SCE/PG&E Basic/Advanced/LMT Program Process Evaluation:

Commercial Lighting Retrofits – Targeted Research

Final Report

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Executive Summary

Introduction

Southern California Edison (SCE) and Pacific Gas and Electric Company (PG&E) contracted Evergreen Economics, Inc., along with Research Into Action and D&R International, in November 2011 to conduct research related to SCE and PG&E's residential and nonresidential energy efficient lighting rebate programs.

There has been much less attention given to the nonresidential market for energy efficiency lighting compared to the residential market. We designed this study to coordinate with and complement existing and ongoing CPUC-directed research. Early in the study design phase, the Evergreen team, with input from SCE and PG&E, prioritized the commercial sector and focused on program strategies aimed at providing commercial customers with high efficiency lighting measures and systems.

Researchable Issues

The Evergreen team's primary goal was to conduct research to inform the following commercial lighting areas of inquiry:

- The supply-side structure of the commercial lighting market for advanced lighting technologies;
- The key drivers of the commercial advanced lighting market;
- The motivations of market actors and end-users; and,
- How and why certain end-users go "above and beyond" the typical lighting retrofit to install commercial advanced lighting.

The *Advanced Lighting Baseline Study*[1] defines advanced lighting for residential applications. The study investigated the baseline market share of certain advanced CFLs in commercial applications in 2010. However, for the purpose of this study, we are explicitly not using the definition of "advanced lighting" found in the baseline study report. This study focuses on specific lighting approaches and certain product categories that are currently advanced (compared to the "status quo" commercial lighting retrofit). The SCE and PG&E program teams assisted the Evergreen team to define advanced in the commercial sector, primarily based on the technologies and practices currently seen as "cutting edge" by the California investor-owned utility (IOU) program teams. For more information about this definition, please refer to Section 1.3.2 of this report.

[1] Source: KEMA, Inc., et al. "Advanced Lighting Baseline Study: Phase 1 and 2" Prepared for the Pacific Gas & Electric Company, Southern California Edison, and San Diego Gas & Electric. August 1, 2011

Data Collection and Analysis Methods

The study consisted of three research tasks.

We conducted a broad residential and commercial critical synthetic analysis of literature, combined with a gap analysis of other, ongoing research.

We then conducted in-depth interviews with market actors to collect information regarding the structure of the market, market actor motivations, and their interactions with commercial end-users.

Lastly, we conducted an end-user telephone survey that focused on retail stores', restaurants', and offices' reasons for installing advanced lighting technologies, and the degree to which upstream actors influenced their decisions.

The Evergreen team integrated into the study a number of other targeted research questions identified by the IOU program staff.

Summary of Results

This section provides a summary of key results from our research.

The critical synthesis of literature influenced the design of the other research tasks, but also identified choice architecture and the stream of influence framework. Most choices are automatic and are driven by situation factors. The collection of situational factors that drive a choice is called the "choice architecture".[2] Thus, with an understanding of human decision-making and the situational factors that influence it, it is possible to affect choice architecture towards a desired outcome, while still leaving the option of making a different choice. Furthermore, according to the literature, commercial lighting market actors strongly influence the choice of lighting products among end-users, and are centralized, easily identified nodes through which multiple lighting decisions are funneled daily. This stream of influence – the midstream and upstream market actors – is where programs should look to influence choice architecture.

Our research found that current market barriers to advanced lighting retrofits are typical for new products in general, and include:

- **High initial cost**, exacerbated by availability of lower cost efficient options;
- **Knowledge and product awareness gaps** among market actors; and,
- **Risk** associated with product uncertainty and high initial cost.

[2] Thaler, R. and Sunstein, C. (2008). *Nudge: Improving decisions about health, wealth and happiness.* New Haven: Yale University Press.

Primary and secondary research allowed us to identify the roles of the key market actors in the lighting retrofit market, which are presented below:

- **Manufacturer representatives** are sales representatives for lighting manufacturers. They promote and sell product packages to lighting distributors and the design community.
- **Lighting distributors** purchase packages of lighting products from manufacturer representatives. They sell lighting products to contractors.
- **Contractors** sell retrofits to end-users, and then procure the retrofit products from distributors and install them in end-user facilities.
- **Lighting designers** do not play a significant role in the lighting retrofit market. We found that most market reported that designers had no involvement in lighting retrofit projects, and all of the designers we contacted reported that they had no involvement in retrofit projects.

Among these market actors, contractors have the greatest influence on what lighting commercial end-users chose to install, and are frequently the only lighting professional to interact directly with the end-user. However, contractor influence on end-user choice does not happen in a bubble. Rather, the knowledge, available choices, and decisions of other market actors in the supply chain affect what contractors recommend to end-users.

Evidence from our primary and secondary research supports this theory and suggests that distributors may offer a unique opportunity for commercial lighting programs in California. Distributors can special order almost any available lighting product, but evidence suggests that what the distributor carries influences the product awareness and choices made by contractors. While contractors influence end-user decisions, our research suggests that the influence they impart on end-users is affected by the relationships and motivations of market actors further upstream. Therefore, one important commercial end-user "want and need" is for a reduction in distributor risk related to actively stocking and promoting advanced lighting technologies, discussed in more detail below.

Recommendations

Our findings support two key recommendations, presented below.

Recommendation – Reduce Distributor Risk

Market actors reported that distributors seek to meet, but not exceed, demand as a way of minimizing their risk. This can potentially constrain the choices presented to end-users by reducing the likelihood that all options are equally presented. In order to affect the choice architecture presented to contractors, and ultimately to commercial end-users:

We recommend investigating and testing strategies to reduce distributor risk. These may include:

- **Accelerating contractor awareness and knowledge** to increase demand of advanced lighting technologies

  Lack of contractor awareness of and experience with advanced lighting products reduces the choices they provide to end-users. Contractor education and outreach is an important part of increasing the prevalence of advanced lighting installations – especially considering they play the role of the designer in advanced lighting retrofit projects. We believe that contractors could also benefit from case studies of successful advanced lighting retrofits in each sector. Providing contractors the tools to learn about and market advanced lighting may both accelerate their knowledge and increase their ability to sell advanced lighting retrofits.

- **Testing midstream buy down strategies**[3] to reduce the amount of capital a distributor must risk to stock advanced lighting products

  A midstream buy down approach would essentially absorb some of the distributor risk associated with stocking advanced lighting products. The program administrators would assume part of the risk by lowering the cost and risk of stocking. A midstream buy down may significantly alter the information and choices provided to contractors. This is integral in affecting contractor decisions, according to the stream of influence and choice architecture framework.

- **Leveraging relationships with manufacturers**, possibly in the form of upstream buy downs, to positively impact terms of sale agreements with their distributors.

  The IOUs have developed relationships with key manufacturers via other lighting rebate programs, such as the Upstream Lighting Program. We think that the IOUs should consider investigating a similar approach for the heterogeneous nonresidential lighting manufacturers (some manufacture one product class, while others manufacture wide ranges of products). Establishing similar relationships to promote advanced lighting products could leverage utility expertise and encourage manufacturers to reduce the risk to distributors of stocking advanced lighting products. Our findings suggest that this does occur in the market, and that some manufacturers provide incentives so that distributors will carry advanced lighting products. The IOUs should investigate ways to increase the prevalence and efficacy of these efforts.

[3] Following completion of the research for this study, a report was issued by DNV KEMA, Inc., that detailed the successes of a midstream approach to commercial LED lighting retrofits in Massachusetts. The findings may not transfer to the California commercial lighting market (particularly for controls), but the findings suggest that such an approach may be successful. That report is located here: http://www.ma-eeac.org/Docs/8.1_EMV%20Page/2013/Commercial%20&%20Industrial%20Program%20Studies/13%20-Large%20C&I%20Yr.%202012%20Bright%20Opportunities%20Program%20Process%20Evaluation%20Final%20Report%206-14-13%20.pdf

The California IOUs should ultimately select one buy-down point only, to avoid overlap and potential double counting of savings.

Recommendation – Tiered Support for Advanced Technologies

The lighting market is competitive, with LEDs and advanced control retrofits competing for market share with lower cost retrofits consisting of less efficient technologies and strategies. The IOUs provide rebates to end-users in order to overcome the lack of competitiveness of more expensive LEDs and controls, but also provide rebates to the same end-users for the lower cost and less efficient retrofits. Market transformation efforts are focused on advanced lighting while resource acquisition is still largely derived from T8 fluorescent retrofits in the commercial segment. This presents a unique challenge to the IOU programs.

We recommend continued support for advanced lighting retrofits in the form of a higher tier of rebates, relative to rebates for basic lighting retrofits.

This recommendation is consistent with the 2013-2014 PIPs, which provide a framework for addressing the unequal playing field for advanced lighting solutions. The calculated incentives program will be "Offering 'premium' incentives for emerging technologies that are proven but not widely employed in the markets for which they are intended (such as solid state lighting, advanced lighting controls, etc.)."[4,5]

Our findings support the IOU strategy to more aggressively promote advanced lighting technologies compared to non-advanced technologies. This type of strategy has been successfully used for clothes washers and consumer electronics, where rebates are offered in two tiers to distinguish for market actors and end-use customers between the "better" and "best" choice.

[4] SCE Statewide Commercial PIP, source: https://www.sce.com/wps/portal/home/regulatory/advice-letters/pending/

[5] PG&E Statewide Commercial PP, source: https://www.pge.com/regulation/EnergyEfficiency2013-2014-Portfolio/Other-Docs/PGE/2013/EnergyEfficiency2013-2014-Portfolio_Other-Doc_PGE_20130423_272470.zip%20

1 Introduction

Southern California Edison (SCE) and Pacific Gas and Electric Company (PG&E) contracted Evergreen Economics, Inc., along with Research Into Action and D&R International (jointly, the Evergreen Team) in November 2011 to conduct research related to SCE and PG&E's residential and nonresidential energy efficient lighting rebate programs.

There has been much attention placed on the residential and mass markets for energy efficiency lighting over the past decade and more, as the California investor-owned utilities (California IOUs) introduced CFLs and eventually began to depend on them to meet significant portions of their electricity savings claims. The California Public Utilities Commission (CPUC) has directed large-scale studies on these markets, including successive waves of consumer, supplier and retail store shelf surveys.

The Evergreen team designed this study to coordinate with and complement existing and ongoing CPUC-directed research. Since there has been much less attention given to the nonresidential market for energy efficiency lighting, the Evergreen team, with input from SCE and PG&E, prioritized the commercial sector and focused on program strategies aimed at providing commercial customers with high efficiency lighting measures and systems.

The research plan evolved during the course of the project for two reasons:

- To avoid overlap with other IOU and CPUC-funded studies, and;
- To accommodate changing research needs resulting from interim findings, building code updates, and changes in program requirements and design.

The focus was further refined so that the research primarily investigated advanced lighting retrofits in the retail, restaurant, and office segments of the commercial lighting market.

1.1 Program Context

The CPUC Energy Division (ED) adopted the California Energy Efficiency Strategic Plan ("Strategic Plan") in 2008[6], outlining ambitious energy efficiency goals for the state of California. The California IOUs' 2010-2012 energy efficiency program portfolios were the first to embrace the Strategic Plan as a guiding framework. These goals include transformation of both the residential and commercial lighting markets "through technological advancement and innovative utility initiatives."[7]

Following release of the Strategic Plan, the ED and stakeholders initiated the development of action plans, providing an action-oriented, project management framework for

[6] The Strategic Plan was updated in 2011. See: http://www.cpuc.ca.gov/NR/rdonlyres/5D0472D1-0D21-46D5-8A00-B223B8C70340/0/StrategicPlanProgressReportOct2011.pdf.
[7] *Ibid.*

implementation of each of the Strategic Plan's chapters. The Lighting Action Plan was completed in 2010, providing specific targets for residential and commercial lighting market transformation initiatives. The overall vision of the Lighting Action Plan is:

> *By 2020, advanced products and best practices will transform the California lighting market. This transformation will achieve a 60-80 percent reduction in statewide electrical lighting energy consumption by delivering advanced lighting systems to all buildings*.

The purpose of this study is to support the IOU initiative program managers in their efforts to assist the state of California in meeting these goals. We worked with program teams at SCE and PG&E[8] to understand their research needs, and conducted targeted research to answer their key questions. This effort is intended to inform a broader and more comprehensive effort that might be conducted in a subsequent research phase.

The research was designed and conducted before release of the California IOU 2013-2014 Program Implementation Plans (PIPs), and therefore we note where our findings may not apply under the current program structure. We identify other areas where our research supports decisions made as part of the PIP process.

1.2 Research Objectives and Overview of Approach

The Evergreen team's primary goal was to conduct research to inform the following commercial lighting areas of inquiry:

- The supply-side structure of the commercial lighting market;
- The key drivers of the market;
- The motivations of market actors and end-users; and,
- How and why certain end-users go "above and beyond" the typical lighting retrofit.

We conducted three research tasks. First, we conducted a broad residential and commercial critical synthetic analysis of literature, combined with a gap analysis of other, ongoing research. We then conducted in-depth interviews with market actors to collect information regarding the structure of the market, market actor motivations, and their interactions with commercial end-users. Lastly, we conducted an end-user telephone survey that focused on retail stores', restaurants', and offices' reasons for installing advanced lighting technologies, and the degree to which upstream actors influenced their decisions.

The critical synthetic analysis of literature ("literature review") addressed both residential and commercial lighting sectors. In the body of this report we present the findings related to

[8] We refer to SCE and PG&E as "the IOUs" for the remainder of the study. Where we discuss all California IOUs, we use "California IOUs"

the commercial sector (for the full report, please refer to Appendix A). The objectives related to the commercial lighting market were to identify the major factors influencing commercial lighting purchases and to identify research gaps.

For the market actor in-depth interviews, we aimed to identify program opportunities to increase the adoption of "advanced" lighting in commercial lighting retrofit projects. This includes identifying the following:

- The role of market actors in the commercial retrofit market;
- Factors (who and what) that influence choice and selection of retrofit lighting;
- Stocking practices and influences;
- Barriers to the adoption of advanced lighting;
- Differences across key segments – retail, office, and restaurants;
- What contractors like and suggested improvements in lighting retrofit rebate program; and,
- What lighting technologies respondents think will be prevalent five years from now.

The primary objectives of the retail, restaurant, and office advanced lighting retrofit customer telephone survey were to identify who was involved in specifying lighting products and to what degree they influenced the process, and to better understand why the end-user installed advanced lighting equipment. In addition, the surveys had the following research goals:

- Collect firmographic information for businesses that installed advanced lighting technologies;
- Assess commercial customer satisfaction with advanced lighting products (in three segments: retail, restaurant, and offices); and,
- Determine awareness of and ability to meet Lighting Strategy Action Plan goals.

1.3 Research Approach

This section describes our research approach.

1.3.1 Critical Synthetic Analysis – Literature Review

For the critical synthetic analysis of existing literature, the Evergreen team reviewed more than one hundred published reports, extracted relevant findings that were based on robust methodologies and datasets, and critically analyzed the findings with important market and/or program implications. To be comprehensive, the Evergreen team gave residential consumer wants/needs and market transformation studies to-date some attention, but were not the dominant focus, as KEMA was concurrently conducting a comprehensive literature review focused on these topics.

In addition, the critical synthetic analysis identified gaps in the existing research that informed the subsequent study research tasks.

1.3.2 Defining Advanced Lighting in the Commercial Lighting Retrofit Market

The Evergreen team needed a definition for advanced lighting in the commercial lighting retrofit market, and worked with the IOU program teams and reviewed IOU program data to develop a working definition for the purposes of this study.

We defined advanced lighting retrofit as having one or more of the following technologies:

- **Advanced LEDs:**
  - Downlights, indoor/outdoor fixtures, other LED task or ambient lamps.
  - Excluded: LED signs, holiday lights, case lighting.
- **Advanced Controls:**
  - Daylighting or an Energy Management System (EMS);
  - Occupancy sensors and photocells with T5 fluorescents or induction lighting (or any advanced lamp or fixture); and,
  - Dimmable ballasts.[9]
  - Excluded: time clocks, occupancy sensors and photocells on any other type of lamp or fixture.

