PG&E AND SDG&E COMMERCIAL LIGHTING MARKET EFFECTS STUDY

FINAL REPORT

Volume I

Prepared for

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E EXECUTIVE SUMMARY

E.1 INTRODUCTION

This is the Final Report of the Pacific Gas & Electric (PG&E) and San Diego Gas & Electric (SDG&E) Commercial Fluorescent Lighting Market Effects Study. This study was funded and managed by PG&E and SDG&E under the guidance of the California Demand-Side Management Measurement Advisory Committee's (CADMAC) Market Effects Subcommittee.

The primary objectives of the study were to:

- Identify changes in the commercial lighting markets that favor the adoption of efficient fluorescent technologies, both in the sponsors' service territories and in the nation as a whole. The study focused on changes in the markets for electronic ballasts, T-8 lamps, and fixtures that integrated those components.
- Assess the extent to which these changes were attributable to the sponsors' programs.
- Project the expected durability of observed market effects.

Other project objectives were to develop detailed characterizations of the demand and supply sides of the fluorescent lighting market and of the interventions into that market by the sponsors, other utilities, and government agencies.

We adopted as the basis for this evaluation the operational definitions of *market transformation* and *market effects* of energy-efficient programs put forth in the *Scoping Study*[1] on market transformation commissioned by the CADMAC and completed in 1996. The key definitions from the *Scoping Study* include the following:

- *Market Transformation* "means a reduction in market barriers due to a market intervention, as evidenced by a set of *market effects*, that lasts after the intervention has been withdrawn, reduced or changed."
- A *Market Effect* is "a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of energy-efficiency products, services, or practices and is causally related to market interventions."

We describe how these definitions were implemented in the research in Section E.3.

1 Eto, J., Prahl, R., and Schlegel, J. (1996) *A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs.* Berkeley, CA: Lawrence Berkeley National Laboratory.

E.2 OVERVIEW OF THE SPONSORS' PROGRAMS

The sponsors' program support of efficient commercial fluorescent technologies can be summarized as follows:

- ***Scale of activity.*** The volume of the sponsors' program activity was huge in relation to the markets targeted. During the period 1992 to 1996, the sponsors paid rebates on about 7.5 million electronic ballasts and 17 million T-8 lamps. These totals account for an estimated 50 to 60 percent of all efficient fluorescent components sold in the sponsors' service territories during the period and for roughly 30 percent of *all* 4-foot fluorescent ballast sales, regardless of type. Rebate activity for both programs peaked in 1994 and 1995.
- ***Focus on applications in existing buildings.*** About 70 percent of the electronic ballasts on which PG&E paid rebates were installed in projects in existing buildings. The results of customer surveys suggest that 50 percent of these ballasts were used in retrofit projects and the remainder in renovation and remodeling projects.[2] Based on analysis of program expenditures, a similar pattern appeared to hold for SDG&E.
- ***PG&E Program Strategies.*** PG&E promoted the use of efficient commercial fluorescent lighting in existing buildings through a variety of mechanisms. The largest of the programs oriented to existing buildings was Retrofit Express, which paid a fixed rebate amount per component. Retrofit Express accounted for approximately 3.6 million of the 5.3 million ballasts rebated over the study period in PG&E's territory. The Customized (Retrofit) program accounted for roughly 0.3 million ballasts rebated. PG&E's new construction programs may have provided rebates for roughly 1.5 million electronic ballasts. Since this program based rebate payments on estimated kW and kWh savings, using lighting power densities (LPDs) specified in the California Building Code (Title 24) as the benchmark, it is difficult to know precisely how many lighting components were involved in achieving these savings.

  PG&E has promoted the development of both the supply and demand side of the market for efficient commercial lighting through a number of other strategies, including: designer education through the Pacific Energy Center, provision of tools to support efficient lighting designs, participation in statewide processes to revise Title 24 (with lower LPDs), and energy audit programs.

  Marketing of the programs focused on the office, retail, and institutional sectors. Projects in office buildings represented 23 percent of total program savings from efficient fluorescent equipment. The corresponding figures for institutional and retail were 19 and 16 percent.[3]

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[2] For this project, "retrofit" projects were defined as those in which fluorescent lighting systems were replaced without making improvements to the surrounding space. "Renovation" projects were defined as those in which fluorescent lighting systems were replaced in the context of other improvements to space already occupied by the respondent. "Remodeling" projects were defined similarly, except that they were undertaken upon change in occupancy (including build-out of new construction).

[3] For this study, the institutional sector includes the following kinds of buildings: primary and secondary schools, government office buildings, health and hospitals, lodging, colleges and universities. Utility records did not distinguish government from other kinds of office buildings.

- ***SDG&E Program Strategies.*** SDG&E's programs to promote retrofit and replacement with efficient lighting among commercial customers began on a significant scale in 1989. Since that time, the programs have evolved substantially in terms of target markets, measures supported, customer incentive levels and formats, and delivery mechanisms. One constant throughout has been a high level of customer contact and logistical support for retrofit projects, including project planning, prescreening of contractors, and, for some customers, full turnkey project management.

  1989-1991. Prior to 1992, SDG&E promoted efficient commercial lighting through two programs, the Commercial/Industrial Incentives and the Commercial Lighting Retrofit program. These programs were marketed by customer representatives to SDG&E's 750 largest C&I customers.

  1992-1997. During this period, a Small Commercial Audit program was started to broaden the range of firms that were participating in the lighting rebate program; participation was opened to a broader range of contractors; and incentive levels were reduced.

  1994-1997. In 1994, the Small Commercial Audit and Lighting Retrofit programs were merged to form the "Power to Save" program. This program targeted smaller customers (100 or fewer fixtures). A per unit rebate structure was introduced; incentives were lowered and discontinued entirely on 4-foot T-8 lamps in 1997.

  New Construction Programs. New construction programs with rebates based on comparisons to Title 24 requirements were in operation during the entire study period.

E.3 RESEARCH AND ANALYTIC METHODS

In developing our characterization of the market effects of the sponsors' programs, we have attempted to answer the following basic research questions.

1. ***Market Changes.*** *To what extent did indicators of adoption of efficient fluorescent technologies change during the study period?* Among end users, such indicators include market share of efficient component purchases, levels of awareness of efficient components and their economic and performance benefits, and adoption of corporate policies to use efficient components. Among manufacturers, key indicators include changes in product features to make them more attractive to customers, reductions in price, and expansion of promotion and distribution activities. Among supply-side actors in the distribution chain, key indicators include changes in stocking, specification, and promotion procedures.
2. ***Attribution to utility programs: efficient product adoption.*** *To what extent did the sponsors' programs assist commercial customers in overcoming barriers to the adoption of efficient fluorescent lighting technologies?* To answer this question, we undertook detailed cross-sectional comparisons of the extent and timing of efficient measure adoption among representative samples of program participants, nonparticipants, and commercial customers in areas where there had been no utility programs to support

efficient commercial lighting. We undertook a similar comparison based on levels of efficient measure market share reported by representative samples of electrical distributors in the program and nonprogram areas.

