, we will review this table with CIEE, CPUC staff and their consultants, and other stakeholders. Based on comments received, we will alter the assessments of uncertainty for various sources and add or delete items.

  We will use Crystal Ball® to conduct Monte Carlo simulations to quantify the overall uncertainty of the savings estimates.[30]

Deliverables. The deliverables for this task will include the memorandum on sources of uncertainty and a memorandum of the results of the savings analysis. The latter will be used as the basis for the corresponding section of the Final Report.

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[29] Monte Carlo methods are a class of computational algorithms that rely on repeated random sampling to compute their results. Monte Carlo methods are often used when simulating physical and mathematical systems. Because of their reliance on repeated computation and random or pseudo-random numbers, Monte Carlo methods are most suited to calculation by a computer. Monte Carlo methods tend to be used when it is unfeasible or impossible to compute an exact result with a deterministic algorithm.

[30] http://www.decisioneering.com

4.5 Task 5: Assessment of Sustainability

Objective. The objective of this task is to develop an assessment of the extent to which the observed market effects of the 2006-2008 IOU programs can be expected to persist in the future.

Activities. The principal activities for this task will be as follows.

1. **Identify and define operationally indicators of sustainability of market effects.** In addition to examples of such indicators called out in the RFP the indicators presented in Section 3.4, the study team will present any other supporting knowledge gained or new indicators developed from the data collections and analysis.
2. **Assess the indicators of sustainability based on the results of research.**
3. **Develop recommendations regarding future program support for efficient HBL equipment.** Based on the results of the above analysis, we will make an assessment as to whether changes in the market for HBL equipment are likely to be self-sustaining. If we find that these changes are not likely to be self-sustaining, we will identify indicators or levels of indicators developed through this project that will signal that the market changes are self-sustaining. We will also use the information gathered in previous steps to develop recommendations concerning the direction of future programs. These will address the specifications of equipment to be supported, the appropriate levels of customer incentives, and the specification of program activities designed to support distributors and contractors.

Deliverables. The deliverables for this task will include a memorandum specifying indicators of sustainability for review and approval by CIEE and CPUC staff and their consultants, as well as memorandum summarizing the results of the analysis described above. This memorandum will serve as the basis for the corresponding section in the Final Report.

4.6 Task 6: Final Report and Presentation

Objectives. The objective of this task is to provide the CPUC, IOUs, and other stakeholders in the project with a succinct but comprehensive presentation of the analyses described in the steps above. Moreover, the final report and analysis databases will contain sufficient detail in regard to research methods and sample development to support replication of key research tasks in future periods.

Activities. The principal activities of this task will be as follows.

1. **Develop the draft Final Report.** We will prepare a draft Final Report; we anticipate that the Scoping Study will be reworked into the Introduction and Methodology sections of the report. The remaining sections will follow the structure of the analyses conducted in the steps above. Appendices to the report will contain the final version of all interview guides and survey instruments, as well as sampling plans and, if requested, banner tables of survey results.
2. We will submit the draft to the CIEE and CPUC staff and their consultants for review. We will prepare a presentation and conduct one or more public webinars or workshops to present the draft report, solicit review comments, and identify the best ways to address issues identified in the review.
3. **Revise the Final Report.** Based on comments received from reviewers and the results of the public workshop, we will prepare a revised version of the report. After the CIEE and CPUC staff and their consultants review the revision, we will make the final round of changes.

Deliverables. The deliverables for this task will include the draft and final versions of the Final Report and draft and final versions of the presentation at the public webinars or workshop(s).

5. Schedule

The schedule of this study is presented in Table 13 below.

Table 13: Schedule of Deliverables

Milestone or Deliverable	Date
Analysis of Market Evolution	
In-Depth Interviews: (10 in total) Manufacturers; (15 in total) Distributors; (15 in total) Contractors	3/10/09
Literature Review	3/2/09
Obtain Databases	Ongoing since kickoff
Draft Report on Market Evolution	6/15/09
Analysis of Market Effects	
CATI Instruments for Distributors and Contractors	Draft 1/5/09; Final 5/15/09
CATI Instruments for End-Users	Draft 5/29/09; Final 6/8/09
Completed CATI Survey Data Set	6/30/09
Summary Memorandum	7/31/09
Estimation of Net Energy & Demand Savings	9/30/09
Assessment of Sustainability	9/15/09
Presentation and Reporting	
Draft Final Report	10/30/09
Draft Presentation Slides to CPUC for review	11/13/09
Presentation at public workshop/webinar	11/20/09
Posting of responses to public comments	12/1/09
Revised Final Report	12/15/09

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.	Design cost minimization: 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. Control technology cost, ease-of-use, reliability and reputation: 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

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				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.