This definition is used to support market actor in-depth interviews and the commercial customer telephone survey, discussed below. Projects that consist of advanced lighting retrofits are considered "bright spots."

1.3.3 Market Actor In-depth Interviews

This section describes the market actor in-depth interview sample design, interview guide development and research implementation approach.

1.3.3.1 Sample Design

The Evergreen team used several sources to develop the sample frame for the market actor in-depth interviews. The majority of contacts came from SCE and PG&E program implementer databases, with additional lists of designers, manufacturer representatives, and distributors from a variety of sources.

SCE provided the Evergreen team with 1,116 records and PG&E provided 610 records of active market actors with which the IOUs engage to promote their programs. We removed

[9] We did not attempt to identify dimmable ballast measures in the IOU tracking databases; dimmable ballasts were only addressed during the in-depth interviews and not the end-user CATI survey.

duplicate records from the contractor, designer, and distributor lists by eliminating records that contained the same business name and telephone number. For businesses identified as manufacturer representative agencies, we maintained duplicates (same business and telephone number in the case where multiple names were included), since the agents may serve different market actors. This resulted in 725 and 447 records, from SCE and PG&E, respectively. PG&E classified contacts as manufacturers, designers, and others in the lighting field, with an additional note field that included detail about the contact's role. SCE's list included two classifications: lighting contractor, and lighting designer. For unclassified contacts, we attempted to discern their role through reviewing their business name (e.g., if the word "contractor" was in the company name, that contact was considered a lighting contractor) or Internet searches of the company.

This process removed 195 contacts determined to be outside the study sample frame based on a determination that they were not a lighting manufacturer representative, contractor, distributor, or designer. This resulted in a sample frame of 977 total market actors, with 53 manufacturer representatives, 734 contractors, 40 distributors, and 150 designers. In order to have sufficiently large sample frames, the evaluation team supplemented the lists of manufacturer representatives and distributors. The New Building Institute provided the team with a list of 23 unique manufacturer representatives. The research team identified an additional 104 distributors based on the results of an Internet search for "lighting distributors California". Table 1, below, provides a breakdown of the final sample frame for the market actor interviews, by the source of the contact information.

Table 1: Sample Frame for Market Actor Interviews by Source

Contact Type	SCE	PG&E	Other	Total
Manufacturer Representatives	13	40	23	76
Contractors	519	215		734
Distributors	16	24	104	144
Designers	95	55		150
Total	**643**	**334**	**127**	**1,104**

Once the sample frame was finalized, a random sample was chosen for each market actor group. Recall that the source of the sample was primarily utility databases; therefore the random sample we used to make calls may not necessarily reflect the broader population of market actors.

1.3.3.2 Interview Guide Development and Research Implementation

The Evergreen team prepared the interview guides in consultation with PG&E and SCE staff in September and October 2012. IOU staff approved the draft interview guide in early October 2012. The research team conducted two pretest interviews with each market actor group to test the instrument guide and determine if any edits to the guide were necessary. The pretest interviews resulted in minor changes to the guide and helped ensure the remaining interviews would be as useful as possible. IOU staff approved the final guide in mid-October

2012. The research team made subsequent modifications to the guides for clarification purposes. The final versions of the guides are included in Appendix B.

Early in the research implementation phase, we determined that the original allocation of interviews by market actor required modification (see Table 3, below). We found the variation in contractors and manufacturer representatives to be greater than anticipated, and we increased the number of interviews in these two groups. We also found that most respondents reported that designers had no involvement in lighting retrofit projects, as defined by IOU program rules (one-for-one replacement). A pretest respondent who had been a designer also emphasized this point. We continued to attempt to complete interviews with designers in our sample, but were unable to complete any, as all of the designers we contacted reported that they had no involvement in retrofit projects.

The team conducted the in-depth interviews between October 15 and December 15, 2012. Interviews averaged 50 minutes for contractors, 55 minutes for distributors, and 40 minutes for manufacturer representatives. The team attempted interviews with potential respondents up to five times each. Researchers called the market actors at different times of day to increase the probability of contact. After the third unanswered telephone call the interviewer left a short message, a call back name and number, and indicated that the contact would be called again in two days for follow-up.

The Evergreen team sought to balance the number of interviews conducted across utility service territories to assess if there were major differences between southern and northern California. Completing surveys with PG&E contacts proved easier, as the PG&E lists included contact names in their database much more frequently than SCE. The final interviews were a 60/40 percent split across the two IOU service territories, with sufficient respondents from each service territory from each group. Table 2 displays the final disposition for each set of market actor interviews.

Table 2: Market Actor In-depth Interview Disposition Summary

	Contractors		Distributors		Manufacturer Reps	
Disposition	**#**	**%**	**#**	**%**	**#**	**%**
Sample Frame	734		144		76	
Sample	121		33		36	
Not Qualified	18		5		5	
Eligible Sample	**103**	**100%**	**28**	**100%**	**31**	**100%**
Partial Completes	4	4%	1	4%	0	0%
Refused	10	10%	5	18%	0	0%
Not Reached	54	52%	12	43%	12	39%
Completed	**35**	**34%**	**10**	**36%**	**19**	**61%**

As shown in the table above, the research team conducted a total of 35 contractor interviews, 10 distributor interviews, and 19 interviews with manufacturer representatives, for a total of

69 market actor interviews. Response rates ranged from 34 to 61 percent across the responding market actor groups, with an overall average of 40 percent. Table 3 provides the proposed and ultimate disposition of survey completes, by market actor type and overall.

Table 3: Target and Completed In-depth Interviews, by Market Actor Type and Utility

Contact Type	Target Completes	Completed Interviews		
		PG&E	SCE	Total
Manufacturer Representatives	20	12	7	19
Lighting Contractors	35	24	15	39
Distributors	10	6	5	11
Designers	5	0	0	0
Total	**70**	**42**	**27**	**69**

Of the market actor types, only contractors received a screening question at the outset of the interview. Contractors were screened for participation in retrofit projects in the office, retail or restaurant segments. If a contractor had not done a retrofit in at least one of these segments, they were excluded from participating in the interview.

1.3.3.3 Strengths and Limitations to the In-depth Interview Method

In-depth interviews are a qualitative research approach designed to get at the depth of an issue. The interviewer uses a structured guide designed to address issues in a logical manner. The interviewer is trained in both interview techniques (e.g. neutral probing) and on the specific guide and project research objectives. The project-specific knowledge is important so that the interviewer can probe when items of particular interest to the study arise.

The opportunity to probe is one of the advantages of this type of qualitative research, especially when exploring issues that are new or for which the respondent's perspective is unknown. In-depth interviews also allow for flexibility to focus on key areas that a specific respondent can address. This was an important component in this study, as the interview guide covered many topics and interviewers needed to prioritize in order to complete the interview within a time frame reasonable to the respondent. We did not receive answers to all applicable questions from every respondent, but were able to capture the range of responses on all critical issues.

In most cases, qualitative research is not designed to be representative of a population. In this study the results are not generalizable to the population for multiple reasons. First, the number of interviews relative to the populations in each market actor group is small. Second, the nature of most questions and responses do not lend themselves to quantitative analysis, where precision levels can be determined. Finally, the sample frames were, in large part, drawn from utility databases and therefore represent a self-selected group; they were not randomly sampled from the broader population of market actors.

Self-selection bias is a problem if it affects the responses on the items of interest. In this research the populations of lighting contractors in the utility databases were large. The range in types of contractors, the business sizes and the varied responses to our questions indicate that we covered a wide range of lighting contractors. The eleven distributors that we interviewed included a variety of distributor types. In this case some of the distributors did not fit the general description of lighting distributors, as they also manufactured lighting products. It is unclear how well the respondent distributors cover the spectrum of distributor types. Almost one-half of the manufacturer representative respondents worked directly for a manufacturer, and most of these manufacturers were small, with limited product lines. The other half worked for manufacturer representative agencies that sell product lines for multiple manufacturers, which represents the majority of manufacturer representatives.

The reader should keep in mind these differences (relative to the general population of market actors). The findings are solid, in that they represent the experience, attitudes and approaches of the market actor respondents. They likely reflect the range of experience, attitudes and approaches of most of the market actors in California. However, the emphasis or relative frequency of some of the findings may differ from the population.

1.3.4 Commercial Customer Advanced Lighting Retrofit Telephone Survey

The commercial customer advanced lighting retrofit telephone survey focused on advanced lighting retrofits in three specific commercial segments: retail, restaurants, and offices. This section describes the sample and survey methods.

1.3.4.1 Sample Design

Absent a dataset of the population of commercial customers who have conducted advanced retrofits, we relied on IOU program tracking data from Q1 2010 through Q1 2012, and screened for advanced lighting projects, based on the definition provided in section 1.3.2. Thus, the results of this research are not a market characterization and are not generalizable to the population, as all respondents received a rebate for an advanced lighting retrofit through an SCE or PG&E commercial rebate program. This effort was intended to explore early adopters of advanced lighting measures using the data that was available at the time.

We determined that 200 completed surveys of both SCE and PG&E commercial advanced lighting retrofits (for a total of 400 completed surveys) would be sufficient for the purposes of this research. In order to complete 200 surveys from customers in each IOU service territory we required a sufficiently large population of identifiable advanced lighting retrofits in the retail, restaurant, and office segments.

For SCE we identified a total of 760 advanced lighting retrofit projects in the program tracking database. Of those, 45 were projects involving LEDs and the other 715 involved advanced controls or control strategies. From those retrofit projects we identified 22 unique *contacts* that received LEDs and 593 unique *contacts* that received controls (many larger commercial establishments had a single contact for multiple retrofit projects). There were only seven restaurants in the SCE service territory whose retrofits included either LEDs or advanced

controls, so it is impossible to provide results specific to restaurants (other than to note the finding that very few have adopted advanced lighting technologies).

The number of advanced projects in the PG&E tracking database was similar. There were a total of 708 retrofit projects identified as either advanced or potentially advanced (the later required a series of screener questions to determine if they were in fact advanced). Exactly 44 projects in retail, restaurant, or offices included advanced LED retrofits, and 674 projects included controls. Similar to the SCE population, the number of unique *contacts* was far fewer, with only 31 and 562 (for LED retrofits and control retrofits, respectively).

1.3.4.2 Survey Guide Development and Research Implementation

The Evergreen team developed a commercial customer telephone survey with guidance and review from utility evaluation, measurement and verification (EM&V) staff, program implementation staff, and other stakeholders. The survey was designed to collect specific data related to retail, restaurant, and office advanced lighting retrofit customers, intended to inform a broader and more comprehensive effort that might be conducted in a subsequent research phase. The data were collected to inform the specific goals of the telephone survey, described below:

- Identify who was involved in specifying lighting products and to what degree they influenced the process;
- Better understand why customers installed high tech advanced lighting equipment;
- Collect firmographic information for businesses that installed advanced lighting technologies;
- Assess commercial customer satisfaction with advanced lighting products; and,
- Determine awareness of and ability to meet Lighting Strategy Action Plan goals.

CIC Research conducted the Computer Assisted Telephone Survey (CATI) effort in two phases. The first phase included SCE customers, while the second phase consisted of PG&E customers. The data from the first phase was used to inform an interim findings presentation, presented to the utilities in January 2013.

The number of total completed surveys is presented below in Table 4. We were unable to complete the target of 200 surveys for PG&E because the majority of projects requiring a series of screener questions failed to qualify for the survey.

Table 4: Commercial Customer Advanced Lighting Retrofit Surveys, by IOU

IOU	Completed Surveys
SCE	200
PG&E	63
Total	**263**

Due to the limited number of completes for PG&E, all findings from the commercial customer advanced lighting retrofits telephone survey are presented in total (with respect to IOU).

2 Critical Synthetic Analysis – Literature Review

This section summarizes key findings that support the results presented in the remainder of this report. All findings in this section are based on secondary sources.

2.1 Background

The Evergreen team conducted a literature review as part of the larger study to inform program staff and stakeholders of the wealth of available literature on lighting programs and markets. The review would also facilitate the identification of research gaps that might be addressed by the market characterization component of this study.

D&R International, the lead team member on this task, conducted a critical synthetic literature review and analysis to offer commentary and synthesis of the wide array of literature.

The objectives specified by SCE and PG&E were to:

- Identify the major factors influencing residential and non-residential lighting purchases including: market trends, distribution channels, product mix and availability, marketing and merchandizing strategies, and customer preferences, with a strong emphasis on the nonresidential market where much less is known;
- Review and consider the supporting quantitative data and its sources along with any full reports or papers that are required reading for the SCE and PG&E program team and staff;
- Identify areas where primary research is needed because there is no published literature available based on reliable empirical data;
- Quickly educate current and new staff on the state of the market, key lighting market factors and successful strategies to consider during program design and implementation; and,
- Organize key findings by major customer segments within residential and non-residential sectors to support program design and implementation efforts.

This effort focused on how the California IOUs can address and change customer decision making on a large scale and at a reasonable level of expense and effort to maximize savings in line with the goals of the Strategic Plan. In doing so, the following topics are addressed in independent, yet interrelated, sections of the full literature review report (Appendix A):

- First, **The Science of Choice** provides an understanding of and new way of thinking about program research and design.
- Next, **Advanced Lighting Technologies** are discussed in detail to provide context for the remainder of the report. This discussion begins with a comparison of advanced, efficient technologies to incumbent, inefficient technologies in three main application

categories: integral lamps (bulbs), linear lamps, and high bay/high output lighting. This section compares the key attributes of commonly used products and discussed benefits and possible pitfalls of focusing programs on those technologies. This section also explores advanced controls and integrated solutions.

- The **Non-residential Lighting** section of this report explores two possible approaches to addressing lighting in the non-residential sector: one in which lighting managers work with the "stream of influencers" for lighting decisions, and a segment-specific approach, in which lighting programs focus on particular segments of the non-residential sector. During the 2010-2012 program cycle, program managers did work with market actors, and did attempt to target specific segments of the commercial sector.
- The **Residential Lighting** section looks first at what California has accomplished with CFLs in the residential sector, then presents data on the uptake of specialty CFLs and LEDs in homes.
- The report concludes with a discussion of **Market Transformation** in California and comparator regions and a **Recap** of the major findings and recommendations in the report, with a focus on priority data gaps that must be filled and program design approaches that will enable SCE and PG&E to more readily pursue California's lighting energy reduction goals.

This review was more expansive than what might be expected from a literature review, encompassing the fields of social psychology, and more recently in the fields of behavioral economics, neuroeconomics, and neuropsychology.

2.2 Choice Architecture

The first central finding from the scientific research is that most choices are automatic, or in technical terminology, heuristic. Most choices have to be automatic because we don't have the time or mental resources to consciously make all decisions required of us. Most of our decisions are driven by situation factors. The collection of situational factors that drive a choice is called the "choice architecture."[10] According to this frame of reference, all choices occur within a choice architecture and all choice architectures, whether consciously constructed or naturally occurring, will generate a particular pattern of responses within a population.

This framework suggests that we all share certain hard-wired tendencies, so outcomes can be predicted for a population as a whole. Thus, with an understanding of human decision making and the situational factors that influence it, we believe it is possible to affect choice

[10] Thaler, R. and Sunstein, C. (2008). *Nudge: Improving decisions about health, wealth and happiness.* New Haven: Yale University Press.

architecture towards a desired outcome, while still leaving the option of making a different choice.

2.2.1 Situational Factors Affecting Choice

According to the choice architecture literature, situational factors presented to purchasers drive choice. These situational factors include:

- The default condition (status quo bias);
- What customers see other businesses doing (social norms/social proof);
- Urgency, often due to limited supply, limited time (scarcity effect);
- Whatever is readily at hand;
- Reminders, prompts, and other attention-getters;
- Relative cost/comparative value (contrast effect/anchoring and adjustment);
- The number of things we have to choose among (choice overload/option paralysis);
- Recommendations from experts; and,
- Familiarity, confidence, and emotional associations (availability heuristic).