3. ***Attribution to utility programs: reduction of market barriers.*** *In what specific ways did the sponsors' programs help customers overcome market barriers that may have inhibited or reduced their use of efficient fluorescent lighting technologies? Similarly, to what extent did the programs induce manufacturers and other supply-side actors in overcoming barriers to expanded production, distribution, promotion, and specification of efficient fluorescent components?* XENERGY undertook the following steps to address this question.

   - *Develop hypotheses regarding the market effects of the sponsors' programs.* Based on our research on the sponsors' program offerings, we developed hypotheses regarding potential effects of the program on barriers to efficient fluorescent product adoption. For example, we hypothesized that increases in demand for electronic ballasts due to utility programs encouraged manufacturers to increase production, improve features, and reduce prices.

   - *Gather information to test the hypotheses.* We collected information to test the various hypotheses primarily from a broad array of information sources, including customer surveys, surveys of distributors, in-depth interviews with contractors, designers, and distributors, and extensive searches of secondary and statistical sources.

   - *Analyze attribution.* We used three basic methods to assess the causal relationship between the sponsors' programs and changes observed in the market: cross-sectional comparisons between the sponsors' local markets and nonprogram areas; self-reported narratives from market actors; and reconstruction of historical sequences of events.

4. ***Assessment of durability of market changes.*** *How likely is it that market effects that occurred during the study period will persist after the reduction or elimination of sponsor programs to promote efficient commercial fluorescent lighting?* We hypothesized that customers' practice of selecting efficient lighting equipment would persist under one or more of the following conditions.

   - Use of efficient lighting products is directly related to key modes of competition or management.

   - Adoption of stated purchase policies.

   - High saturation of efficient equipment.

E.4 SIZE AND SEGMENTATION OF THE SPONSORS' COMMERCIAL LIGHTING MARKETS

The sponsors' commercial lighting markets are very large. They constitute 4 percent of the total U.S. market for commercial lighting equipment. Table E-1 summarizes measures of market size.

Table E-1
Summary Measures of Market Size

Indicator	SDG&E	PG&E	TOTAL PROGRAM AREA
Number of Establishments*	99,008	466,614	566,622
Total Square Feet (millions)	403	1,865	2,268
Percent of U.S. Total Sq. Feet	0.7	3.3	4.0
Number of 4-foot Ballasts (000s)	4,805	17,786	22,592
Number of 4-foot Lamps (000s)	9,612	35,572	45,814

* Per the Dun & Bradstreet MarketPlace Database. Differs from utility customer count due to inclusion of renters who do not directly pay electric bills.

The study results indicate that the commercial market is highly segmented in terms of adoption of efficient lighting equipment and related variables. Generally, the segmentation reflects the strength of customers' motivations to invest in energy efficiency and organizational resources available to develop and manage efficiency improvements and equipment purchases. Thus, penetration of efficient equipment is highest in the institutional and owner-occupied office sectors, which have high rates of owner occupancy and relatively large facilities. The relatively high levels of efficient product market share in the leased office sector reflects the high motivation of Real Estate Investment Management companies (REIMs) to control costs and deliver net operating income to investors.

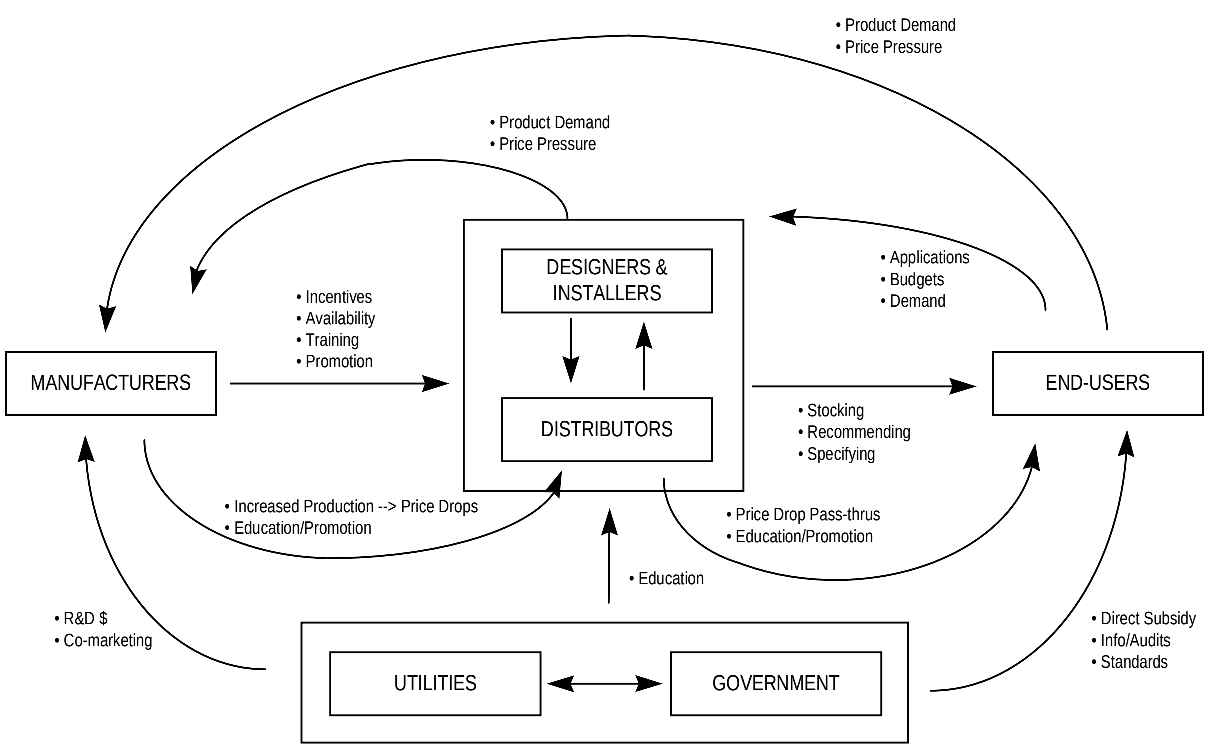
Table E-2
Summary Information on Market Segments