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				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 -	EMERGING ENERGY-EFFICIENT INDUSTRIAL	A range of advanced lamp, ballast, fixture, and light pipe technologies can	Promotional efforts have been mainly focused on commercial sector	• LAWRENCE BERKELEY NATIONAL LABORATORY	The potential for widespread application and large-scale energy savings in manufacturing facilities is beginning to spark an interest in greater promotion of

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	1997, 1999, 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	significantly reduce 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	applications. • 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.	• Government 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	the technology by utilities: • 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.

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	technologies 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		esthetically-pleasing light • Reduced installation and maintenance costs			

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	first costs 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					

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	environmental 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	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	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	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.

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	2006 – 2015 MARKET — COMMERCIAL AND INDUSTRIAL LIGHTING AND LIGHTING CONTROLS RETROFIT Secondary research: 1998, 2000, 2002 - 2005 Market predictions for 2006 – 2015 **Report Date:** November 2005	.wi.gov/docview.asp?docid=154	save between 40 to 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	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,	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	• BC Hydro • Builders • Consultants • School/University boards • Warehouse/Facility managers	Pulse-start Metal-halide: Electricity savings of 11% over 400-W metal-halide fixtures can be achieved. High-Intensity Fluorescent: Electricity savings of 48% relative to the 400-W metal-halide fixture.

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	milestone 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		other benefits include 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 colour rendition of the HIF lamps, electricity savings of 45 to 50% can be achieved over conventional metalhalide lighting.	applications. • 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.		

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			• Other benefits over traditional instant-start metal- halide lamps include shorter restrike times, better colour, 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/LightningReferenceGuide-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	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.

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			funds for 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	Even as new technology displaces old fluorescent, incandescent, and high-intensity discharge sources, the use of fluorescent lighting in heavy commercial and	• 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.

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			technologies.	industrial facilities 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	CALIFORNIA STATEWIDE COMMERCIAL SECTOR ENERGY EFFICIENCY POTENTIAL STUDY Study ID #SW039A FINAL REPORT VOLUME 1 OF 2 Main Report http://calmac.org/publications/CA_EEPot	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,	• 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

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	Commission 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)	V1_rev.pdf	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,	market penetration 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		larger customers. • 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

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			December) provides a specific analysis of the hard-to-reach market segments in which the CPUC has expressed recent interest.	equipment 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		success: small (<20 kW) customer 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

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				in market penetration should be expected.		occupancy sensors and dimming 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

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						share of commercial lighting savings in 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

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						in appropriate applications. Such 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/ShheddingLight.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	TECHNOLOGY BRIEF • Interior High Bay Lighting	Standard metal halide fixtures have been the dominant technology	Not defined in reviewed document.	• Pacific Gas & Electric • Manufacturers	PG&E offers eligible customers $100 per fixture for qualifying Interior High Bay Linear Fluorescent Fixtures.

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	provided. **Report Date:** 2001	Applications http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/agriculture/pge2001mo_collateral_factsheets_highbayfluorescents.pdf	in high bay lighting applications, but 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		• Warehouse/Facility managers • Schools/university board	• With potential savings of $140 per year in energy costs when replacing a 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	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.

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			distribution. • Since T5HO 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:**	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

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	March 2002					
2002	**Study Period(s):** Cites secondary data from 2002, 2003 and 2004 **Report Date:** 2005	T-5 Fluorescent, Bright Idea or just another flash in the pan? http://www.advancedenergy.org/progressenergy/T5versusT8.html	When working through lighting issues, there are several important factors to consider: • Light depreciation • Efficacy • Initial and operating costs • Fixture light dispersion • Controls • Light quality	The initial cost of 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.	• Suppliers • Customers • Warehouse/Facility managers • Manufacturers • Lighting Research Center (NY)	It appears fluorescent fixtures are 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).