These factors are listed roughly in order of their importance and strength. According to the literature, the more factors present, the stronger the effect.

2.2.2 Application of Choice Architecture

As discussed above and in greater detail in Appendix A, choice architectures drive most decisions. Lighting purchase decisions are shaped by existing choice architectures.

If you want to influence choices you need to:

- Understand the current choice architecture; and,
- Figure out which tools will best enable you to reshape it to favor the choices you want people to make.

2.3 The "Stream of Influencers" Approach

The theory behind an approach our team prescribes, the stream of influencers approach, is simple: *Why hunt through the forest when you can wait by the waterhole?* In this analogy, the forest represents individual commercial lighting end-users conducting retrofit projects, and the waterhole represents the end-user interactions with market actors.

This theory implies that to increase the uptake of efficient lighting solutions, efficiency program managers must somehow reach those organizations that are planning to undertake

new construction, major renovation, or small-scale lighting installation projects while they are in the process of designing, specifying, and procuring products.

For most organizations, such projects are infrequent and the period in which lighting decisions can be influenced is brief. Their interest and retention of information related to efficient lighting will be extremely low during the vast majority of the time, when they are not in the midst of planning the project. Thus, we posit that it is extremely difficult and resource intensive to reach these organizations through traditional marketing strategies. Revisiting the analogy, trying to reach the end-users in the commercial retrofit market is like hunting through a vast forest in search of scarce game.

Just as the hunter can improve their chances of catching dinner by staking out the water hole, energy efficiency program managers can best encourage adoption of energy-efficient lighting solutions by working with the market actors responsible for conducting lighting retrofits, such as electrical engineers, architects, distributors, installation contractors, and manufacturers.

According to the literature, these market actors strongly influence the choice of lighting product and are centralized, easily identified nodes through which multiple lighting decisions are funneled daily.

2.3.1 "Stream of influencers" in Lighting Retrofits

For replacements and small-scale renovation projects, the literature suggests that distributors are the key influencers, with contractors playing a supporting role. Nearly 90 percent of all lighting distributors offer lighting design services, and two-thirds of the time a distributor is directly involved in lighting design, product specification, and selection. Based on our analysis of available literature, we found that distributors ultimately influence all of the purchasing decisions of their electrical contractor customers by how they stock, price, place, and promote their products.

We found that distributors sometimes sell directly to building owners or managers who install the replacement products themselves, but frequently they sell to contractors who are hired to install products, particularly when a fixture or ballast is being replaced.

The literature suggested the role of contractors to be significant because they typically have latitude to substitute products or lighting solutions, and will often do so if a less expensive option is available or if the specified product cannot be procured easily.

A study in 2000[11] found that half the time contractors installed a product other than the one specified. We conclude that it is critical to encourage contractors to seek efficient products in all installations, but it is equally, if not more important, to encourage distributors to stock

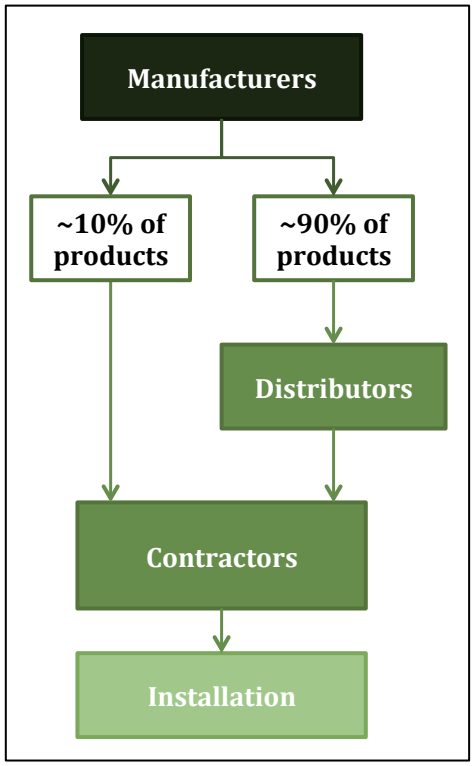
[11] Xenergy, Inc. "Commercial and Industrial Lighting Study, Volume 1." Prepared for the Northwest Energy Efficiency Alliance. December 2000.

higher quantities of efficient products at reduced cost, thereby indirectly encouraging contractors to use efficient products.

2.3.2 Flow of Product

Based on our synthesis of available literature, the stream of influence only tells part of the story. For example, one can encourage the purchase of efficient products only where efficient products are available. Products that are not readily availability or have excessively high first cost are unlikely to be considered.

Figure 1: The Flow of Commercial Lighting Products



As indicated in Figure 1, manufacturers and distributors play the largest role in determining which products are available in the market.[12,13] Manufacturers have the most direct influence on product availability and price because changes in manufacturer pricing are magnified through the supply chain.

Based on our review, General Electric, Philips, and Osram Sylvania dominate the screw base and linear fluorescent lamp categories. Prominent CFL manufacturers include these three, as well as TCP and Feit Electric. The large players, as well as many smaller manufacturers, manufacture solid-state lighting. Additionally, there are a few dominant chip makers (e.g., Cree Lighting, Lighting Sciences Group, and Nichia) who produce LEDs, some of which (e.g., Cree) are moving toward vertical integration.

Understanding the flow of products leads to a reemphasis of the role of distributors. Only 10 percent of products are purchased directly from the manufacturer; the remaining 90 percent pass through distributors.[14,15] There is no available information regarding differences in the makeup of products flowing through distributors versus directly from manufacturers to contractors.

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[12] Source: Xenergy, Inc. "Commercial and Industrial Lighting Study". Prepared for the Northwest Energy Efficiency Alliance. 2000.
[13] Source: KEMA, Inc., et al. "High Bay Lighting Market Effects Study: FINAL REPORT." Prepared for the California Public Utilities Commission. June 18, 2010.
[14] Source: Xenergy, Inc. "Commercial and Industrial Lighting Study". Prepared for the Northwest Energy Efficiency Alliance. 2000.
[15] Source: KEMA, Inc., et al. "High Bay Lighting Market Effects Study: FINAL REPORT." Prepared for the California Public Utilities Commission. June 18, 2010.

2.3.3 Choice Architectures of Commercial Lighting Market Actors

From the stream of influence and flow of products, our team observed that there are several classes of market actors whose choice architectures influence which lighting solutions are selected and installed.

We suggest that the greatest and fastest energy savings will be achieved if efficient lighting solutions become the default or at least the preferred option for each market actor. According to the analysis of literature findings, whether this is practical or cost-effectively achievable may depend on the strength of the factors shaping the current choice architecture and utility program managers' abilities to change these factors.

2.4 Bright Spots Analysis

During the literature review, our team observed that much of the lighting program evaluation and research studies focused on identifying barriers to the purchase and stocking of efficiency options. However, few studies focused on the areas in which such purchases were happening – the "bright spots". One outcome of the synthesis of the literature reviewed for this study was to recommend that the IOUs conduct a bright spots analysis to understand what shaped the choice architecture and led to the desired outcomes. A bright spots analysis uses these successes as beacons to enable identification of the complete suite of situational factors that lead to natural adoption, which can then be used as a framework or template for accelerating adoption within that segment or other segments.

2.5 Study Implications

This literature review was the first main study task. Based on our critical synthesis, we determined the following key conclusions:

- **Most lighting decisions are quick and automatic**, so structuring programs to influence customers most directly at the time that they are making decisions can have a huge effect on program results. This is true for the residential and non-residential sectors, though the tools used to influence each sector differ.
- **There are advanced technologies that can deliver superior energy performance and better light quality than many incumbent lighting technologies.**

Regarding potential strategies to impact the commercial lighting market, the critical synthesis of literature determined that the IOUs should implement the following three strategies:

1) Target specific products or applications (i.e., advanced lighting).
2) Identify and work with those who influence decisions about lighting installations (i.e., the "watering hole").
3) Target specific, high-potential segments of the sector (e.g., offices, retail, and restaurants).

The outcome of this task, beyond the above conclusions and a stand-alone report (Appendix A), was to influence the remainder of the study. First, we used the key observations from the literature review to focus our approach. Second, we identified gaps in the existing research and worked with the IOUs to identify priorities for this study. Third, we incorporated the key takeaways from this review in our findings, conclusions and recommendations.

- **Choice architecture and stream of influence:** we focused one of our two remaining study tasks on market actors, since we identified them as the source of influence for commercial lighting decisions.
- **Bright spots:** we focused our second remaining study task on commercial customer advanced lighting retrofits, since we learned that barriers have been studied and that an examination of successes may uncover additional insights that may be used as a framework to accelerate advanced lighting adoption.
- **Data gaps:** the critical synthetic analysis of commercial lighting literature identified the following key data gaps in our understanding of choice architectures within the commercial lighting market:
  - Profitability of efficient technologies vs. incumbent technologies;
  - Strength of drivers other than profit;
  - Market actors' current views of efficient lamps and controls;
  - What it will take to make the efficient lighting solution the preferred option for each market actor;
  - The extent to which market actors specialize in particular technologies, sectors, or end-uses; and,
  - Availability of advanced technologies among distributors.

3 Commercial Lighting Market Actor Interview Findings

This section reports on the findings from 69 in-depth interviews with three groups of market actors: manufacturer representatives, distributors and lighting contractors. These groups play a substantial role in supplying lighting products and retrofits to the end-user.

The overall objective of these in-depth interviews was to identify utility program opportunities to increase the adoption of advanced lighting in California's commercial lighting retrofit market.

To address this objective we asked respondents questions in order to:

- Understand the roles respondents play in relation to commercial retrofits;
- Identify who and what influences the choices and selection of commercial lighting in retrofit situations;
- Identify key barriers to the adoption of advanced lighting in the California commercial lighting retrofit market;
- Explore market actor strategies to promote advanced lighting; and
- Identify differences across three commercial segments (retail, office, and restaurants).

We found no differences in how market actors responded based on location across the two service territories, and thus are comfortable generalizing the results to the entire region.

3.1 Market Actor Respondent Characteristics

This section provides background characteristics for the market actors interviewed as part of this evaluation. These characteristics are not necessarily generalizable to the population of market actors in California.

3.1.1 Manufacturer Representative Respondent Characteristics

Lighting manufacturer representatives fall into two broad categories: factory manufacturer representatives who are employed by the manufacturer, and independent representatives who, in general, work for lighting manufacturer agencies (in this report we refer to these two groups as factory representatives and independent representatives).

The research team spoke with 19 manufacturer representatives, roughly half factory representatives and half independent representatives. Respondents reported working in the lighting industry from three to 34 years, averaging 16 years. Manufacturer representative firms averaged about 25 employees locally and ranged from two to 100 employees (in the state of California).

While the local full-time equivalent (FTE) numbers were relatively small, about half of the factory representatives worked for large manufacturers that had up to 122,000 FTE globally.

The other half of factory representative respondents worked for smaller manufacturers and engaged in sales activities not associated with factory representatives from larger firms. These included limited direct sales to end-users (that are not national accounts), and in two cases, direct sales of retrofit projects to the end user.

Independent sales representatives tended to be from smaller firms, with all firms reporting less than 50 FTE locally, some having a greater regional presence. Of the ten independent manufacturer representatives, half worked with fewer than 50 manufacturers and half worked with more than 50 manufacturers.

3.1.2 Distributor Respondent Characteristics

The research team completed 11 interviews with people representing firms that distribute lighting equipment. Respondent experience ranged from three to 34 years in the lighting industry. Most distributor respondents were either electrical or lighting suppliers. Two distributor respondents we characterized as hybrids, as they both manufactured and distributed lighting products. One company is new, and is developing and distributing LED products. The other manufactures and distributes ballasts and controls.

3.1.3 Contractor Respondent Characteristics

The research team completed 39 interviews with parties representing lighting contracting firms. Given the research goal to identify differences across offices, retail, and restaurants, we screened respondents to make sure they or their firms had completed a lighting retrofit project in at least one of these segments within the past two years.

We identified three types of lighting contractors among the respondents. The first is an electrical contractor for whom lighting is a subset of the company's projects. The second is a lighting contractor whose business is devoted to lighting. The third type is an energy specific contractor who does lighting retrofits in conjunction with other energy efficiency retrofits. We refer to all as contractors throughout the report because their experiences and perspectives did not differ much. In any case where there was a difference between contractors, we note the specific type of contractor. Contractor respondents included seven or more contractors of each lighting contractor type, with six firms not categorized. Those contacted worked for organizations that ranged in size from one to 217 employees. We did not ask respondents about their work in other commercial sectors.

The great majority of respondents held executive or management roles. Several others held sales positions. Respondent experience in the lighting industry averaged 16 years and ranged from two to 33 years. About half of the respondents were aware of CalCTP certification, six were CalCTP certified, and eight had certified personnel on staff.

3.2 Commercial Lighting Retrofit Market

In this subsection we discuss market actor roles within the context of the lighting retrofit market. In addition to the market actor interviews, our knowledge of the overall lighting

retrofit market was informed by the literature review conducted by D&R and conversations with program staff and market informants throughout the project. This section synthesizes the findings from these information sources and integrates the insights gained from market actor interviews.

3.2.1 Roles of Manufacturer Representatives

A lighting manufacturer representative is a sales representative that promotes or sells product lines to distributors, the design community, and in some cases large accounts. Manufacturers moved away from having large direct sales staff. As noted above, there are two types of manufacturer representative: factory representatives who are employed by the manufacturer, and independent representatives who work for lighting manufacturer agencies.

3.2.1.1 Factory Representatives

Factory representatives promote products from a single manufacturer. Factory representatives for large international companies with a full range of products are regionally based. Because of California's size there are multiple factory representatives per large manufacturer in the state. Factory representatives for the large lighting companies support the independent representatives, and promote products to the design community, distributors and large national customers. Although they assist with product promotion, and in some cases sales, the majority of products go through a distributor to the end-user in a lighting retrofit project.

The factory representatives work to increase sales of their manufacturer's product. These representatives typically have large sales territories that may include multiple states. There are two basic ways the representatives interact with the market in relation to retrofit projects. First, they educate independent representatives about new products. Second, the factory representatives will support the independent representatives by providing trainings and product information to distributors and the design community, and sometimes by providing technical assistance on more complicated projects.

3.2.1.2 Independent Representatives

Independent manufacturer representative agencies are hired by the manufacturer to cover a specific territory. An agency typically represents one large manufacturer and a variety of specialty manufacturers. The agency promotes products to distributors, the design community, and very large end-users (e.g. municipalities or national accounts). They sell products to distributors. They also provide customer service for the major manufacturer, providing pricing and product information to the design, distributor and end-user community. They will provide specification or other services, when needed, particularly when a design professional is not involved in the project.

Independent representative agencies tend to have smaller territories than factory representatives of large companies. These agencies vary in how they assign sales responsibilities. Many independent representatives serve either the design community (architects, engineers and lighting designers) or distributors, but some independent

representatives handle both. Some independent representatives focus on municipalities or other large end-users, such as national chain accounts. Often other agency staff are responsible for addressing customer non-sales related service needs.

Independent representatives maintain relationships with key market actors within their territory. These representatives spend time educating, updating, and providing information to their customers. Independent representatives will also arrange trainings from factory representatives on product offerings. They keep abreast of designers' product needs and pass these on to factory representatives. Independent representatives negotiate with the distributors regarding which and how much of the products the distributor will carry. They compete for shelf space with representatives for other agencies who may have similar product offerings.