Segment	Percent of Estab's.	Percent of Floorspace	Average Facility SF	Percent of SF Owner-Occupied	Market Share: El. Ballast	Market Share: T-8 Lamps
1. Office/Owner	17%	8%	145,544	96.6%	71%	48%
2. Office/Leased	17%	22%	51,432	0.0%	48%	46%
3. Retail/Sole	29%	7%	15,336	28.0%	25%	16%
4. Retail/Multisite	8%	8%	41,373	23.6%	30%	29%
5. Institutional	14%	43%	509,267	78.0%	53%	41%
6. Other	15%	12%	112,285	42.6%	12%	10%
All Segments	**100%**	**100%**	**198,567**	**50.4%**	**47%**	**41%**

E.5 SUMMARY OF MARKET EFFECTS OF THE SPONSORS' PROGRAMS

In order for an energy-efficient product to be self-sustaining in the marketplace, both supply-side and demand-side interests must become aligned with respect to the value of the efficient product. On the supply side, it is critical that the product is available, that vendors are aware and knowledgeable about the measure, and that they stock, promote, and specify it in their business interactions with end users. On the demand side, it is equally critical that end users are aware and knowledgeable about the measure. Both supply-side and end-use characteristics are dynamic and interactive in real markets. To illustrate these dynamics, we present in Figure E-1 below a conceptual representation of the relationships between the different market actors and their activities with respect to commercial lighting supply and purchases. In addition, we include in the diagram the ways in which utility and government agents may intervene to stimulate these markets. Whether intentional or not, certain types of interventions have the potential to create naturally reinforcing feedback mechanisms in the marketplace. In fact, most of the relationships presented in the figure are positive feedback loops.

Figure E-1*
Basic Mechanisms of Transformation
in the Commercial Lighting Markets



**Adapted from Easton, 1997*

The markets for fluorescent lighting equipment are dominated in terms of product design, availability, and price by manufacturers who operate on a national and international scale. We therefore begin by summarizing the impact of utility programs in general, and the sponsors' programs in particular, on the national markets. These changes in the national market provide the framework within which local market changes and program market effects can be assessed. We then move on to summarize the market effects of the sponsors' programs in their own territories and present our assessment of the durability of those effects.

E.5.1 Scope of Utility Market Interventions

From 1988 to 1996, U.S. utilities and, to a lesser extent, government agencies, conducted a massive, multifaceted, and sustained intervention in the markets for fluorescent lighting system components. During this period, utilities nationwide paid out nearly $2 billion in rebates for efficient fluorescent lighting components. These rebates subsidized the purchase of roughly half of all electronic ballasts shipped domestically during this period. This is 16 percent of *all* ballasts shipped during the study period. Other important utility efforts included large-scale customer education programs, negotiations with manufacturers concerning performance features of fluorescent lighting components, and participation in the development of stricter building codes. Utility efforts were complemented by government education programs such as the U.S. EPA's *Green Lights*, as well as state and regional initiatives to increase required lighting efficiencies in commercial building codes.

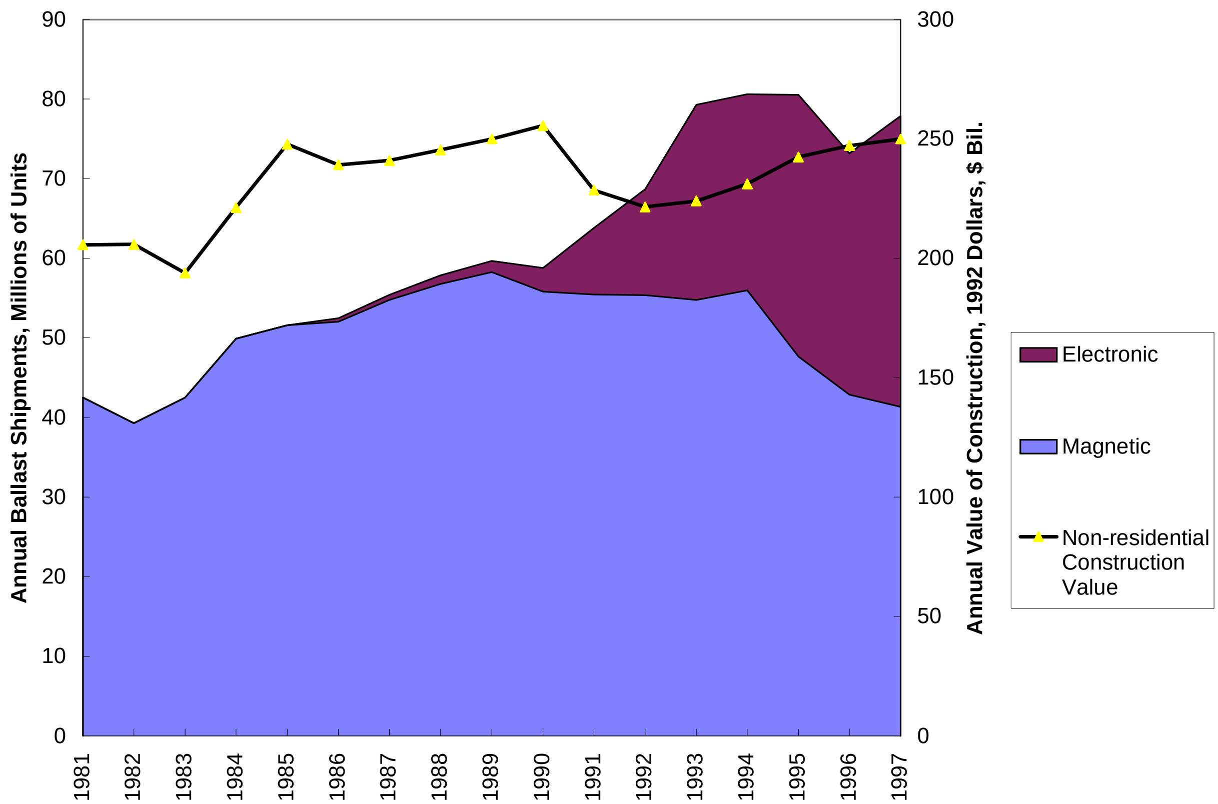
The sponsors' programs constituted a major presence in both their local markets and the national market. The sponsors paid rebates on roughly 50 to 60 percent of all electronic ballasts and T-8 lamps sold in their service territories during the study period. Units rebated through their programs accounted for 6 percent of all electronic ballasts sold in the U.S. during the study period. Moreover, the sponsors' program volume peaked during 1994 and 1995, as the activities of utilities elsewhere declined. During these years, the sponsors' programs accounted for roughly 15% of rebated electronic ballasts nationally, almost 4 times their 4 percent share of national commercial floorspace. This provided continuing support for manufacturers to expand the market for electronic ballasts and T-8 lamps.