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						• Fluorescent fixtures are about 30% less expensive to maintain on a light 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 CO2 emissions by 716,000 pounds.
2004	**Study Period(s):** No dates provided - Researchers at Lawrence	New Lighting Solutions for High-Bay Spaces: High-output T5 Lamps and Luminaires at Camp Pendleton	As energy conservation in industrial spaces becomes an increasing concern, lighting retrofit	Not defined in reviewed document.	• Lawrence Berkeley National Laboratory • Marine Corps Base Camp Pendleton • Tetra Tech EM, Inc. • San Diego Gas and	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

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	Berkeley National Laboratory 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	http://www1.eere.energy.gov/femp/news/news_detail.html?news_id=8304	projects are being encouraged as a way to save energy and improve the quality of the work environment.		Electric	including easier control, dimming ability, good color rendition, and high energy efficiency.
2004	**Study Period(s):** No dates provided. **Report Date:**	High/Low-Bay Applications: Fluorescent or Metal Halide?	Fluorescent lighting offers a number of advantages versus metal halide lighting: • Higher	Relighting projects typically require installation of new fixtures, which can inflate payback	• 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

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	November 2004	http://www.aboutlightingcontrols.org/education/papers/high-low-bay.shtml	efficiency/energy savings • Higher lumen 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	periods and reduce return on investment. 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.		advantages over HID fixtures. Fluorescent lighting has dominated the <15 ft. ceiling height niche, but new 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
			occupancy sensors, photocells and scheduling systems			
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,	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

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	and (5) benchmarks program 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					be attributed to a high volume of greenhouse heat curtains rebated. 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.

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	program staff to support the evaluation 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	CALIFORNIA STATEWIDE RESIDENTIAL SECTOR ENERGY EFFICIENCY POTENTIAL STUDY Study ID #SW063 FINAL 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	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	• Pacific Gas & Electric • Southern California Edison Company • Southern California Gas Company • San Diego Gas & Electric Company • California Public	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

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	remaining potential energy savings 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	VOLUME 1 OF 2 Main Report http://www.calmac.org/publications/PGE_PotentialStudy_Vol1_05242006.pdf	completion of this database, data on commercial measure 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.	the forecast of the remaining lighting potential: • 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	Utilities Commission • California Energy Commission • Natural Resources Defense Council • Itron, Inc. • KEMA, Inc. • RLW Analytics, Inc. • Architectural Energy Corp.	foot T8s in large commercial establishments to 11% for eight-foot T8s in small commercial establishments. • 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

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	continuation of the incentives in effect 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					MW in the 2000 analysis to 1380 GWh and 250 MW in the 2004 analysis.

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	average between current (2004) 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-	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	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%.

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		12_workshop/review docs/MEASURE_BLD_01.PDF	heat and produce superior lumen maintenance. • 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	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	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.

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	and HID' (Energy User News) 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		with electronic ballasting and good reflectors. • 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.			There are several large national companies that have had so many problems with poorly designed T5HO 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</u>

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						<u>Option</u> • Electronic ballasts for 250 to 450W PS MH have logged millions of 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):**	Commercial Services: Incentives	Sacramento Municipal Utility	Not defined in reviewed document.	• Sacramento Municipal Utility	<u>2005/2006 Prescriptive Rebate Schedule</u> Incentive allowed for wall or ceiling

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	Presents 2005/2006 Prescriptive Rebate Schedule **Report Date:** 2005	for Lighting Controls http://www.smud.org/en/business/rebates/Documents/incentlightcontrol.pdf	District (SMUD) provides financial incentives to lighting 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.		District • Customers • Lighting contractors	mounted sensor (including high-bay): $55/sensor • No incentive payment can be greater 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	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	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-

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	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. **Report Date**: 6/22/2007		their system life. • They also have other advantages including instant restrike, more uniform light distribution, and better color rendering.			qualified and FEMP-designated performance requirements for all procurements of energy-consuming 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

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						to use HPS systems, they are required to meet the corresponding metal halide system requirements.
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	T8 versus T5 High Bay Lighting http://www.nexstarlighting.com/FCKeditor/userfiles/File/Present	<u>T8 Technology</u> • In widespread use in Canada for over 15 years • Highest lumen per watt in most fixtures	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)

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	lighting **Report Date:** June 5, 2007	ationT8vsT5.pdf	• Components (lamps and ballasts) are reliable and relatively inexpensive • 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			• T8 solution has the lowest capital cost

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			options available at 347V			
2008	**Study Period(s):** No date provided. **Report Date:** Dec 10, 2008	HID Versus Fluorescent for High-Bay Lighting http://www.bchydro.com/powersmart/technology_tips/buying_guides/lighting/hid_versus_fluorescent.html	High-intensity discharge light 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	<u>Electrodeless induction lamps</u>: • 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.	• Manufacturers • Warehouse/Facility managers • Schools/university board • Designers/Architects	Although improvements in lamps, ballasts and luminaires may eventually 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
			depreciation rates • Better dimming options • Faster start-up and 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	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.