3.2.2 Roles of Lighting Distributors

Distributors of commercial lighting may sell a broad range of commercial equipment (e.g. Grainger), a range of electrical equipment, or sell lighting products exclusively. A typical lighting distributor buys product from manufacturer representatives and sells to installation contractors. Some distributors also sell directly to large accounts, such as municipalities and national companies. Some lighting distributors provide value-add services to contractors, such as technical assistance on complicated projects, and sales training (although this is less common).

Since the distributors sell products to contractors, they do not want to compete with them. In addition to selling them product, most distributors provide additional support for the contractors, who generally are regular customers. Most of the distributors we interviewed reported having the capacity to specify lighting, and several described activities that approached lighting design. Almost all distributors reported making sales calls to end-users or working with contractors to do sales calls. For example, one electrical supply distributor said their firm trains contractors to sell efficiency so that the contractors will buy efficient products from them. Another lighting supplier sells retrofit projects by cold calling potential customers, and then subcontracts the installation out to contractors.

Several distributor respondents emphasized their neutrality when it comes to product selection. They described adding value in their role as a distributor of multiple product lines, whereas manufacturer representatives are interested in promoting only their product lines. One distributor explained the situation as such:

> *"The manufacturers tend to wrap their product around any solution. Our role as a distributor puts us in the role of identifying the right product to the customer. That's where distribution is key – it gives us flexibility."*

Distributors reported they want products that will sell quickly, as they buy the products up-front from the manufacturers and cannot return items. Often they are paying interest on the products, so "time is money." Sales representatives negotiate with them on price, quantity and

mix of products in order to get new products on the shelves. Sales representatives want to maximize the amount of product from their manufacturer, as well as to introduce new products to the market. If a new product is not selling, they will work with the distributor to help them increase sales.

3.2.3 Roles of Contractors

The term lighting contractor refers to a range of contractor types who install lighting systems in buildings. Lighting contractors can be full-service electrical contracting firms, those that specialize in lighting, or those that act as energy efficiency specific contractors. To install lighting the firm must have licensed electricians. Lighting contractors range from small one-person shops to large firms with multiple locations. We found that some focus on either new construction, residential, or commercial projects, while others tend not to focus on a particular sector or project category. In interviews, contractors indicated that on larger projects they tended to work as a subcontractor to a general contractor, while on smaller projects they worked directly for an end-user. However, we did not obtain information indicating that the size or complexity of a given project affects the type of lighting contractor selected.

We found that lighting contractors did not typically specialize in a particular sector, but work across all sectors. The great majority of respondents had completed retrofit work in the office sector in the past two years, and overall contractors reported doing the most projects in that sector. This was followed by retail and then restaurants in terms the number of sector specific projects over the past two years. These findings likely reflect the relative magnitude of lighting retrofit work across these three sectors.

For most lighting retrofit projects the end-user hires the contractor directly. In general, the contractors purchase their lighting products from distributors. In these cases it is the lighting contractor who provides information to the end-user regarding lighting options and costs. Unless the end-user is knowledgeable or talks to multiple contractors, a single lighting contractor may be the only source of lighting information they receive. Thus, the options provided by the contractor may be all that they consider (and possibly, think apply to their situation).

Most contractors obtain lighting retrofit projects through referrals and marketing. A smaller number reported door-to-door sales efforts and targeted advertising. One reported getting their retrofit work from a company that sells rebate eligible lighting retrofit projects and distributes the work among a group of lighting contractors. For large scale retrofits, involving a general contractor, the general contractor will select the lighting contractor.[16]

[16] Some of these major retrofit projects may not qualify for rebates through utility lighting *retrofit* programs.

3.2.4 Lighting Design, Specification, and Calculations

In new construction projects an architect, engineer or lighting designer will develop a lighting design for a building. Presumably, this design has a significant influence on what is installed, although specifications can be altered as project timelines and budgets are adjusted. We planned to complete in-depth interviews with a sample of designers to understand how the design process works in retrofit projects. What we found, through multiple attempts to interview designers about their experience, is that design professionals are rarely involved in lighting retrofit projects. Our interviews with the other market actors, as well as with end-use commercial customers (discussed below in Section 4) confirmed this.

We asked the contractors, distributors and manufacturer representatives questions to understand how lighting design, specification and calculations occur in retrofit projects. Given the lack of a design professional for most retrofit projects, it was especially important to determine who performed these functions, if in fact they were implemented. For clarification, we define the terms below, based on how they are used for new construction and major retrofit projects:

- **Design** involves identifying the location and type of lighting that best fit the application. Members of the design community (i.e. architect, design engineer or lighting designer) are usually involved only in new construction or full-scale remodels.
- **Lighting specifications** describe the conditions and product expectations, and include a fixture schedule that details the products with manufacturer and product number tied to drawings, and a visual reference to the specified product.[17] In new construction this is completed by a member of the design team and is generally part of the design. In retrofit situations a lighting specification that meets all these criteria is rare.
- **Calculations** are done to determine adequate light levels, to demonstrate energy savings, and to comply with applicable codes (including California's Title 24).[18] These are done both as part of lighting designs and as part of lighting specifications.

Reported by market actors, end-users are unwilling to pay for a design professional in most retrofit situations. When done, it is often for large and complex retrofit projects, when there are special lighting needs (for example in up-scale restaurants or art galleries), or when the project is not a one-for-one change out. For retrofit projects requiring lighting designs, distributors or manufacturers often fill this role instead of a member of the design community.

The study findings regarding who provides lighting specifications for retrofit projects are less clear. Respondents in each of the interviewed market actor groups said they specify lighting for a retrofit in some situations. But in the ensuing discussion what they described is more

[17] Architectural Lighting, The Lighting Specification Process, Jean Sundin, Sept. 29, 2008
[18] Effective January, 2014 Title 24 codes will apply to any retrofit that involves 10 percent or more of the fixtures.

akin to selecting a replacement product, without all of the considerations and detail identified in the above definition of product specification.

Market actors report that lighting calculations are done for the majority (but not all) of lighting retrofits. They are done to meet code, ensure adequate lighting and to show energy savings. While most market actors have the capacity to do lighting calculations within their firm, contractors or distributors are most likely to do lighting calculations for retrofit projects.

The remainder of the subsection provides more detail about the nuances of lighting design, specification, and calculations.

3.2.4.1 Lighting Design

We asked all three market actor types questions to determine if and when lighting designs are prepared for lighting retrofit projects. As mentioned above, design is reportedly rare in retrofit projects. This is in part due to the expense, and in part due to a perception that it is not necessary. The more expensive and complex a project, the more likely a designer is involved.

Distributors varied in how they approached lighting design. One distributor reported that initially many retrofit customers want a lighting designer, but quickly realize that design is too expensive. Instead a distributor or contractor will fulfill the product selection role. Other market actors made statements that support this, saying that retrofit projects rarely include a design professional due to the added expense. According to one distributor:

> *"Usually it's just me. It is using specifications to design because I know the lumen output and the throw-pattern of light fixtures. If customers want aesthetics, then we get into other lighting like LED and inductive fluorescent…"*

Another distributor reported working with designers to select products:

> *"A good retail or restaurant customer will have a lighting designer involved, who may work with us, in tandem, to come up with the best solution because the lighting designer/architect will typically pick premium products. […] If cost and quality are balanced out then we've done our job. I can't call myself a lighting designer though. Some of my competition will, even though they are not."*

Four distributors said they provide design services or have lighting specialists available to provide design for projects that are not one-for-one replacements. In some cases these contacts reported interacting with the market somewhat differently than a classic distributor.

3.2.4.2 Lighting Specification

We also asked market actors to consider the prevalence and frequency of lighting specification in the retrofit process. Reportedly, most retrofit projects do not include a full lighting specification, and instead a contractor or distributor selects the products based on basic lighting calculations used to inform lighting selection. Additionally, other market actors

report that they forgo specification as they primarily work with products with which they are familiar.

Regarding specifying lighting products, one contractor reported:

> *"I've been doing this for 15 years so I know what works, unless they are asking for something really specific. With retrofitting there are only so many things you can do with an existing fixture. There are parameters you need to work within and there are only a couple of things you can go with and as a rule they are going to use the cheapest thing they can."*

Several contractors mentioned working with manufacturer representatives to specify products for larger or more complicated projects. They describe their experiences working with manufacturer representatives on these retrofits:

> *"I usually evaluate existing fixtures (wattage and voltage) and conduct preliminary lighting readings. If necessary I'll do photometric readings. I can provide full photometrics to the customer based on a proposed design that I work with manufactures to write product for."*

> *"I can give them [an LED manufacturer] a site map with dimensions and they have engineers that can put together the full photometrics and identify the right products."*

Most distributors reported having the capacity to specify products and reported doing it in some retrofit situations. Distributors pointed out that they are brand neutral in that they sell product from multiple manufacturers. This puts them in a position of looking at the best solution for the customer. Other distributers noted that in retrofit projects the objective is *equivalency* (to the existing lighting).

Most manufacturer representatives reported that their firm has no role or a minimal role in specification for *retrofit* projects. They had varying perspectives on how projects are specified in retrofit situation, as exemplified below:

> *"A distributor will come to us for a bid, I'm not a specifier. A contractor will specify most of the time."*

> *"Distributors do not specify. We will help with some specifications. We will look at what is suitable to retrofit. We do not determine array or load calculations. End-user or contractor will do that."*

> *"We do not specify. A contractor will come to us and we will update them on technology that we have. The contractor or ESCO will specify, and an engineer might get involved in complex projects."*

Manufacturer representatives for large companies reported assisting with project specifications in *limited* cases. One factory representative for a small, specialized manufacturer who sells directly to end-users also reported specifying products.

3.2.4.3 Lighting Calculations

Basic lighting calculations are common in retrofit projects and inform lighting selection. Project complexity and expense affect when and who does the lighting calculations. Most of the respondents have the internal capacity to do lighting calculations and all market actor type reported situations where they might do them.

The more common, simple and least expensive retrofit projects are the most likely to be installed without calculations or have basic calculations completed by a contractor. For example, one contractor reported that lighting calculations are not necessary for simple one-for-one replacements, especially in offices. Another contractor said that about 75 percent of their projects are "straight remove and replace," which require only basic light distribution calculations to ensure that replacement lighting matches previous levels. Large customers (with facilities staff) sometimes do their own lighting load calculations.

In addition to assuring compliance with Title 24 requirements and adequate light levels, some contractors described calculations as valuable for demonstrating energy savings potential. Contractor comments include:

> *"The calculations have to be done because we are looking for energy savings. I use a light meter to show them foot-candles and will recommend calculations based on the type of building and the working space. I look at the specifications and go by the energy calculations primarily."*

> *"We do calculations… it's bulb to bulb, but I do it as a matter of course to calculate savings and show them what annual savings will be."*

One distributor saw the situation differently, reporting that distributors have more involvement, saying:

> *"Whoever guarantees the lumens is responsible for doing the calculations. It depends… it either falls on the contractor (not very often), but usually it's us, the distributor in retrofit applications. About 20 percent of the time it falls on the manufacturer. There are many distributors that will involve a manufacturer at an early stage and then just provide the lamps. In these cases, a manufacturer rep would do a foot-candle reading. It's more common that the distributor is responsible for the foot-candle reading, but most of the time it isn't even taken."*

One manufacturer representative who primarily works with municipalities reported performing lighting level calculations for their customers. Other manufacturer representatives reported having in-house electrical engineers who do lighting load calculations on projects for which the manufacturer representatives specify equipment.

3.2.5 Market Relationships that Affect Commercial Lighting Retrofits

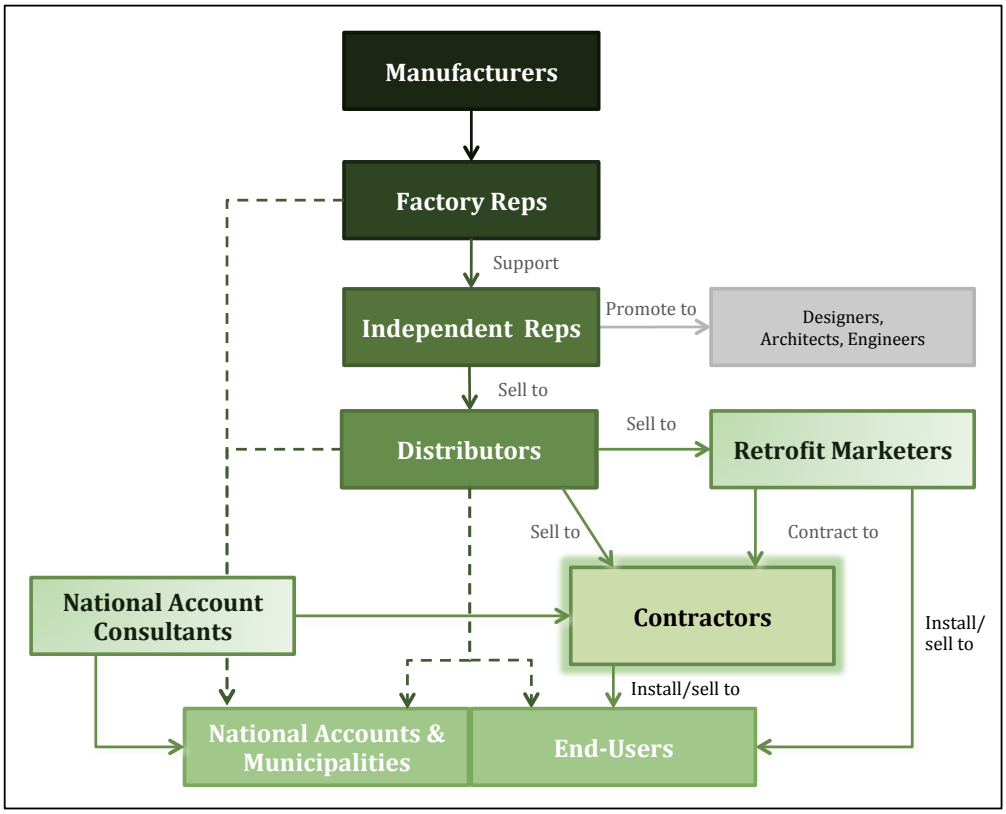
This section discusses the relationships among the market actors in terms of product flow and influence on what is offered or installed. Our findings are based on in-depth interviews with a sample of market actors, and thus may not be generalizable to the population of market actors in California.

Figure 2 presents a graphical representation of the relationships and influences for most retrofit projects. Since some market actors play non-traditional roles (such as a lighting product manufacturer who sells retrofit projects to end-users), almost any relationship is possible. This figure and discussion strive to represent the majority of the commercial retrofit market.

Figure 2 includes two market actors not interviewed and not yet introduced in this report.

- **National Account Consultants**. These are firms hired by national chains (e.g. 7-Eleven) to handle lighting retrofits. They are responsible for determining, with the client, the lighting retrofit strategy for the client's stores. Since they are responsible for substantial lighting loads, they often have direct relationships with manufacturer representatives. We did not interview these actors and are thus unsure whether they are factory, individual, or a combination of the two types of representatives. We are also uncertain if the products they specify flow through local distributors or are shipped directly by the manufacturer.
- **Retrofit Marketers.** These firms provide a range of energy efficiency services that usually include retrofit project design and installation. In many cases ESCOs provide upfront project financing with the end-user paying for the retrofit from the money saved on reduced energy costs.

Figure 2: Lighting Retrofit Market Actor Relationships



The sections below describe the influence of each market actor type on the advanced lighting products included in lighting retrofit projects. To better describe how market actors influence retrofit product choice, we include discussion regarding their relative knowledge of available products as well as the factors that motivate each actor.

3.2.5.1 Manufacturer Representatives' Influence and Motivations

Manufacturer representatives are the most knowledgeable about advanced lighting options, and the most motivated to promote them in the market. Manufacturer representatives focus their efforts promoting products to the design community (which is rarely involved with retrofit projects) and to distributors. They report that they expect the design community to convince end-users of the value of advanced lighting and their product. The product is then sold through the distributors.