E.5.2 The Impact of Utility Programs on National Equipment Shipments

At the national level, the concerted efforts of utilities and government agencies led to a rapid increase in the demand for electronic ballasts and T-8 lamps. This growth consisted of two trends: (1) an expansion in demand for ballasts and lamps far beyond levels required to keep pace with current levels of commercial construction; and (2) a rapid increase in the market share of efficient equipment. Based on manufacturers' shipment data, the market share of 4-foot electronic ballasts increased from 13 percent in 1991 to 47 percent in 1997.

Figure E-2 illustrates the dramatic impact of utility programs on the national markets for efficient fluorescent components. The solid areas show power factor-corrected fluorescent ballast shipments from 1981 through 1997; the darker area represents electronic ballast shipments. The black line shows the value of new construction put in place in constant (1992) dollars.[4] Prior to 1990, changes in ballast sales tended to parallel changes in construction expenditures with a lag of about a year. In 1991 and 1992, levels of construction spending dropped sharply, reflecting national recession conditions, and have not yet returned to pre-recession levels. Ballast shipments, on the other hand, increased over 36 percent between 1990 and 1994, and most of this increase was accounted for by the steep rise in electronic ballast shipments. In addition, between 1992 and 1994 roughly 60 percent of electronics were rebated nationally. The rapid increase in the market share of efficient ballasts is also apparent from Figure E-2.

Figure E-2
Trends in Electronic Ballast Shipments and Nonresidential Construction Expenditures: 1981-1996



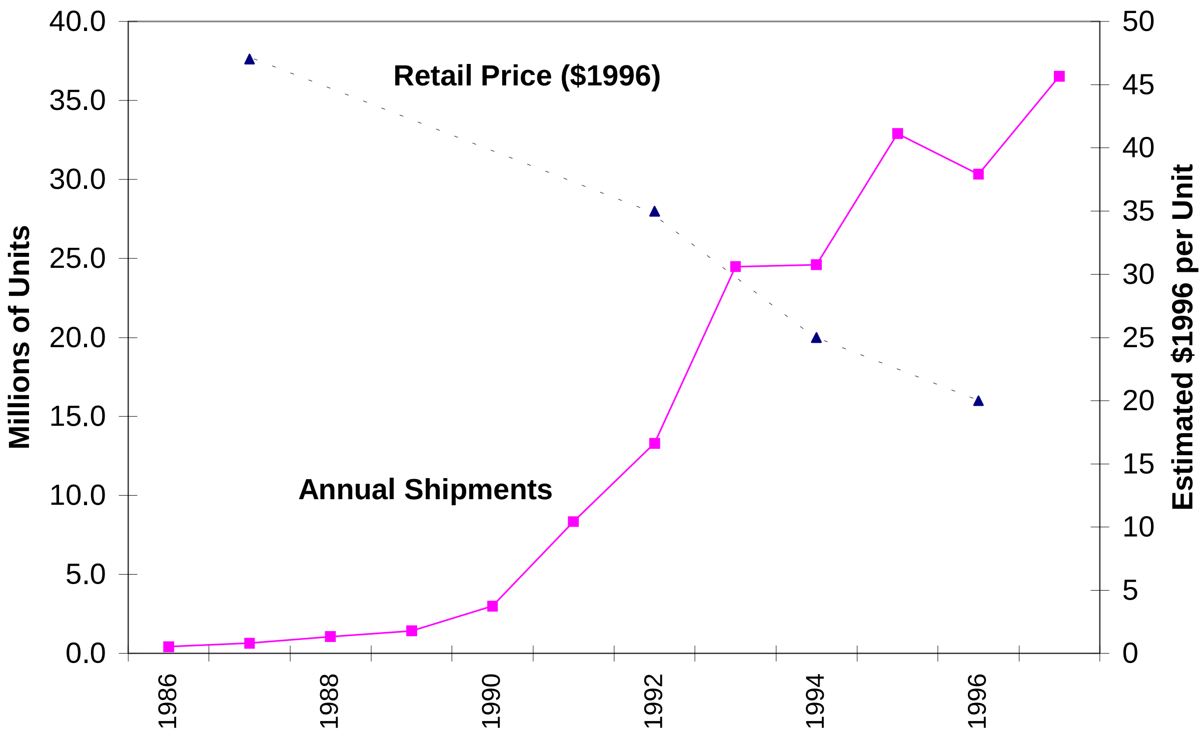
E.5.3 The Impact of Increased Demand on Component Prices and Features

The rapid expansion of demand for electronic ballasts and T-8 lamps contributed to increased competition among manufacturers for market share. This competition led to

[4] Sources: U.S. Bureau of the Census, *Current Construction Reports*, Series C30. Represents value of construction put in place during the year. Includes renovations and additions and installed cost of normal building services. For ballast shipments: U.S. Bureau of the Census, *Current Industrial Reports.*

improvements in product reliability and features, increased levels of promotion, and significant decreases in price. For example, the difference in price between a 2-lamp electronic ballast and a magnetic ballast decreased from $10 in 1992 to $5 in 1996. For some fixture configurations, electronic ballasts currently cost less than magnetic ballasts. The difference in price between T-12 and T-8 lamps decreased from $2.25 in 1992 to $1.25 in 1996. Figure E-3 illustrates the rapid decrease in electronic ballast prices along with the rapid increase in shipment volumes.

Figure E-3
Electronic Ballast Shipment and Price Levels



The evidence linking utility programs to decreases in the incremental costs of electronic ballasts and T-8 lamps is strong. While only two of the six manufacturers credited utility programs with direct influence on their production and pricing decisions, four of the six interviewed attributed a broad range of production, promotion and pricing decisions to the increased volume of efficient component sales during the early and mid-1990s. The analysis presented above clearly links utility programs to that increase in demand. Moreover, most ballast and lamp manufacturers stated that they would not have made the same production-related decisions in the absence of the California programs and the increase in demand to which they were linked. These decisions covered:

- Timing and size of production runs.
- Allocation of shipments to California versus other regions.
- Changes in technical product specifications to meet sponsor requirements.

The combination of increased demand, declining prices, product improvements, and enhanced promotion appears to have created a feedback loop between customers and supply-side actors that has supported the "take-off" of efficient fluorescent lighting systems and their components. Penetration of electronic ballasts, the core of efficient fluorescent lighting systems, has reached 47 percent, with shares as high as 80 and 90 percent in some regions and market segments.