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			switching capability • Continued reliability when there is lamp failure • 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.	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

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	These findings build on the first phase of the study, 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					back of the circuit chip. Improper heat dissipation changes the light color over time. • Federal lighting technology investment 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

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						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 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

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						energy efficiency and lighting quality. • They ensure that participating projects exceed code requirements by at least 25% while avoiding projects that utilize 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):**	California Energy Efficiency Potential	The study forecasts short- and mid-term	Market barriers to adoption include:	• Itron • Pacific Gas and	In many space types, higher efficiency lighting sources or fixtures with

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	This report summarizes the findings of the California 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	Study - CALMAC Study ID: PGE0264.01 http://calmac.org/publications/PGE0264_Final_Report.pdf	gross and net market potential resulting from the installation of energy efficiency 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	• Customer understanding of the savings possibilities and the measure characteristics • Customer inertia or buying patterns that are hard to change. • Vendors' knowledge of the measure and willingness to stock the measures	Electric • Southern California Edison Company • Southern California Gas Company • San Diego Gas & Electric Company • California Public Utilities Commission • California Energy Commission	improved optics were used to lower the lighting power densities (LPD). • For some spaces, the measure values were further reduced by the ratio of 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.

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	assumptions and unifying the approach undertaken for 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		measures for retrofit, replace-on-burnout, conversions, and new construction situations. • Energy savings resulting from changes in behavior, or requiring major redesign of existing systems, were not included in this study.			

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	through 2016 (10 years) while the mid-term potential 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	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

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			environment			Utilities Commission that must be met. As a result, rebates have risen to an all-time high to meet quota.
2008	**Study 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,	State of Wisconsin Public Service Commission of Wisconsin: Focus on Energy Evaluation Business Programs: Channel Studies— Fiscal Year 2008 Final Report: January 17, 2009	**Primary Program 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	Lack of Awareness of opportunity with some market segments and financial barrier with customers with lower hours of operation.	Contractors were 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.	There was an increase in net Wisconsin 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

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
	relative to standard HID technology, and to understand the impact of potentially reduced Focus support for this technology on the stability of the market.) **Report Date:** January 17, 2009		fluorescent lighting systems, across all market segments, compared to any increase in net market 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			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-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

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
			technology.			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 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.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						The following results generally support the notion that Focus has affected the market for energy efficient lighting in 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

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						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 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.

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						• 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 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-

Initial Study Period	Study Timeframe	Name of Report	Market Theory	Market Barriers	Market Actors	Market Effects & Indicators
						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. 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: 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.

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

    PROBE
    j. Financial incentives/rebates for purchase/installation of qualifying equipment
    k. Technical assistance in identifying energy-saving opportunities
    l. Technical assistance in specifying and purchasing energy efficient equipment
    m. Technical assistance in design of installations
6. What kinds of incentives or assistance are provided to distributors and installers?

    PROBE
    n. Financial incentives for promotion or sale of qualifying equipment
    o. Technical assistance in identifying energy-saving opportunities
    p. Technical assistance in specifying and purchasing energy efficient equipment
    q. Technical assistance in design of installations
    r. Advertising or merchandising support
7. **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:
    s. Financial incentives/rebates for purchase/installation of qualifying equipment
    t. Technical assistance in identifying energy-saving opportunities
    u. Technical assistance in specifying and purchasing energy efficient equipment
    v. Technical assistance in design of installations
    w. Customer education materials
    x. Training oriented to facility managers or purchasers
8. **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:

y. Financial incentives/rebates for purchase/installation of qualifying equipment

z. Technical assistance in identifying energy-saving opportunities

aa. Technical assistance in specifying and purchasing energy efficient equipment

bb. Technical assistance in design of installations

cc. Vendor education materials

dd. Training oriented to designers, specifiers, installers?

III. Program Logic

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

ee. The way distributors promote and sell energy-efficient lighting products?

ff. The way that contractors promote, design, and install energy-efficient lighting products?

gg. Customers' awareness of efficient lighting products?

hh. Customers' understanding of the energy savings and other benefits associated with efficient lighting products?

ii. Customers' lighting equipment purchasing practices in the absence of financial incentives?

10. 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.

11. 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:

jj. Customers

kk. Manufacturers

ll. Distributors

mm. Installation Contractors

nn. Lighting Designers

oo. Architects

12. 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:

pp. Customers

qq. Manufacturers

rr. Distributors

ss. Installation Contractors

tt. Lighting Designers

uu. Architects

13. FOR EACH INFLUENTIAL GROUP NAMED ASK:

vv. 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

ww. 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

14. 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?