Manufacturer representatives are motivated to increase sales in the product classes or categories supported by the manufacturer or manufacturers they represent. Negotiations are the manufacturer representatives' tool to encourage distributors to carry specific lighting packages – which sometimes include advanced lighting. As noted above (see section 3.2.2), the distributors pay interest on stocked products and are unable to return unsold goods. In order for the distributor to stock products seen as riskier to their bottom line, a manufacturer may offer lower prices or better financing terms in exchange for carrying newer products. They

also offer incentives for sales of specific products within a limited time period. If the distributor is having trouble moving a product, the manufacturer representative may provide assistance (usually in the form of guidance or training).

Some manufacturer representatives work directly with large end-users, such as municipalities or large national chains. In these cases they promote the advanced lighting directly to the end-user, and likely work with them to find suitable applications for the products.

Two factory representatives for smaller manufacturers who worked directly with end-users described cold calling and opportunity marketing as internal leads develop. Both of these contacts describe working with relatively large end-user organizations, including corporations and municipalities.

3.2.5.2 Designers' Influence and Motivations

Designers are rarely involved in retrofit projects, and thus exhibit very limited direct influence on the lighting retrofit market. The retrofit projects they are involved with tend to be larger, more complex, or have specific aesthetic requirements. Reportedly, designers are too expensive for the majority of retrofit situations.

3.2.5.3 Distributors' Influence and Motivations

The majority of lighting products flow through a distributor before reaching the end-user. Despite this, currently the distributors do not appear to exhibit significant influence on the products installed in retrofit situations. As a trusted source for information, however, they are in a position to influence the contractor over time.

Distributers varied in their knowledge and attitudes toward advanced lighting, as did their motivation to promote advanced lighting products. Many stock based on what their customers – lighting contractors – are purchasing. They tend to view themselves as suppliers, not promoters, and are motivated to move what is on their shelves. Their engagement with end-users is limited. A small number of distributors reported selling jobs directly to the end-user (some for installation by contractors they supply).

3.2.5.4 Contractors' Influence and Motivations

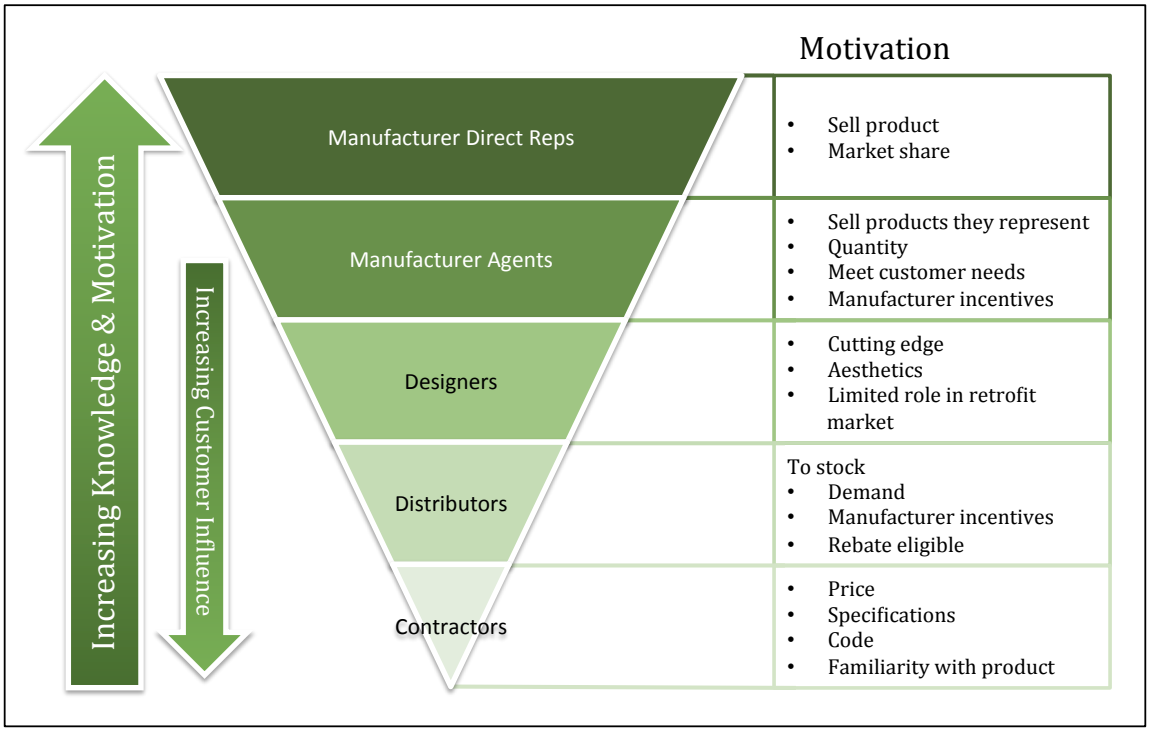
Based on our interviews with market actors in general and contractors specifically, we found that contractors have the highest level of engagement with end users on retrofit projects, and in most cases are the ones who sell the projects. This puts them in the best position to influence the efficiency of the products selected. There was a wide range in knowledge and promotion of advanced lighting among the contractors interviewed. Contractors reported being knowledgeable about energy efficiency but were not necessarily comfortable promoting the most advanced products on the market due to lack of knowledge about the products or skepticism about the product's quality or durability.

Contractors want to ensure that the products they install are reliable and meet customer needs. Contractors also expressed concern about cost. Even those that promote advanced

lighting expressed concerns about product quality for some newer products (and may communicate that to customers), and are sensitive to customer price concerns. They do not want to bid themselves out of a project.

Figure 3 is based on findings from the in-depth interviews with all market actors, and summarizes the market actor influence on the lighting retrofit decision maker relative to their knowledge of, and motivation to sell, advanced lighting technologies. It illustrates that the most knowledgeable and motivated market actors are the ones furthest from the end-user.

Figure 3: Market Actor Influence, Knowledge, and Motivations



3.3 Adoption and Promotion of Advanced Lighting

One objective of the research was to identify who and what influences the choices and selection of commercial lighting in retrofit situations. Our description of the market demonstrates that lighting contractors very often are the only market actor to interact with the end-user in a retrofit project. They sell the project, and what they promote (or bid), substantially influences what is ultimately selected. In this section we discuss contractor recommendations for advanced lighting products in three market segments, as well as end-user response to these recommendations. End-users who adopt advanced lighting recommendations from contractors and other market actors are considered "bright spots."

The findings in this section are derived from interviews with a sample of California lighting market actors, and thus are not necessarily transferable to the population. Program designers should exercise caution citing this information.

3.3.1 Contractor Advanced Lighting Recommendations

Contractors are important in the promotion of advanced lighting in the retrofit market, as the contractor may be the only lighting professional who interacts with the end-user. We asked contractors if they recommended three categories of advanced lighting products to each of the three market segments of interest. The advanced lighting categories included LEDs, dimming ballasts, and controls. How often contractors recommended these equipment types varied by sector, except in the case of controls. Contractors report recommending different types of advanced lighting based on their perception of the segment needs. There is some indication, however, that what they offer is affected by what they think the customer will buy (see LED discussion in section 3.3.1.1 below).

We also asked the contractors what types of customers are interested in going above code. Contractors identified a couple of (uncommon) situations where customers explicitly try to exceed code, including a building seeking LEED certification or organizations wanting to be corporate leaders. Some also noted it is more likely to happen when the building is owner-occupied. Despite this, there are multiple situations where customers exceed code in order to meet other objectives, such as lighting quality. These objectives differ somewhat by sector, as discussed below.

3.3.1.1 Contractor Advanced Lighting Recommendations – Offices

Contractors are more likely to recommend controls in offices than dimming ballasts or LEDs. The controls that respondents discussed were simple ones, such as occupancy sensors in bathrooms and photocells in offices. Some contractors did report putting dimming ballasts in conferences rooms, where lights are often lowered to allow for presentations, but most contractors did not promote dimming ballasts in the office sector.

Although contractors did not recommend LEDs in office situations, many said that customers ask for them. One contractor said:

> *"It depends on what the clients can afford. Customers increasingly want LEDs – they just want to be green or they look at long-term cost. About 30 to 40 percent now want LEDs as opposed to 5 to 10 percent last year. We lay it all on the table. Increasingly, customers understand the value of retrofits for the longer term."*

Multiple contractors indicated that greater adoption of LEDs in offices will happen as soon as the prices come down. They report that customers ask for LED products, but the initial cost or longer payback period dissuades them. Multiple other contractors indicated that their customers are interested in the lowest cost options and would not go above code.

3.3.1.2 Contractor Advanced Lighting Recommendations – Retail

Most contractors reported recommending LEDs in retail situations, and about one-half recommend controls. Few responding contractors recommended dimming ballasts in retail spaces. Contractors see LED lighting as well suited for retail space because of the ability to highlight products with directional or spot lighting. Customers do not necessarily ask for it, but most contractors identify LEDs as a good fit for retailer's needs and often recommend them. Not all customers take the recommendation; they typically go for a less expensive option.

Retail spaces are frequently unwilling to go above code. Often retailers are interested in the best product, which they define as quality, warranty, brightness and appearance. Installing lighting beyond code requirements is more common in larger retail stores, where one contractor estimates it occurs 30-40 percent of the time.

3.3.1.3 Contractor Advanced Lighting Recommendations – Restaurants

Contractors recommend all three categories of advanced lighting in restaurant projects. Contractors see LED products as well suited to restaurants, where aesthetics are important. Restaurants often want dimmable lighting and have many point source lighting needs, features amenable to LED solutions. Also, newer LEDs mimic the look of incandescent lighting, which appeals to the restaurant sector.

Contractors also reported recommending dimmable ballasts in restaurants. In some cases the dimmable ballasts are replacing existing, less efficient dimming ballasts. The dimmable ballasts help create the desired ambiance. Contractors report high uptake on this recommendation. One contractor said that almost 100 percent of their restaurant customers install dimming ballast on their recommendation because *"it's not like we're replacing static ballast with a dimming ballast. It's mostly dimming for more efficient dimming."* Another said that restaurants generally take their recommendation to install dimming ballasts, while other sectors generally do not take this recommendation.

3.3.2 Other Factors Supporting Advanced Lighting Adoption

Market actors identified several additional factors that support advanced lighting adoption, including codes and standards and utility rebate programs, as well as market actor education.

3.3.2.1 Codes and Standards

Many respondents (of all types) identified codes and standards as a strategy to encourage the adoption of advanced lighting technologies – including more integrated, comprehensive solutions. Several believed that Title 24 will convince people to install LEDs:

> *"Title 24 promotes our cause. Title 24 will give us and our competitors more business."*

> *"There are a lot of requirements in California to meet code. To meet code, the only way is with LED. In the last year I have not had any conversations with a customer replacing HID, where LED doesn't come up as part of the solution."*

Similar comments emerged in discussing controls. Contacts noted that they are mandated in new construction and that controls can fit well into retrofit projects. According to one manufacturer representative, controls are not hard to sell because they are part of law now.

There is uncertainty among market actors regarding the impact of Title 24 lighting codes applying to a larger percentage of retrofit projects. Some respondents indicated that until costs come down, more products become eligible, and the economy improves, some commercial customers might defer retrofits. Market actors believe other end-users may plan and stage retrofits so that they are not required to meet Title 24 lighting codes.

3.3.2.2 Using Utility Programs

Both manufacturer representatives and contractors mentioned utility programs as a method to promote advanced lighting. The programs impact advanced lighting adoption in two primary ways:

- Reduce the first cost of the products; and,
- Provide credibility to the products.

Five of the six manufacturer representatives identifying utilities as a promotional strategy believed that the programs increase uptake.

3.3.2.3 Midstream Strategies

Manufacturer representatives look to midstream market strategies to promote advanced lighting. They promote to and educate the design and distributor community in anticipation that this will filter through the market. Several of the suggestions centered on items respondents themselves could do to encourage the installation of advanced lighting products. These include manufacturer representatives engaging more fully with distributors by offering incentives or rebates to stock products, providing payments or spiffs (a bonus for a sale), and extending payment terms so that they don't have to pay for a given products for nine months rather than 30 days.

> *"We offer incentives to distributors... but it's a big amount of money for distributors to lay out up front for LED or controls. Distributors like the product, but are resistant to stock too much because of price."*

3.3.3 Primary Barriers to Adoption of Advanced Lighting

Discussion of barriers to the adoption of energy efficient lighting, in general, and advanced lighting specifically, emerged at different points in the interviews. In the section below we describe these barriers and discuss how the different types of market actors understood and described them. These findings are based on in-depth interviews with a sample of California lighting market actors, and are not necessarily generalizable to the population of market actors in California (or elsewhere).

3.3.3.1 High Initial Cost

High initial cost was the most frequently mentioned barrier to installing advanced lighting products among all three market actor groups. Several respondents noted that this problem was exacerbated by current economic conditions that have created reluctance among commercial end-users to make any non-essential expenditures. Even when end-users are willing to make lighting efficiency upgrades, the costs of advanced lighting relative to other (rebated) lighting equipment are very high, and paybacks are longer.

Installation contractors also to mentioned customer unwillingness to spend money on any lighting retrofit project, even those with paybacks as little as six months. Some pointed to current economic conditions, while others said that there are customers who will never choose efficient options. Accessing these hard-to-convince and severely budget-constrained customers is a perennial challenge, exemplified by this comment:

> *"I've quoted a payback of three months and they wouldn't do it because of first cost."*

Manufacturer representatives also pointed to price as a barrier. They often framed high first cost as requiring distributors and contractors to convince customers that the product is worth these costs. They believe that rebates and lower prices, which accelerate payback, will reduce this barrier. Two representatives' comments included:

> *"There is no barrier other than price. [LED] products speak for themselves in terms of energy savings and lower maintenance costs."*

> *"Unless price goes down to fluorescent prices, LEDs will not see full adoption. Right now LEDs are a four to five year return on investment with current rebates. When [return on investment] gets to two years LEDs will be an easy sell."*

3.3.3.2 Knowledge and Product Awareness Gaps

Our interviews with the market actors revealed variation in knowledge about advanced lighting products. Manufacturer representatives were very knowledgeable, and report that designers are interested in the products. Interviews with distributors and contractors revealed variation within both groups in knowledge of and interest in promoting advanced lighting.

Members of the design community, according to several manufacturer representatives, are likely to seek out information about new products. Designers are in general, interested in new technologies, and often are looking for lighting to fit specific applications. Manufacturer representatives promote products to the design community, anticipating that they will specify them in projects. Unfortunately, members of the design community are rarely involved in lighting retrofit projects.

Distributors and contractors do not have the same level of interest in convincing their customers to try something new. Contractors and distributors will follow specifications, but they are less likely to adopt new products quickly compared to the design community. The

design community wants to be *cutting edge,* whereas contractors and distributors want to sell product they are familiar with.

Manufacturers said that it is harder to promote new products to distributors and contractors.

> *"It is harder sell, train, and explain new products [to contractors and distributors compared to designers]. It is harder to tell [contractors and designers] to sell a $245 fixture over a $105 fixture even when the payback is about two years on the $245 fixture."*

A few distributors were fully aware of the products available and their applications, and were motivated to get the products on the market. At least one distributor was taking contractors out on sales calls to end-users to educate them on how to sell the products.

Most distributors, however, did not report promoting any particular product and will stock what is demanded.

Contractors revealed varying knowledge and interest in advanced lighting. They often pointed to high initial price as a barrier, which may have made them hesitant to promote advanced lighting to customers. Many were unaware of the variety of advanced lighting products available and of their applications. This may have contributed to their selectivity in what they offered to the market segments. The critical synthetic analysis of literature supports this, in that it found evidence that contractors rely on familiar technologies to reduce callbacks, and that choice is often driven by availability and price (see Section 2 and Appendix A).