E.5.4 Market Effects in the Sponsors' Service Territories: End Users

The national trends in the ballast and lamp markets were even more pronounced in the sponsors' service territories. The programs had a large net impact on the number of electronic ballasts and T-8 lamps purchased by their commercial customers during the study period. The penetration of electronic ballasts increased from 17 percent in 1991 to 55 percent in 1997; the market share for T-8 lamps in the sponsors' territories grew from 11 percent to 51 percent over the same period. By contrast, as Table E-3 shows, electronic ballasts have only achieved 29 percent penetration in areas where no utility programs have been offered. The market share of T-8 lamps is estimated at 27 percent in nonprogram areas.

Depending on the method used to estimate net program impacts, the sponsors' programs were directly responsible for the purchase of 7 to 8 million electronic ballasts during the study period and 13 to 15 million T-8 lamps. This is roughly one-third of all fluorescent lighting equipment currently in use in the sponsors' commercial markets.

Table E-3
Market Share of Efficient Equipment
Reported by Sample Distributors

Technology	Area	% Annual Market Share by Year		
		1997	1994	1991
T-8 Lamps	Program	51%	27%	11%
	Nonprogram	29%	12%	3%
Electronic Ballasts	Program	55%	29%	17%
	Nonprogram	27%	13%	3%

The impact of the programs in terms of net purchases of efficient fluorescent components appears to be concentrated in the institutional and office sectors – and particularly in owner-occupied office buildings. The program had little effect on the penetration of efficient equipment in the retail, wholesale, and miscellaneous other sectors. In these market segments, the penetration of efficient equipment in the program and nonprogram areas was basically the same.

The sponsors' programs reduced a number of important barriers to customer adoption of efficient fluorescent technologies. Most importantly, they:

- Increased customer awareness of efficient fluorescent technologies.
- Increased customer awareness of the full range of benefits associated with efficient fluorescent technologies.
- Helped customers reduce perceived costs of replacing inventories of standard equipment.

In addition, we can infer from comparisons of customer behavior between the program areas and nonprogram areas that the programs induced customers to develop resources and procedures to overcome barriers to measure adoption. These include designating staff to act as energy managers and establishing policies regarding the purchase of efficient lighting equipment. Table E-4 provides additional detail of findings regarding reductions of market barriers.

E.5.5 Market Effects in Sponsors' Service Territories: Other Supply-Side Actors

The sponsors' programs contributed to reducing a number of important barriers to the promotion of efficient fluorescent technologies by supply-side actors in the sponsors' service territories. Most importantly, they:

- Encouraged designers and installers to use the provision of efficient equipment as a strategy to gain and retain market share.
- Encouraged distributors to increase stocking of efficient equipment in order to gain and retain market share.
- Set the stage to make revisions to California's Title 24 building code that will practically require the use of efficient components politically acceptable to most supply-side actors.

Table E-5 provides additional detail on the programs' supply-side market effects.

E.5.6 The Durability of Market Changes

Our assessment of the durability of changes in the commercial market for fluorescent lighting equipment in the sponsors' service territories addresses two questions.

1. How likely is it that the current levels of market share for electronic ballasts and T-8 lamps in the sponsors' service territories would persist in the absence of continued market intervention by local utilities?
2. How likely is it that growth in market share for electronic ballasts and T-8 lamps will persist in the absence of continued market intervention by local utilities?

We believe that evidence gathered through this study generally supports the conclusion that current levels of market share for efficient components would persist in the absence of further local utility market interventions. The key evidence suggesting the likely persistence of current levels of market share for efficient equipment includes:

- Persistence in the growth of market share both nationally and in the program area in the face of declining utility support and incentive payments.
- Widespread awareness (facilities encompassing 70 percent of total floorspace) among end users of the benefits of efficient fluorescent lighting equipment.
- Low and declining incremental costs for efficient equipment.
- The adoption of purchase practices that require the use of efficient equipment by facilities encompassing roughly one-third of total floorspace.
- The promulgation of revisions to Title 24 that will effectively require the use of electronic ballasts and T-8 lamps in most permitted construction.

We also identified evidence that suggests the recent pace of growth in efficient product market share is unlikely to be sustained. This evidence includes the following.

- Despite a decade of intense promotion and plentiful rebates, the retail and miscellaneous sectors have not adopted efficient fluorescent technology in great numbers. Moreover, adoption of efficient products by smaller customers in virtually all sectors is relatively low. It is unclear what more the sponsors can do to get the attention of these customers.
- Manufacturers continue to resist the phase-out of magnetic ballasts and associated lamp technology. This resistance may be prompted by fear of loss of market share in other countries and loss of margin, which is relatively higher for magnetic than for electronic ballasts.

Table E-6 summarizes this evidence.

Table E-4
Program Effects on Demand-Side Market Barriers

Hypothesized Effect	Evidence for Change	Utility Program Attribution	Relative Importance of Effect
Increase in awareness and knowledge of the product.	**Strong.** Lack of awareness of efficient technologies mentioned most often as a barrier to adoption early in program period.	**Strong.** Nearly 80 percent of program participants report being unaware of efficient fluorescent technologies prior to participation. Customer survey results corroborated by manufacturers, distributors, designers, and contractors.	**High**
Increased awareness of full range of program benefits.	**Strong**. High percentages of program participants are aware of a broad range of product advantages, including: longer useful life, reduced lumen degradation, reduced maintenance costs.	**Strong.** Program area nonparticipants and nonprogram area customers generally cannot cite any benefits. Few even recognize reduced electric costs. Corroborated by observations of supply-side actors.	**Moderate**
Reduced perception of costs associated with switching from standard to efficient lighting.	**Strong.** Over half of program participants mention reluctance to take on expense associated with use of two kinds of fluorescent technologies during transition.	**Moderate.** Some indirect corroboration from supply-side observers who identify cost as a barrier.	**Moderate**
Increase in use of internal energy managers.	**Moderate.** Survey finds significantly higher percentage of establishments with energy managers in program area than in nonprogram area. Strong association between having an energy manager and penetration of efficient components.	**Moderate.** Cross-sectional evidence shows strong association between energy manager on-site and program participation. However, this may simply reflect self-selection.	**Moderate (could be important for durability)**
Increase in adoption of policies to purchase only efficient fluorescent components.	**Moderate.** Survey finds significantly higher percentage of establishments with purchase policies in program area than in nonprogram area. Strong association between having such a policy and penetration of efficient components.	**Moderate.** Cross-sectional evidence shows strong association between purchase policy and program participation. However, this may simply reflect self-selection.	**Moderate (could be important for durability)**