15. 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?

16. 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?

17. To your knowledge, has customer demand for efficient high-bay lighting increased over the past two years?

18. 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?

19. 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?

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

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

xx. From within California?

yy. What about sources outside of California?

Thank you so much for your time

APPENDIX C: 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 same3
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

Contact Name: [from sample] _____

Company: _____

City or Town: [from sample] _____

Address: [from sample] _____

City, State, Zip [from sample] _____

Telephone: [from sample] _____

Fax Number: _____

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 same3
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 same3
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

22. Which energy efficiency programs are you working on?
23. What are your responsibilities regarding those Programs? What role do you play, if any, in:

    zz. Planning, designing, managing, and administering the Program,

    aaa. Marketing the Program to customers,

    bbb. Marketing the Program to distributors and installation contractors,

    ccc. Managing distributor and installation contractor participation in the Program.

    ddd. Administering the delivery of financial incentives to customers

    eee. Administering the delivery of technical services to customers

    fff. Other aspects of the Program?

General Program Objectives and Operations

24. **First, could you please describe for me what your understanding of high-bay lighting technologies is?**
25. **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:

ggg. Financial incentives/rebates for purchase/installation of qualifying equipment

hhh. Technical assistance in identifying energy-saving opportunities

iii. Technical assistance in specifying and purchasing energy efficient equipment

jjj. Technical assistance in design of installations

kkk. Customer education materials

lll. Training oriented to facility managers or purchasers

26. 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:

mmm. Financial incentives/rebates for purchase/installation of qualifying equipment

nnn. Technical assistance in identifying energy-saving opportunities

ooo. Technical assistance in specifying and purchasing energy efficient equipment

ppp. Technical assistance in design of installations

qqq. Vendor education materials

rrr. 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.

27. As you understand them, do the goals of the program include the stimulation of long-term changes in …

sss. The way distributors promote and sell energy-efficient lighting products?

ttt. The way that contractors promote, design, and install energy-efficient lighting products?

uuu. Customers' awareness of efficient lighting products?

vvv. Customers' understanding of the energy savings and other benefits associated with efficient lighting products?

www. Customers' lighting equipment purchasing practices in the absence of financial incentives?

28. 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.

29. 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:

xxx. Customers

yyy. Manufacturers

zzz. Distributors

aaaa. Installation Contractors

bbbb. Lighting Designers

cccc. Architects

30. FOR EACH INFLUENTIAL GROUP NAMED ASK:

dddd. 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

eeee. 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

31. 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:

ffff. Customers

gggg. Manufacturers

hhhh. Distributors

iiii. Installation Contractors

jjjj. Lighting Designers

kkkk. Architects

Experience with the Program

32. 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?

33. 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?

34. 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?

35. To your knowledge, has customer demand for efficient high-bay lighting increased over the past two years?

36. 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?

37. 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?

38. 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?

39. To your knowledge, have sales of efficient high-bay lighting increased over the past two years?

40. 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?

41. Do you have any thoughts or suggestions about what the program the program could do to accelerate market acceptance of efficient high-bay lighting?

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

llll. From within California?

mmmm. What about sources outside of California?

Thank you so much for your time

APPENDIX D: Third Party and Partnership Program Summaries

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. Small Facility Direct Install: Provide energy efficient retrofit services for

Program	Name	Implementer	Description	Target Market	Key Market Actors	Delivery Strategy
						selected small public facilities. • Qualifying customers may gain a number of energy-efficient upgrades for free. <u>Retro-Commissioning (RCx) / Monitoring-Based Commissioning (MBCx)</u>: 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	Multifamily Residential Direct Install: Energy efficiency experts will investigate designated neighborhoods and identify multifamily homes that qualify for the installation of a variety of free energy-efficient measures. Small Business Direct Install: 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. Energy Efficiency Services and Incentives for Municipal Buildings: 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. Energy Efficiency Education and Information Services: Provide energy clinics and classes for residents, community-based organizations and businesses. Codes and Standards Support: 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 E: 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[31].

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.

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.

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[31] 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 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 F: 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
Information	519	Other information services	5240	1,935

Meaning of NAICS economic sector code	2002 NAICS Code	Meaning of 2002 NAICS code	California (Employees)	AL-GA-MS-SC (Employees)
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
Professional, scientific, and technical services	5417	Scientific research & development services	211340	28,894

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	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