3.3.3.3 Risk and Product Uncertainty

Both distributors and contractors appear to be risk averse, and several attributes of advanced lighting technologies make them risky. High initial costs were mentioned in conjunction with these factors, exacerbating the perceived risk:

- **Unproven product claims.** According to several respondents, customers are more likely to accept higher first costs if they trust the claims made about the product. One contractor reported that they try to assure their customers about manufacturer claims regarding product lifespan, but customers are reluctant to purchase the product once they know the price.
- **New, unknown manufacturers**. There are numerous new LED manufacturers. One contractor stated that manufacturers with long histories in the lighting marketplace (e.g., Sylvania, Phillips) have an advantage in selling products. Contractors (and customers) are more willing to trust a product from a brand they recognize and already trust, compared to a manufacturer unknown by them.
- **Varying quality.** Contractors discussed challenges in identifying "*garbage LEDs"* and wanted to see poor quality products taken off the market faster. Several contacts brought up the Design Lights Consortium (DLC), but noted that DLC efforts were not sufficient to identify reputable products. Respondents noted that regulations might not

be strong enough, particularly around power factor versus color temperature and lumens per Watt.

- **Rapidly changing product market.** Distributors share the uncertainty around product performance and see a risk associated with carrying inventory that may not sell. They fear that products will be replaced with something better and cheaper (particularly in the rapidly evolving markets for LED products and wireless control systems). This makes them reluctant to order lighting product stock that could become a liability.
- **Compatibility with existing controls.** A manufacturer representative and other experts we talked to identified potential compatibility issues between new products and existing controls.

3.3.3.4 Stricter Lighting Codes

California's 2013 codes (Title 24 for lighting and Title 20 for lighting controls) become effective January 21, 2014. These codes are stringent and will apply to a greater percentage of lighting retrofit projects than earlier codes. Among other changes, the code mandates daylighting sensors to adjust lighting near windows, reduces lighting power density requirements, and reduces the percentage of light fixtures that can be altered (from 50 to 10 percent) before code compliance is required. The code also adds buildings less than 10,000 square feet to those required to have lighting power demand response capability.

These lighting code requirements will increase the costs of all lighting retrofits that meet or exceed replacement of 10 percent of the fixtures. The lower power density lighting itself is generally more expensive. The inclusion of dimming ballasts combined with controls further increases the cost of retrofits. The requirement of lighting power demand capacity in smaller buildings further increases costs for these smaller businesses.

Wireless controls could improve the economics of lighting control retrofits. Respondents described wireless controls as an opportunity for retrofit projects because they avoid the costs associated with hard wiring. According to one distributor, controls in retrofit projects have been cost prohibitive but wireless control systems are bringing the price down.

The impact of more stringent (and thus costly) code requirements, as well as their application to a greater percentage of retrofit projects, is uncertain. At least one respondent thought that the additional code requirements could result in fewer lighting retrofit projects overall.

3.3.3.5 Market and Policy Features

A few manufacturer representatives spoke broadly about the effect of policy and market structure on adoption of energy efficient lighting solutions. These topics included:

- **The ebb and flow of government or utility support for energy efficiency.** The loss of government or utility support for energy efficiency programs creates uncertainty in

the market. Furthermore, loss of government or utility support can have direct impacts on efficiency.

- **Regional differences in the adoption of advanced lighting.** Several respondents noted that the San Francisco Bay area may be quicker to adopt advanced lighting products, relative to other parts of the state.

3.3.3.6 Product Availability

In general, product availability did not emerge as issues for contractors, distributors, or manufacturer representatives.

While two contractors mentioned product availability, only one of them found it problematic. The first contractor buys LED products in bulk, usually for projects that they have already sold, and the product is typically shipped within three weeks. The second contractor reported that distributors were keeping fewer products on the shelf to avoid economic risk. According to this contractor, because most LEDs come from Asia, manufacturers seek to avoid unnecessary shipping costs by only selling large quantities. This can mean waiting for product until a distributor has enough orders to buy a large batch of LEDs.

Manufacturer representatives did not report any issues associated with product availability. As one representative noted:

> *"Distributors will put a margin on anything and sell anything. End-users drive the process."*

3.3.3.7 Distributor Stocking

Generally, distributors did not report product availability as a barrier to installing advanced products in the marketplace. All but one distributor reported stocking advanced lighting products, but the quantity and variety of products is uncertain. Most reported that if they did not have something in stock, that they could get it quickly. Of the ten distributors that responded to questions about products they stock, nine stocked at least one type of LED product, nine stocked dimming ballasts, eight stocked advanced lighting controls, and six stocked step-dimming ballasts. The one respondent that stated they did not stock LEDs represented a company that manufactured and distributed ballasts and controls exclusively (LEDs were not part of their company's purview). While most distributors claimed to stock LEDs, the specific LED products stocked varied.

For example, when asked if respondents stock high bay LEDs, LED replacements for HID, or LED retrofit kits, only four respondents stated they carry all those products. Distributors identified three primary reasons for not stocking specific LED products: cost, availability, and performance uncertainty.

Cost was the primary reason for not stocking product, and statements included claims that the product is either too expensive or the rebates are not sufficient. For example, one distributor stated they do not stock high bay LED because they had *"Not seen a product worth ordering.*

The [return on investment] is too expensive. I have yet to see an LED high bay that would pay for itself in less than 3 years." Another distributor stated they do not stock LED retrofits because there are no rebates for the kits and the price is too high.

The second reason given for not stocking specific LED products reflects a lack of awareness of product availability. One distributor did not stock high bay LEDs or LED retrofit kits because *"there aren't any LED high bays"* and there is *"no such things as an LED kit."*

Distributors also expressed concerns about product quality and performance. One distributor said they do not stock high bay LEDs because they *"don't think the efficacy of the LED is there yet for high bay, although they say it is, but I don't think they have enough lumens/watt in industrial applications to justify going to LED."*

Distributors reported stocking products based on several criteria, including customer demand, reputability of the manufacturer, and the availability of rebates. As mentioned previously, distributors are careful about stocking because the lighting market can change quickly and they cannot return unsold lighting equipment. Therefore, they want to be sure they can move a product before adding it to their inventory.

Distributors also did not believe that their current stock would affect an advanced lighting project. If a customer or contractor requests a product not in stock, distributors will order it. When asked to estimate how long it might take to receive shipment on ordered products, contacts reported a range of just one week to over four weeks. Wait times vary for different products. One distributor reported that if they did not stock dimming ballasts, it could take several months to get resupplied. This distributor regularly stocks dimming ballasts so availability is still not an issue for their customers.

3.4 Utility Rebate Program Experiences

The research team asked all respondents about their experience with utility rebate programs and if or how they tracked utility rebates. Contractors and distributors reported relying primarily on utility websites for information. They also reported turning to the DLC website to identify eligible LED products. Manufacturer representatives paid less attention to utility program details than distributors and contractors, and more attention to getting their products listed as rebate eligible. Additional details about each respondent type are below.

These findings are derived from in-depth interviews with a sample of lighting market actors in California, and are therefore not necessarily transferable to the population of lighting market actors.

3.4.1 Manufacturer Representative Awareness and Tracking

About half of the manufacturer representatives reported tracking utility programs. Those that did not do it themselves often mention that someone else in their organization is responsible for tracking them. One respondent from a major lighting manufacturer reported tracking

lighting rebates nationally was their primary responsibility. Sales people in their company contact them for assistance in identifying incentives for specific projects.

Independent representatives are more knowledgeable about the California rebate programs. One representative agent that serves northern California noted that tracking utility retrofit rebate programs is *"a significant part of [their] business. We need to know what is PG&E rebateable (sic) and Energy Star rebateable (sic)."* This respondent said they know where to get rebate information, and whom to contact at utilities if they have questions.

3.4.2 Distributor Awareness and Tracking

Nearly all of the distributors interviewed reported tracking rebate programs at some level. Like contractors, distributors use utility websites and email updates to track changes to the qualified product list. Because they are likely to be asked about specific products, several distributors described specific strategies for tracking. One distributor asked a third party program implementer to determine if one manufacturer's product specifications matched those of another manufacturer's qualified product. Another maintains a spreadsheet of products in case they are asked about rebates. Several reported that they increased their tracking activity after having problems related to confusion over rebate eligibility.

3.4.3 Contractor Awareness and Tracking

All contractors reported tracking rebate programs and attempting to stay abreast of qualified products.[19] Contractors described a variety of strategies for staying informed, reflecting different levels of engagement with sponsoring utilities. Most commonly, contractors reported using utility websites for tracking measure eligibility and turning to the DLC to identify rebate eligible LED products.

Several contractors noted that in addition to referencing utility websites, they also consult with distributors or authorized vendors. For example, one contractor identifies products from IOU guidelines and then asks distributors to find brand names that fit the rebate program. Another contractor described using the IOU list of pre-authorized distributors to contact distributors who can identify rebate eligible products for certain projects.

Several contractors distinguished between standard and custom projects, noting the complexity of applying for calculated rebates.

3.4.4 Importance of Rebate Programs

Market actors believe the rebate programs are important for two key reasons related to advanced lighting adoption. First, they believe that utility rebate programs drive retrofit projects through reducing first cost and increasing product awareness. Second, utility support

[19] The contractor contacts all came from utility databases, so this was expected, and may not reflect the general population of contractors in California.

enhances the credibility of products and the performance and energy savings claims made by market actors. Below we discuss these themes in more detail.

3.4.4.1 Utility Programs Drive Projects

Most of the respondents said that utility program incentives lower the cost of projects and this encourages customers to take action, leading to increases in project or product sales volume. Many viewed the programs as a *"win-win"* for all parties involved.

> *"Anytime we can get a customer money, that is good. I try to get as much money as possible for customers [from utility programs]."*

> *"Utility programs induce the customer to do the job."*

In addition to encouraging action in general, several noted that incentives specifically help market actors promote the newest efficiency technology in the marketplace by helping to overcome barriers associated with price and familiarity. Incentives help market actors to sell more advanced products and more expensive projects than they could do in the absence of utility programs.

Several distributors indicated that programs affect what they stock and sell. As one distributor noted, programs create demand for products, which affects stocking. This positive feedback can create changes in the product mix offered to end-users.

3.4.4.2 Credibility by Association with Utility

Respondents also noted the credibility and legitimacy that utility programs convey to customers. For manufacturer representatives the credibility is for their products, while for contractors it is for their work. Several manufacturer representatives said their customers like to know that the products they are offering are endorsed by the utility. Utility approval makes customers more comfortable installing a new product.

> *"Anytime a utility is willing to stand behind a product, it adds credibility to … the product."*

Another manufacturer representative elaborated on how new technology development funds offered by utilities make it possible for an end-user to install a new product at little or no cost in order to see how the product performs and understand the customer experience. This new technology incentive *"helps prove a product in a case-study like format."* These case studies can be useful in demonstrating the pros (and cons) of a new product.

Another contractor appreciated the IOU's documentation of energy savings. Providing customers with this type of documentation *"makes selling jobs easier"* by legitimizing the project to the customer.

3.4.4.3 Other Benefits

Respondents identified other benefits of the utility programs, including:

- The opportunity to access high quality training;
- Ongoing communication efforts on the part of utilities, particularly in cases where they seek input from manufacturers about programs; and,
- The consistency of utility programs. Having at least a two-year program cycle for rebates helps distributors know what to expect.

3.4.5 Market Actor Recommendations for Utility Program Improvement

This section provides recommendations made by contractors regarding ways in which they believe utility programs could be improved.

3.4.5.1 Simplifying Participation

The most common source of complaint about utility programs centered on participation processes viewed as too complicated, burdensome, or slow. Eighteen contacts (11 contractors, four manufacturer representatives, and one distributor) described onerous paperwork or mentioned delays that occur in the process of applying for and receiving incentives. Other respondents, however, noted that it is relatively easy to participate in utility programs, describing the process as straightforward. The availability of applications and eligible measures lists on-line is also considered helpful.

Common suggestions for simplification included overarching requests to make the on-line processes simpler, program staff contact information clearer, and application processing faster – particularly for projects that require calculated incentives. Two contractors specifically mentioned experiencing excessive paperwork and cumbersome processes with projects seeking on-bill financing.

3.4.5.2 Changing Incentive Policies

Many market actors suggested that incentives be set higher, particularly for LED products, and many wanted a broader list of qualified lighting products. To further this point, some reported that the substantial price difference between fluorescent tube and LED products for the same application make the rebate for LEDs insignificant. One respondent noted that the LED product most applicable to the retrofit market – retrofit kits that allow customers to change to LEDs without replacing fixtures (which is a costly and disruptive option) are not well understood. One manufacturer representative recommended that utilities provide more incentives to distributors and less to do it yourself (DIY) stores such as Lowe's and Home Depot (the reasoning being that lowering the price for distributors could lower product prices for contractors, and thus consumers).

Some market actors suggested eliminating incentives for products that compete with advanced lighting solutions to further encourage adoption of advanced lighting technologies.

Comments about expanding the list of eligible measures other than LEDs were limited. These respondents suggested rebates for building energy management systems and for induction lighting.

3.4.5.3 Product Quality Concerns

Respondents expressed concern that inexpensive and low quality (cheap) efficient lighting products are entering the marketplace and undermining high-quality efficient lighting products. According to one contractor, contractors need training to help them identify and install quality products. Another contractor stated that utilities should conduct more verification of lighting installations to make sure contractors are doing an adequate job for their customers. A third contractor expressed concern with contractors that specify low-quality inexpensive products and services to win a bid. Lastly, three manufacturer representatives reported frustration with low-quality inexpensive products, with two representatives noting that the cheaper products do not last as long as higher quality products.

3.4.5.4 Product Eligibility and Design Lights Consortium (DLC)

Several contractors were familiar with the DLC list and certification process. These contractors tended to acknowledge that the utilities were being cautious about LED incentives, perhaps because of experiences with poor quality CFLs in the 1990s. At the same time, several described frustration with having multiple certified product lists and a process that occasionally moved slower than the market.

3.4.5.5 Adjusting to a Dynamic and Confusing Market

Two respondents specifically mentioned the effects program cycles have on the lighting market. However, where one suggested the programs should be permitted to adapt within a program cycle, the other was averse to substantial changes between program cycles because of costs associated with adjusting to program changes.[20]

Several market actors described market confusion that can result from competing third party programs. One offered an example in which third parties offered higher rebates and then ran out of money – creating hard feelings among customers promised more lucrative incentives and among the contractors that offered them. Another believed that the enhanced incentives third party implementers provided created an unfair strategic advantage.

3.5 Expectations: The Next Five Years in Commercial Lighting

The team asked respondents to identify what products will be most prevalent in five years. Almost all respondents said that LEDs would be the dominant lighting product in the market in five years. Overall, market actors believe that LED prices will go down, product quality will improve, and products for more applications will be available.

[20] This study did not assess the effects of program cycles on the lighting market and market actors. More research is needed to understand any effects of the cyclical nature of the California IOU rebate programs.

3.5.1 Expectations of Manufacturer Representatives

Manufacturer representatives reported that LEDs would dominate the lighting market over the next five years. Manufacturer representatives identified the following key factors and trends they believe will lead to more LEDs in the marketplace:

- LEDs will help address increasingly stringent codes;
- LEDs will have more applications as new buildings and major remodels start to design lighting with LEDs in mind;
- Manufacturers will offer additional types of replacement LED bulbs that allow end-users to replace lighting without making infrastructure changes, such as replacing poles and fixtures;
- LED manufacturers entering the marketplace will push the market to make quality products; and,
- LEDs are easily controlled by wireless technology. Improvements in wireless controls will accelerate the adoption of controlled LEDs since controls will not require changes to wiring.