Table E-5
Program Effects on Supply-Side Market Barriers

Hypothesized Effect	Evidence for Change	Utility Program Attribution	Relative Importance of Effect
DISTRIBUTORS, DESIGNERS, & INSTALLERS			
Programs lead designers and installers to use specification of efficient lighting equipment as a competitive strategy.	**Strong.** Great deal of self-reported change in specification practices during the study period.	**Moderate**. A portion of the effect is first order (among vendors that proactively promote). The remaining portion appears to be second order (among vendors whose practices are a reaction to end users demand).	**High**
Changes in distributor stocking.	**Strong.** Great deal of self-reported change in stocking practices during the study period. Also, large cross-sectional difference in stocking patterns between program area and nonprogram area distributors.	**Moderate** from direct interventions to distributors. **Strong** from demand stimulus.	**Low (distributor inventories can change quickly)**
GOVERNMENT			
Changes in government codes and standards.	**Strong.** High likelihood of revision to Title 24 that will virtually require T-8 lamps and electronic ballasts.	**High**. CEC and State have been hesitant to revise standards in the past. Demand increases and accompanying end users, designer, and other vendor acceptance of T-8s and EBs provided more politically acceptable environment for revision. PG&E staff report high level of involvement with code revision process. Corroborated by other participants.	**High (standards will lock in market transformation for new buildings)**

Table E-6
Findings Regarding Durability of Market Changes

Conditions Supporting Durable Change	Conditions Mitigating Durable Change
Persistence of Current Levels of Market Penetration	
Continued increase in market share. From 1994 to 1997, national market share of electronic ballasts increased from 31% to 47% despite a decrease in utility support from $326 million to less than $250 million. **Widespread awareness.** Facilities encompassing 70% of total commercial floorspace report having purchased electronic ballasts and/or T-8 lamps in the past 5 years. **Low incremental costs.** Keen competition and consolidation in the electrical equipment market suggests that manufacturers will continue to compete on price. Current incremental costs for electronic ballasts are well within reported investment criteria. **Purchase practices and policies.** Of program area customers, 32% report having policies to purchase only efficient fluorescent components. **Energy Managers.** Facilities representing at least 67% of all commercial space have a designated energy manager. The presence of energy managers is associated with high penetration of efficient equipment.	**High saturation.** Paradoxically, high levels of saturation may mitigate continued high levels of market penetration. If program efforts are reduced, the proportion of retrofit and renovation-related lighting equipment purchases will fall and the volume of replacement purchases will rise. The market share of efficient equipment purchased for replacement is around 30%, versus roughly 50% for other purchase events. **Continued price resistance.** Among customers who have *not* used electronic ballasts and T-8 lamps, perceptions of high price continue to be identified as a barrier to adoption.
Continued Growth in Market Penetration	
Promulgation of Title 24 Revisions. The Title 24 Revisions likely to take effect in 1999 will virtually require the use of electronic ballasts and T-8 lamps in most market segments for any projects requiring building permits.	**Lack of interest among retail and "other" segments.** Despite massive programs including product rebates, customer education, contracting assistance, and – for some segments – direct installation, most customers in the retail sector and smaller customers in the office segments have not chosen to participate, nor have they adopted efficient equipment on their own. It is not clear what more utilities can do to reach these customers, beyond support for code enforcement. These sectors account for 54% of total establishments and 28% of total floorspace in the program area. **Manufacturer resistance to magnetic ballast phase-out.** Generally, manufacturers have lobbied against federal product standards that would phase out magnetic ballasts for fear of lost international market share and margins. At least one U.S. ballast manufacturer has recently built a magnetic ballast factory.

1 INTRODUCTION

This is the Final Report of the Pacific Gas & Electric (PG&E) and San Diego Gas & Electric (SDG&E) Commercial Fluorescent Lighting Market Effects Study. This study was funded and managed by PG&E and SDG&E under the guidance of the California Demand-Side Management Measurement Advisory Committee's (CADMAC) Market Effects Subcommittee. It is one of several market effects studies commissioned in 1997 and reviewed by the CADMAC.

In this introduction to the report, we present an overview of the objectives, context, and methods employed, including:

- The operational definitions used for the study.
- The scope of objectives pursued.
- A brief overview of the sponsors' program during the study period.
- Our approach to the general methodological challenges.
- A summary of the market effects hypotheses and research methods employed.
- A summary of the data collected.
- A guide to the chapters and appendices in this report.

1.1 OPERATIONAL DEFINITIONS AND OBJECTIVES OF THE PROJECT

We have adopted as the basis for this evaluation the operational definitions of *market transformation* and *market effects* of energy-efficiency programs put forth in the *Scoping Study*[1] on market transformation commissioned by the CADMAC and completed in 1996. The key definitions from the *Scoping Study* include the following:

- *Market Transformation* "means a reduction in market barriers due to a market intervention, as evidenced by a set of *market effects*, that lasts after the intervention has been withdrawn, reduced or changed."
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1.2 PROJECT SCOPE AND OBJECTIVES

The efficient technologies within the scope of this study include T-8 lamps, electronic ballasts, and new luminaires utilizing these components. The study period includes the sponsors' programs during the period 1992-1996, while the markets addressed include both retrofit and new construction. Each of the sponsors has previously evaluated the load impacts of their programs within the scope of this study. The primary objective of the current study, however, is to develop a better understanding of the market effects that may have been induced by these programs, the extent to which these effects may be lasting, and whether, in sum, or on a segment basis, conclusions with respect to the transformation of the markets in question can be made.

Underlying the broad purpose of this project mentioned above, the specific, individual research objectives include the following:

- To develop detailed demand-side and supply-side fluorescent lighting market characterizations, including segmentation analysis with respect to customer decision-making processes and supply-side vendors' business models.
- To fully characterize the extent of sponsors' market interventions as well as those of other entities, including government agencies via codes, standards, and programs.
- To identify and document changes in the fluorescent lighting market over the study period.
- To identify, document, and quantify to the extent possible the fluorescent lighting market effects.
- To determine the extent to which identified market effects are attributable to sponsors' programs specifically, or utility programs in general.
- To project the expected durability of any observed effects.
- To develop recommendations and lessons learned with respect to market transformation research methods and future actions in the commercial fluorescent lighting market in California.

1.3 OVERVIEW OF SPONSORS' PROGRAMS

In this subsection, we present a summary of the sponsors' program activities over the study period. Note that a more detailed accounting of these efforts is provided in Section 4 of this report.

We provide in Figure 1-1 a very general summary of the major program activities of the sponsors' nonresidential lighting-related programs. The lighting programs of the sponsor utilities resulted in the installation of millions of efficient lighting components and systems. Most of these installations were the result of incentives paid to end users and other market actors.

Figure 1-1
Timeline of PG&E and SDG&E Lighting Program Activities

PG&E

New Construction

- Start program to promote Title 24 to large commercial customers
- Promote Title 24 LPD+20% through incentives and education -- attempt to address small customers
- Increase educational efforts to designers & general market through PG&E Enegy Center
- Address stocking of efficient products through vendor incentives -- targeting owners and property managers
- Update incentive structure to increase share of whole building performance projects
- Push for 20% or better over Title-24

Retrofit

- Retrofit Express started to push most efficient lighting components
- Special emphasis on working with PG&E divisions
- First year of CustomNet and targeting of local chains
- Transition away from rebates as well as dropping technologies with high saturation

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Nonresidential CEE Spending -> (PG&E)								$57,945,000	$57,878,000	$80,402,000	$52,385,000	$44,625,000		
Lighting Rebates -> (SDG&E)						$74,647	$5,416,342	$6,656,309	$9,090,772	$15,631,347	$22,011,449	$12,044,417		

SDG&E

New Construction

- Promotion of Title 24+ to architectural and mechanical-electrical design firms
- Focus on 4' lighting
- Launch Savings through Design program based on Title 24 for all projects
- Dropped whole building performance approach in favor of prescriptive/custom mix
- Adopted LPD approach for better than Title 24 (+ >14%)

Retrofit

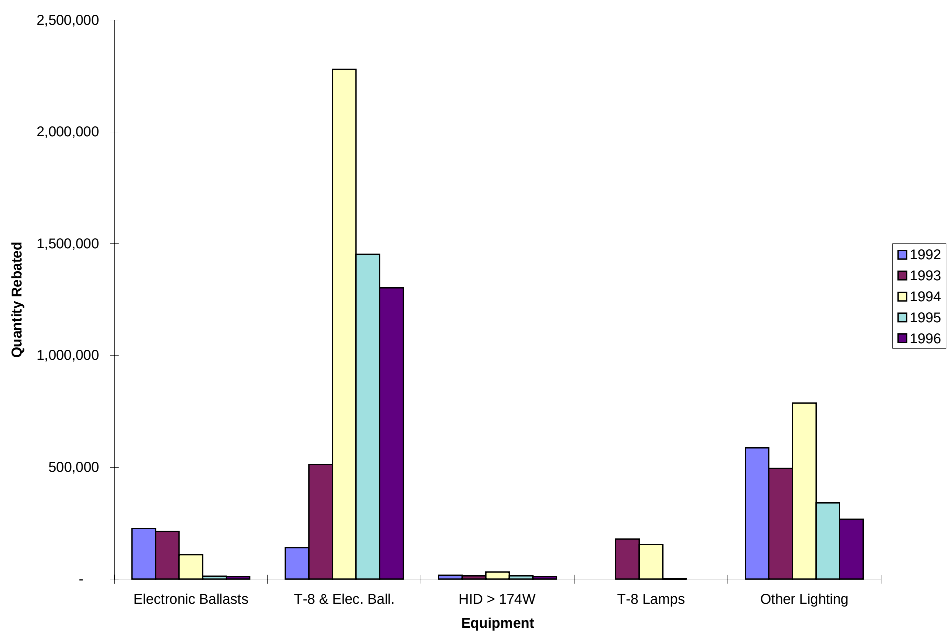
- Custom lighting retrofit through a few contractors for large commercial
- Quantity-based incentives
- Broaden list of contractors, start audit program for small commercial, use of kWh based incentives
- Merge programs into Power to Save -- emphasis on schools and military bases
- Prescriptive rebates started -- drop 4' T-8 lamps

From a market effects perspective, however, the direct change-outs do not provide the complete picture. The utility programs also involved many other activities, such as education and training, that may have directly or indirectly reduced market barriers.[2] The focus of our study is on the major incentive and customer information programs over the 1992 to 1996 period.

Peak rebate-based program activity occurred in the mid-1990s for both utilities, specifically in 1994 for PG&E and in 1995 for SDG&E. This can be clearly seen in Figures 1-2 and 1-3. Note that the first figure presents only data from PG&E's Retrofit Express program, but that this program generally represented approximately two-thirds of the company's T-8 and electronic ballast activity. Also note that most of the T-8 lamp and electronic ballast data obtained from PG&E's MDSS database are bundled. As a result, it is difficult to precisely estimate the exact numbers of ballasts and lamps for each program type.

As Table 1-1 shows, the ballasts and lamps rebated through the sponsors' programs accounted for a large portion of the estimated total flow of purchases. The volume of equipment rebated through PG&E's new construction programs is an estimate based on reported savings and staff comments on the representation of lighting measures in the overall mix of equipment supported by the programs. Moreover, based on estimates of the penetration of efficient technologies discussed above, the sponsors accounted for 50 to 60 percent of the purchases of efficient equipment.

Figure 1-2
PG&E Retrofit Express: Lighting Quantities by Measure Type by Year



[2] For example, a recent study of the Market Effects of PG&E's Energy Center has been completed recently: PG&E Energy Center Market Effects Study, Draft Final Report, prepared for PG&E by TecMRKT Works, December 1997.

Figure 1-3
SDG&E Lighting Product Rebate Activity by Year

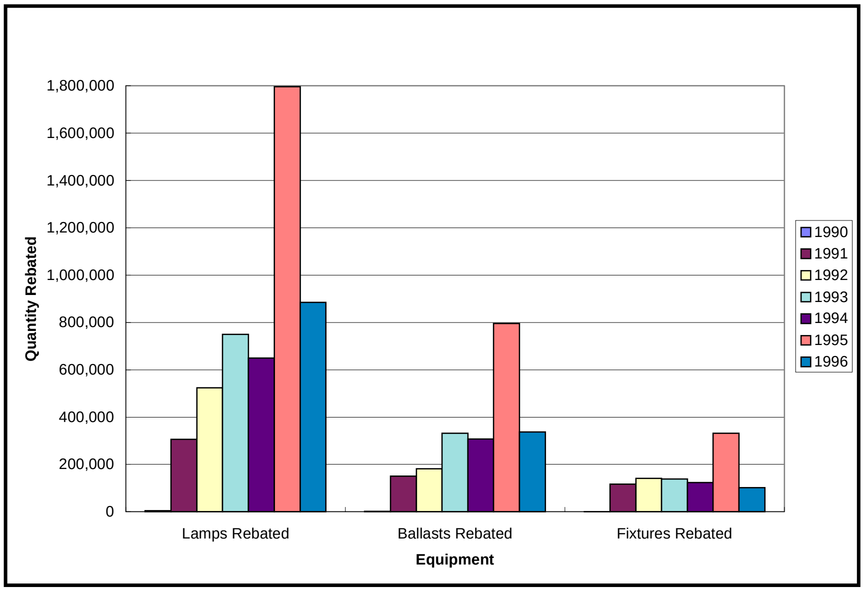


Table 1-1
Unit Volume of Sponsors' Program Activity
in Relation to Total Purchase Volumes*