3.5.2 Expectations of Distributors

Distributors also said LEDs would be the prevailing lighting technology over the next five years. Three distributors were very specific, saying that LEDs could replace the two-lamp four-foot (2x4') fluorescent fixtures commonly used in offices. One of these distributors wants manufacturers to make an LED panel that could replace the fluorescent tubes. Another distributor was aware of LED products to replace 2x4' fluorescent fixtures but found them to be expensive and lacking sufficient lumen output. This distributor expects that manufacturers will refine their product over the next five years and LEDs will *"take over the market."*

One distributor went further, stating their belief that *"LEDs will replace everything. In five years there's no reason that any fixture shouldn't be LED."*

3.5.3 Expectations of Contractors

Similar to manufacturer representatives and distributors, most contractors believe that LED adoption will accelerate in the next five years. They believe that LEDs will take substantial market share from fluorescent tube and other lighting, although one market actor noted that fluorescent would likely always appeal to customers focused solely on high first-cost concerns.

Twenty-five percent of interviewed contractors tied increased adoption of LEDs to increased adoption of lighting controls. They note that LEDs work well with controls and expect controls will become more common due to Title 24 requirements. One contractor mentioned that if LED control designs are standardized, LED controls could be used in conjunction with smart meters and smart grids to increase the number of facilities enabled for demand response.

Another contractor believed that LED adoption will increase due to the ease with which they can be controlled.

4 Commercial Customer Advanced Lighting Retrofit Telephone Survey Results

The Evergreen team conducted surveys with participating SCE and PG&E nonresidential retail, restaurant and office customers who received an "advanced" lighting retrofit between Q1 2010 and Q1 2012.

The research aims to assist in addressing the complexities in the commercial lighting market by concentrating on a subset of high priority customer segments, with a focus on advanced lighting adopters to understand the motivations underlying such purchase decisions. Much research has been done to determine market barriers, and this initial phase of customer research is intended to explore the bright spots (see Section 2.4) – not only *who*, but also *why* and *how* early adopters made their decision to go "above and beyond" a more typical retrofit. This effort is intended to inform a broader and more comprehensive effort that might be conducted in a subsequent research phase.

The objectives of the retail, restaurant, and office advanced lighting retrofit customer telephone survey are to:

- Collect firmographic information for firms that installed advanced lighting technologies;
- Identify who was involved in specifying lighting products and to what degree they influenced the process;
- Better understand why the customer installed the high tech advanced lighting equipment;
- Assess commercial customer satisfaction with advanced lighting products; and,
- Determine awareness of and ability to meet Lighting Strategy Action Plan goals.

For a complete set of banner tables from the Commercial Customer Advanced Lighting Retrofit Telephone Survey, please refer to Appendix C.

4.1 Profile of Participating Customers and Projects

This research focused on three key nonresidential market segments identified by the utilities: retail stores, restaurants[21], and offices. This section provides a flat characterization of the firmographics for businesses interviewed as part of this research. All of the contacted businesses conducted lighting retrofits through an IOU rebate program between Q1 2010 and Q1 2012.

[21] Very few restaurants conducted advanced lighting retrofits during the course of the study period (2010 - Q1 2012), and therefore there are no findings specific to the restaurant segment.

Nearly half of respondents own the facility in which they conduct business (49 percent), and nearly half lease (48 percent), with the remaining three percent managing the facility under an agreement with the building owner (the specific structure of the agreements remain unknown). Among the 48 percent of businesses that lease their facility, nearly two-thirds have three years or less remaining on their lease (63 percent), and 81 percent have five years or less remaining on their lease.

Across all three segments, nearly all businesses that installed advanced lighting retrofit projects pay their own electricity bill (92 percent). There was no statistical difference between those businesses that owned versus those who leased their facility.

The businesses surveyed as part of this evaluation provided estimates of square footage for their facilities. Table 5 provides a breakdown of the facility square footage, by segment, among respondent firms.

Table 5: Respondent Facility Square Footage, by Segment

Square Footage	Offices (non-medical) (n=147)	Restaurants (n=4)	Retail Stores (n=112)	Overall (n=263)
Less than 1,500	3%	25%	4%	4%
1,500 - 5K	18%	25%	28%	22%
5K - 10K	25%	50%	23%	25%
10K - 25K	20%	0%	26%	22%
25K - 50K	12%	0%	12%	11%
50K - 75K	6%	0%	1%	4%
75K - 100K	2%	0%	2%	2%
Over 100K	8%	0%	4%	6%
Don't know / Refused	6%	0%	2%	4%

4.2 Retrofit Process

This section explores the retrofit process from the business' standpoint, including the roles of the business and market actors in making decisions related to the retrofit, the impact an advanced lighting retrofit has on a business, and end-user satisfaction with the retrofit process.

4.2.1 Roles in the Retrofit Process

The evaluation team asked respondents questions regarding the involvement and relative impact of market actors on their retrofit process. They were also asked what role, if any, their business held in determining what types of lighting to install.

Since the evaluation only surveyed respondents who *had* installed advanced lighting technologies, it is impossible to draw conclusions regarding whether the roles or relative impact of market actors is different for non-advanced lighting retrofit projects. However, in this section we note where these findings corroborate findings from the market actor in-depth interviews, discussed above in Section 3.

4.2.1.1 Role of the Market Actors

Lighting contractors and utility representatives[22] were the most frequently cited market actors involved in recommending and specifying lighting equipment mentioned by end-users. As shown in the "Mentioned" column in Table 6, below, both groups were mentioned by nearly one-third of respondents.

However, this only tells part of the story, as lighting-specific contractors are not always involved in the installation of lighting retrofits (see section 3.2.3). More than half of all respondents (51 percent) mentioned that contractors of some type were responsible for recommending the lighting equipment to the business. This finding is consistent with the High Bay Lighting Study (KEMA)[23], which found that 53 percent of businesses who received a recommendation regarding high bay lighting did so from contractors.

It is also important to understand whose input was the most influential among the various market actor groups on the businesses' selection and acceptance of advanced lighting technologies. As shown in the "Most Important" column in Table 6, below, 56 percent of respondents report that contractors (of one type or another) had the greatest influence among market actors. Twenty-nine percent reported that utility representatives had the greatest influence.

The results presented above and shown in Table 6 suggest that contractors play the largest role in specifying advanced lighting technologies. It is important to note that these findings are from the viewpoint of the end-user, and that the business may not be privy to the market actors upstream of the contractor who they directly engage with. These findings corroborate the findings in Sections 3.2.3 and 3.3.1 of the market actor interview section: contractors are most often the market actor responsible for encouraging end-users to install specific lighting equipment. The finding is further supported by similar findings from market actor interviews conducted as part of KEMA's High Bay Lighting Study, which found that the majority of lighting distributor sales revenue came from sales to contractors (44 percent overall), and that "the contractor is the most common sales channel to the end user and influencer in the specification process."[24]

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[22] It is unclear if the utility representatives are from the utility or function as an ESCO.

[23] Source: KEMA, Inc., et al. "High Bay Lighting Market Effects Study: FINAL REPORT." Prepared for the California Public Utilities Commission. June 18, 2010

[24] Source: KEMA, Inc., et al. "High Bay Lighting Market Effects Study: FINAL REPORT." Prepared for the California Public Utilities Commission. June 18, 2010

Table 6: Market Actors Who Recommended Advanced Lighting Equipment

Type	Mentioned	Most Important
Lighting Contractor	35%	35%
Utility Representative	35%	29%
Electrical Contractor	17%	17%
In-house Facilities Manager	6%	4%
General/Unknown Contractor	4%	4%
Lighting Distributor	3%	2%
Engineer	2%	2%
Designer/Architect	1%	1%
Manufacturer Representative	>1%	>1%

4.2.1.2 Importance of Market Actor Input

Respondents were asked to provide an assessment of the importance of market actor input in their lighting equipment choice. On a ten-point scale, with "1" being "not at all important" and "10" being "extremely important", respondents reported a mean rating of 8.6 out of 10, with 90 percent of respondents reporting an importance rating of seven or greater.

This finding demonstrates the critical role market actors play in determining the specific lighting technologies that retail, restaurant, and office customer install, among those customers willing to adopt advanced lighting technologies. This finding is different than the findings in the above section because it highlights the importance of the input, not the relative importance of the sources of input.

The majority of respondents reported that their advanced lighting retrofit resulted from outreach from market actors (overall 76 percent). Evidently, a sales approach is driving advanced lighting retrofits, as opposed to customers seeking out more advanced products. This suggests that market actor promotion of advanced lighting is an important factor in increasing the number of advanced lighting retrofits. This is not to disregard the critical importance of end user awareness and acceptance of advanced products, but suggests that even willing end users are more often sold on the retrofit than seek it out.

Contrary to supply-side findings from the in-depth interviews and the literature review, respondents from every retail store, restaurant, and office reported that the equipment recommended or specified by market actors was ultimately installed, regardless of equipment and market actor type. This suggests two possibilities that are mutually exclusive on a project by project basis, but not at the market level:

- Despite differences between what was specified and what gets installed, the businesses we contacted *perceive* no difference; and/or,

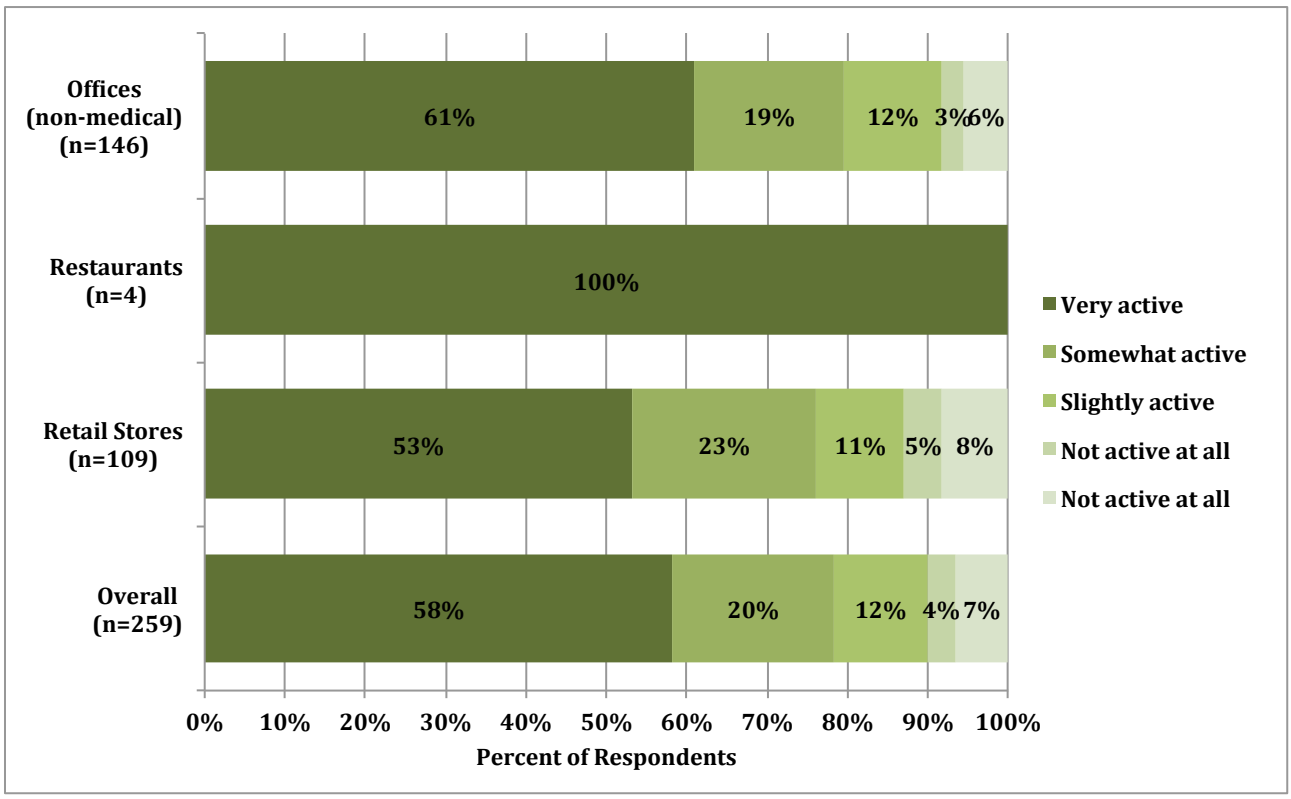
- The businesses we contacted received the lighting technologies specified by market actors at an abnormally high rate compared to the general population.

From the perspective of the Lighting Strategy Action Plan, only what gets installed is of any importance; neither perceptions nor specifications produce energy savings. The research team is unable to fully understand this issue within the scope of this project, but believes that more research is possible.

4.2.1.3 Role of the Business

As shown in Figure 4, below, approximately 78 percent of respondents report that their business plays either a "very active" or "somewhat active" role in lighting purchase decisions at their facility (there is no statistically significant difference between retail stores and offices).

Figure 4: Level of Activity in Lighting Purchase Decisions, by Segment



"Very active": involved in all phases and have veto power.
"Somewhat active": approve decisions and provide some input and review.
"Slightly active": have a voice, but it's not the dominant voice.
"Not very active": part of a larger organization.
"Not active at all": business doesn't get involved in these issues.

4.2.2 Retrofit Impact on Business and Satisfaction with Retrofit Process

Simply put, the specification and installation for advanced lighting retrofits typically have minimal impact on commercial businesses.

Shown below in Table 7, the specification process for advanced lighting projects typically takes less than two weeks (reported by 80 percent of respondents), with the majority requiring one week or less to specify (59 percent of respondents). Respondents were very pleased with the amount of time the specification process took for their advanced lighting retrofit. Even firms whose specification process took longer than two weeks typically reported high levels of satisfaction with the duration of the process, although there is a trend of declining satisfaction with increased specification time (as would be generally expected).

Table 7: Business' Satisfaction with Duration of Specification Process

Duration of Specification Process	Percent of Respondents	Mean Satisfaction (1-10 scale)
Less than 1 week	59%	9.3
1 - 2 weeks	21%	9.2
2 - 3 weeks	7%	8.9
3 - 4 weeks	3%	8.7
1 - 2 months	7%	8.5
2 months or more	4%	8.6
Overall (n= 230)		9.2

Table 8 shows the number of retrofits by duration of retrofit installation process, as well as the associated mean satisfaction among responding businesses. The vast majority of advanced lighting retrofit installations required less than one week to complete (78 percent of respondents), and 15 percent took between one and two weeks. Only seven percent of respondents reported that their retrofit took longer. Satisfaction was very high among businesses whose installation took less than one week (9.5 out of 10). Satisfaction drops for retrofits taking longer than three weeks, with the mean level of satisfaction (6.5 out of 10) statistically significantly lower than projects taking less than one week or two to three weeks.[25]

[25] Mean satisfaction for projects taking greater than three weeks is not statistically different from those projects taking one to two weeks. However, when all projects of less than three weeks are compared to all projects of three weeks or more, the mean satisfaction is statistically significant at the 90% level of confidence.

Table 8: Business' Satisfaction with Duration of Retrofit Process

Duration of Retrofit Process	Percent of Respondents	Mean Satisfaction (1-10 scale)
Less than 1 week	78%	9.5*
1 - 2 weeks	15%	8.6
2 - 3 weeks	4%	9.6*
3 weeks or more	3%	6.5
Overall (n=246)		9.2

*Significantly different from "3 weeks or more" at 90% level of confidence

4.3 Advanced Lighting Technologies

The vast majority of projects meeting the advanced retrofit description provided in Section 1.3.2 – the "bright spots" – were retrofits consisting of occupancy sensors controlling T5 lighting (including high bay T5s) or induction lamps. Very few retrofit projects in the retail, restaurant, and office segments from the IOU program tracking databases included LEDs. We present findings for LED purchase decision motivations and satisfaction with LED characteristics, but the number of completed surveys across utilities and segments totaled exactly eight respondents, so this information is not transferable to the population and there is no statistical significance across response categories.

As with LEDs, there were insufficient retrofits in the population of retail, restaurant, and office retrofit projects in the IOU database to cover all advanced control types. Namely, no interviews were conducted with respondents who had daylighting controls, photocells controlling either T5 or induction lamps, or an EMS installed as part of a retrofit project. Interviews were completed with customers who had installed occupancy sensors on T5 fluorescent fixtures or induction lighting.

4.3.1 LED Retrofit Findings[26]

Respondents report that saving energy and saving money were the primary motivations for installing LEDs in their business. Four firms reported that saving energy was the single main reason they installed LEDs, and three firms reported lower energy bill or saving money. One firm reported that the main reason for installing LEDs was that their previous equipment had failed.

Satisfaction with the installed LEDs is very high. Respondents were asked to provide their level of satisfaction with the light quality, light output, and physical appearance of the installed LEDs on ten-point scales, with "10" being "extremely satisfied" and "1" being "not at

[26] For LED retrofit findings we will present results in terms of number of projects, as we were only able to complete interviews with a total of eight firms who installed advanced LEDs.

all satisfied". The results are presented below in Table 9, and show that all interviewees were very satisfied with the characteristics of the installed LED products.

Table 9: Business' Satisfaction with LED Characteristics

LED Characteristic	Mean Satisfaction (1-10) scale
Light Quality (n=8)	9.8
Light Output (n=8)	9.6
Physical Appearance (n=7*)	9.4

* One respondent was unable to quantify their level of satisfaction with the physical appearance of LEDs

4.3.2 Advanced Control Retrofit Findings

Respondents whose retrofits included advanced controls were asked to provide their primary reason for including advanced control strategies in their lighting retrofit. As shown below in Table 10, a majority of respondents who installed occupancy sensor controls (who also installed T5 fluorescent lamps or induction lighting) and a plurality of respondents who installed high bay fixtures with integrated occupancy sensors cite "saving energy" as the primary reason for installing the equipment. Saving money was also important, cited by 14 percent of those who received non-integrated controls, and 19 percent by those who received integrated controls.

Despite the significant importance of contractor input when compared to other market actors (discussed above), contractors were cited as the primary reason for installing advanced controls by only 14 percent and 13 percent of firms who installed non-integrated controls and integrated controls, respectively. While contractors are the market actors responsible for driving the messaging to end-users, commercial advanced lighting "bright spots" still focus on the favorability of the retrofit in terms of energy savings and economics, in the eye of the end-user.

Table 10: Primary Reason for Installing Advanced Controls, by Control Type & Segment

Primary Reason for Installing Controls	Occupancy Sensor Controls				High Bay Fixtures with Integrated Occupancy Sensor Controls			
	Offices (non-medical)	Restaurants	Retail Stores	Overall	Offices (non-medical)	Restaurants	Retail Stores	Overall
Saving energy	62%	50%	60%*	61%*	46%	-	35%*	41%*
Lower energy bill / saving money	13%	0%	10%	12%	21%	-	14%	19%
Recommended by contractor	15%	0%	11%	14%	12%	-	16%	13%
Improved functionality	6%	50%	10%	8%	10%	-	18%	13%
Recommended by IOU rep	2%	0%	6%	4%	3%	-	4%	3%
The rebate / equipment savings	1%	0%	3%	2%	3%	-	10%	6%
Other	1%	0%	0%	1%	6%	-	2%	4%
n=	99	2	70	171	70	0	49	119

"*Improved functionality*" includes improved lighting, safety/security, convenience, and automation
* Significantly different response rate between control type groups at 95% level of confidence.

Overall satisfaction with both the non-integrated and high bay integrated occupancy sensor measures was high (8.4 and 8.9 out of 10, respectively). There was no statistical difference in ratings among business types or between businesses who of the same type who received different measures (or who received both, and provided ratings for each type).

4.4 Lighting Strategy Action Plan

As noted earlier, the Evergreen team did not conduct surveys with a representative sample of the population of commercial lighting or advanced commercial lighting retrofit projects. However, we believe the findings related to the end-user awareness of and ability to meet the goals of the Lighting Strategy Action Plan provide a likely ceiling for awareness among the general population. We believe consumers who are amenable to advanced lighting retrofits are likely more aware of the related policies in the state of California than those consumers who are either unaware, or unaccepting of the technologies.

Among responding firms, slightly more than one quarter reported that they were aware of the Lighting Strategy Action Plan (28 percent). Nearly 40 percent of respondents believed that their firm could further reduce lighting related energy usage in their facilities (likely because a majority of businesses had installed control strategies and not LEDs). There were no statistical differences among commercial segments interviewed.

Firms noted that they could further reduce their energy usage by retrofitting areas not yet upgraded, purchasing newer lighting technologies (i.e., LEDs for companies who were surveyed for their control-related projects), upgrading their exterior lighting systems, reducing the hours of use of their lighting, and incorporating non-lighting energy efficiency upgrades at their facility.

5 Conclusions and Recommendations

This section presents our study conclusions and recommendations based on the literature review, market actor interviews, and surveys with businesses that received IOU rebates for advanced lighting retrofits.

5.1 Critical Synthetic Analysis – Literature Review: Implications

The study included an expansive synthesis of the available literature that encompassed the fields of market research and social psychology, and more recent literature in the fields of behavioral economics, neuroeconomics, and neuropsychology.

The critical synthesis of literature influenced the design of the other research tasks, but also produced key takeaways, which we summarize here:

- **Choice architecture and stream of influence:** The first central finding from the scientific research is that most choices are automatic because we don't have the time or mental resources to consciously make all decisions required of us. Most of our decisions are driven by situation factors. The collection of situational factors that drive a choice is called the "choice architecture".[27] According to this frame of reference, all choices occur within a choice architecture and all choice architectures, whether consciously constructed or naturally occurring, will generate a particular pattern of responses within a population.

  Thus, with an understanding of human decision-making and the situational factors that influence it, we believe it is possible to affect choice architecture towards a desired outcome, while still leaving the option of making a different choice.

- **Bright spots:** We found that few studies in our review focused on "bright spots" – successes that may facilitate identification of the complete suite of situational factors that lead to natural adoption, which can then be used as a framework for accelerating adoption. Barriers have been studied but examination of successes may uncover additional insights that may be used as a framework to accelerate advanced lighting adoption.

5.2 Advanced Lighting Market Conditions

Our primary and secondary research provided an overview of some of the key market conditions that influence sales of advanced lighting products.

[27] Thaler, R. and Sunstein, C. (2008). *Nudge: Improving decisions about health, wealth and happiness.* New Haven: Yale University Press.

5.2.1 Market Actor Roles

We identified the roles of the key market actors in the lighting retrofit market from the market actor interviews, which are presented below:

- **Manufacturer representatives** are sales representatives for lighting manufacturers. They promote and sell product packages to lighting distributors and the design community.
- **Lighting distributors** purchase packages of lighting products from manufacturer representatives. They sell lighting products to contractors, and sometimes provide value-add service such as product specification, technical assistance, and training of contractors.
- **Contractors** sell retrofits to end-users through referrals, marketing, and door-to-door sales. They then procure the retrofit products from distributors and install them in end-user facilities.
- **Lighting designers** do not play a significant role in the lighting retrofit market.

5.2.2 Lighting Retrofit Drivers

Table 11 presents our understanding of what motivates market actors and commercial end use customers when they are considering a lighting purchase (or sale). This characterization is supported by findings from all three research tasks.

Table 11: Market Actor and End-User Motivations

Role in the Market	Motivations
Manufacturer Representatives	• Increase sales • Negotiate favorable terms with distributors
Distributors	• Meet, but do not exceed demand (from contractors) • Sell products rapidly • Negotiate favorable terms with manufacturer representatives
Contractors	• Increase sales • High end-user satisfaction
End-Users	• Saving money and payback period via energy savings • Recommendations from contractors

5.2.3 Barriers to Advanced Lighting Retrofits

Current market barriers to advanced lighting retrofits are typical for new products in general. We found from our primary research that market actors frequently mentioned high initial cost (especially powerful in a poor economy), which was also identified in the literature review. According to market actors, this barrier is exacerbated by the availability of lower cost efficient lighting options with faster paybacks, especially for LEDs. The end-user "bright spots"

research suggests that advanced lighting adopters tend to prioritize energy savings and/or operating costs over first cost.

Another barrier is knowledge and product awareness gaps. Currently, distributors and especially contractors reportedly lack the awareness or knowledge to comfortably promote the benefits of advanced lighting over other options. Any lack of knowledge or awareness affects the choices of end-users, as contractors may fail to present advanced lighting solutions to their customers.

Risk associated with product uncertainty and high initial cost also creates barriers for distributors, contractors, and end-users. Market actors report that end-users do not want to purchase expensive, unproven equipment. They also say that contractors want to sell retrofits comprised of lighting products they are familiar and comfortable with in order to reduce risk.

Our findings suggest that barriers to adoption of advanced lighting in the commercial retrofit market are related to product awareness and perceived risk, which is derived from high cost and product uncertainty (typical of new technologies).

5.2.4 Market Actor Influence on Lighting Retrofit Projects

Based on findings from all three research tasks, contractors have the greatest influence on what lighting commercial end-users chose to install. Market actors and commercial end-users confirmed that contractors are frequently the only lighting professional to interact directly with the end-user in lighting retrofit situations. The contractor typically approaches the end-user, providing them with information and lighting options, often based on what the contractor is familiar with and believes to be both applicable and amenable to the end-user. The motivations of contractors – as many sales as possible with few return visits – could work against rapid adoption of new technologies and installation considerations in line with advanced lighting guidelines.

Contractor influence on end-user choice does not happen in a bubble. Rather, an important finding of the market actor research, corroborated by the critical synthetic literature review, is that the knowledge, available choices, and decisions of other market actors in the supply chain affect what contractors recommend to end-users.

Therefore, it is important to discuss the market actors upstream of the contractors in order to develop a better understanding of how to influence contractors, and thus their recommendations to commercial end-users. The theory behind this stream of influencers approach that we identified as part of the synthesis of the literature is: *Why hunt through the forest when you can wait by the waterhole?* The theory implies that programs should identify the highest leverage points and concentrate efforts there. Evidence from our primary and secondary research supports this theory and suggests that distributors may offer a unique opportunity for commercial lighting programs in California.

Based on the primary and secondary research, we observed that manufacturer representatives promote their advanced lighting products to distributors. They may negotiate with distributors to stock certain products as part of lighting packages. These packages come with specific financing terms, which are also part of the negotiation process. The outcome of these manufacturer representative-distributor negotiations has an effect on the options promoted to contractors and, as stated above, this impacts the options presented to end-users.

Mentioned as a barrier to advanced lighting adoption in section 5.2.2, the research suggests that distributors, like many lighting market actors, are risk averse. The risk that distributors face in the lighting market is the potential inability to rapidly turn over their stock of products, as they are unable to sell them back to the manufacturer and also pay interest on the products in their warehouses. This financing structure means that distributors are more comfortable stocking items they know are in high demand, and thus avoid products they believe to be costly or new and untested. Since the role of distributors is to sell products to contractors, their lack of familiarity or confidence may play a role in what they offer for sale. While stocking per se is not a barrier – any product can be ordered through a distributor regardless of whether it is stocked – what the distributor carries influences the product awareness and choices made by contractors (recall that distributors are motivated to sell what they have in stock). Furthermore the value-add services provided by distributors, such as training to contractors and providing product specification, are likely influenced by the outcome of their negotiations with the manufacturer representatives.

In conclusion, while contractors influence end-user decisions, the influence they impart on end-users is affected by the relationships and motivations of market actors further upstream. The negotiations of the manufacturer representatives and distributors may be a particularly important factor influencing the choices provided to end-users by contractors.

In this case, the *watering hole* is the risk perceived by distributors in carrying and promoting advanced lighting technologies for commercial retrofit applications. Therefore, one important commercial end-user "want and need" is for a reduction in distributor risk related to actively stocking and promoting advanced lighting technologies, discussed in detail below.

5.3 Reduce Distributor Risk

Market actors reported that distributors seek to meet, but not exceed, demand as a way of minimizing their risk. This can potentially constrain the choices presented to end-users by reducing the likelihood that all options are equally presented.

We recommend investigating and testing strategies to reduce distributor risk. These may include:

- **Accelerating contractor awareness and knowledge** to increase demand of advanced lighting technologies

Lack of contractor awareness of and experience with advanced lighting products reduces the choices they provide to end-users. Contractor education and outreach is an important part of increasing the prevalence of advanced lighting installations – especially considering they play the role of the designer in advanced lighting retrofit projects. We believe that contractors could also benefit from case studies of successful advanced lighting retrofits in each sector. Providing contractors the tools to learn about and market advanced lighting may both accelerate their knowledge and increase their ability to sell advanced lighting retrofits.

- **Testing midstream buy down strategies**[28] to reduce the amount of capital a distributor must risk to stock advanced lighting products

  A midstream buy down approach would essentially absorb some of the distributor risk associated with stocking advanced lighting products. The program administrators would assume part of the risk by lowering the cost and risk of stocking. A midstream buy down may significantly alter the information and choices provided to contractors. This is integral in affecting contractor decisions, according to the stream of influence and choice architecture framework.

- **Leveraging relationships with manufacturers**, possibly in the form of upstream buy downs, to positively impact terms of sale agreements with their distributors.

  The IOUs have developed relationships with key manufacturers via other lighting rebate programs, such as the Upstream Lighting Program. We think that the IOUs should consider investigating a similar approach for the heterogeneous nonresidential lighting manufacturers (some manufacture one product class, while others manufacture wide ranges of products). Establishing similar relationships to promote advanced lighting products could leverage utility expertise and encourage manufacturers to reduce the risk to distributors of stocking advanced lighting products. Our findings suggest that this does occur in the market, and that some manufacturers provide incentives so that distributors will carry advanced lighting products. The IOUs should investigate ways to increase the prevalence and efficacy of these efforts.

The California IOUs should ultimately select one buy-down point only, to avoid overlap and potential double counting of savings.

[28] Following completion of the research for this study, a report was issued by DNV KEMA, Inc., that detailed the successes of a midstream approach to commercial LED lighting retrofits in Massachusetts. The findings may not transfer to the California commercial lighting market (particularly for controls), but the findings suggest that such an approach may be successful. That report is located here: http://www.ma-eeac.org/Docs/8.1_EMV%20Page/2013/Commercial%20&%20Industrial%20Program%20Studies/13%20-Large%20C&I%20Yr.%202012%20Bright%20Opportunities%20Program%20Process%20Evaluation%20Final%20Report%206-14-13%20.pdf

5.4 Offering Higher Tiered Incentives for Advanced Lighting

The lighting market is competitive, with LEDs and advanced control retrofits competing for market share with lower cost retrofits consisting of less efficient technologies and strategies. The IOUs provide rebates to end-users in order to overcome the lack of competitiveness of more expensive LEDs and controls, but also provide rebates to the same end-users for the lower cost and less efficient retrofits. Market transformation efforts are focused on advanced lighting while resource acquisition is still largely derived from T8 fluorescent retrofits in the commercial segment. This presents a unique challenge to the IOU programs.

We recommend continued support for advanced lighting retrofits in the form of a higher tier of rebates, relative to rebates for basic lighting retrofits.

This recommendation is consistent with the 2013-2014 PIPs, which provide a framework for addressing the unequal playing field for advanced lighting solutions. The calculated incentives program will be "Offering 'premium' incentives for emerging technologies that are proven but not widely employed in the markets for which they are intended (such as solid state lighting, advanced lighting controls, etc.)."[29,30]

Our findings support the IOU strategy to more aggressively promote advanced lighting technologies compared to non-advanced technologies. This type of strategy has been successfully used for clothes washers and consumer electronics, where rebates are offered in two tiers to distinguish for market actors and end-use customers between the "better" and "best" choice.

[29] SCE Statewide Commercial PIP, source: https://www.sce.com/wps/portal/home/regulatory/advice-letters/pending/

[30] PG&E Statewide Commercial PP, source: https://www.pge.com/regulation/EnergyEfficiency2013-2014-Portfolio/Other-Docs/PGE/2013/EnergyEfficiency2013-2014-Portfolio_Other-Doc_PGE_20130423_272470.zip%20