Units Rebated: 1992-1996 by Program Type (in millions)					
Utility	**Retrofit**	**Custom**	**New**	**Total**	**% of Total Purchases: 1992-1997**
PG&E					
Electronic Ballasts	3.6	0.3	1.5	5.3	28%
T-8 Lamps	6.9	0.8	4.4	12.1	24%
SDG&E					
Electronic Ballasts	--	--	--	2.2	32%
T-8 Lamps	--	--	--	4.7	27%
Sponsor Total					
Electronic Ballasts				7.5	30%
T-8 Lamps				16.8	26%

*A number of assumptions are required to convert utility tracking system data to units, as many measures are bundled. In some cases, for example the PG&E New Construction programs, total savings at the end-use level was converted into estimates of the number of electronic ballast and T-8 lamps. The total number of units rebated should thus be considered approximate estimates.

1.4 APPROACH TO GENERAL METHODOLOGICAL CHALLENGES

The working definition of market transformation developed in the *Scoping Study* poses two (at least) formidable challenges to analysts of program effects. The first is attribution of effects to specific programs. The second is demonstration of lasting effects. In the paragraphs below, we provide examples of approaches available to analyze these questions. These methods continue to evolve and are being further refined through their application in studies such as this one.

1.4.1 Attribution of Market Effects to DSM Programs

There are three basic methods that can be used to assess the extent to which efficiency programs contributed to changes in the market. These are:

Self-reports. In this method, information is collected from end users and other market actors concerning their motives for adopting or promoting energy-efficient products and services. This can be accomplished through tightly structured survey questionnaires for large samples or in-depth interviews of smaller samples. Both approaches have been implemented successfully. In applying this approach, it is important to look for corroboration of attribution from different groups of market actors. For example, if manufacturers report that they increased volumes of efficient equipment production in response to opportunities created by utility programs, and we receive contemporaneous reports of increased product availability from distributors and customers in the program area, then we can assign greater weight to the manufacturers' attribution of program influence.

Cross-sectional comparison. This method involves comparison of the behavior of market actors who have been affected by the programs in question to the behavior of market actors who have not been exposed to any efficiency programs. To the extent that indicators of market effects or changes can be found among market actors in the "program area" but not among those in the "nonprogram" area, these effects may be considered to be attributable to the program. The comparison between program and nonprogram areas can be affected in a number of ways. One is to make a simple comparison of the penetration of efficient measures or practices, based on customer survey data or reports from distributors. Another is to use survey data on measure purchases and customer characteristics from program and nonprogram areas to model the effect of the program using discrete choice analysis. Both of these approaches have been implemented in analyzing the spillover effects of programs to promote commercial lighting.

Time series or historical analysis. Market effects do not really lend themselves to the application of formal time series analysis techniques. Observations of market conditions occur too infrequently, and there are too many variables to be tracked. However, we have found that careful reconstruction and analysis of the chronology of market events can be very useful in assessing the role that efficiency programs have played in market change. The long and relatively stable history of the sponsors' programs and protracted participation of some customers may also provide opportunities to model the effect of past program participation on subsequent decisions to implement efficiency measures with and without rebates.

Application of these methods is complicated by the complexity of the events being analyzed and the multiplicity of influences on market actors. For example, it is difficult to disentangle the effects of the programs offered by the large California utilities on manufacturers' decisions since these programs ran in roughly the same time frame and supported much the same measures. Moreover, large C&I lighting programs were operated by many other utilities in the same time frame. There were also revisions to professional lighting standards and the lighting portions of state building codes during the time period. In the face of such complications, we have found that it is best to use evidence generated from a number of sources and qualitative as well as quantitative methods to create a balanced assessment of the effects of one utility's programs. We have found that arraying time line information on a number of potential market influences can help analysts sort out the relationships between various events and trends.

1.4.2 Identifying Lasting Effects

Because markets are dynamic, there are few guarantees that changes in manufacturer, retailer, or customer adoption of efficient technologies will persist. However, from related work, we have identified some conditions that suggest that market effects of energy-efficient programs will continue. These include:

- *Reductions in incremental production costs.* If the incremental costs of an efficient measure decrease from levels that initially resulted in economic performance that was well over end-users' thresholds, to levels that are below such thresholds for large fractions of the market, such changes are likely to be sustainable because of the positive feedback relationships involved. (That is, when incremental costs drop below economic thresholds for the majority of customers, the resulting increase in demand is likely to produce capacity and production increases that result in economies of scale, reducing production costs further. This kind of positive feedback loop can result in a "take-off" effect for the new product.)
- *Changes in customers' investment criteria and decision-making processes.* The flip side of the discussion in the paragraph above is that if end users change their economic thresholds (e.g., increase acceptable payback periods or decrease required ROIs) to levels that result in an increase in the number of cases in which the efficient measure passes the required threshold, then a positive and self-sustaining feedback mechanism may be initiated. This is accomplished via the reduced production costs resulting from the economies of scale generated by the increased customer demand.
- *User benefits in addition to energy savings*. For example, variable speed drives achieved fairly rapid penetration despite high first costs during the introduction stage of product development. Among the reasons for this growth was the added precision of control VSDs provided in manufacturing applications.
- *Manufacturer investment in specialized production capacity.* Retooling lines to build a new model refrigerator or compact fluorescent lamp is immensely expensive. For example, at a recent conference, a representative of Maytag reported that it took sales of

at least 50,000 units to amortize the costs of retooling. Thus, once manufacturers make an investment in a new plant, they are likely to support its product.

- *Adoption of energy efficiency as a competitive strategy.* In some segments of the lighting industry, we have found that competitors use the offer of efficient lighting to gain temporary advantage over their competitors. To the extent that the use or specification of efficient equipment becomes standard practice in a design or contracting market, an individual competitor risks loss of market share and may incur higher inventory costs by offering lower-efficiency products.

1.5 MARKET EFFECT HYPOTHESES AND RESEARCH METHODS EMPLOYED

We present in Table 1-2 a summary of the hypotheses we examined with regard to the market effects of the sponsors' programs to promote efficient fluorescent lamps, ballasts, and fixtures. Also presented in Table 1-2 are market effects indicators related to each hypothesis that we investigated through data collection and/or synthesis of past data collection efforts. The columns to the right indicate the data sources that we utilized to develop the market effects indicators. A number 1 in the right hand columns indicates that the data source was a principal source of information for our analysis. A number 2 indicates that the data were supplementary. An "**x**" in the column labeled "Other Research" indicates that we have utilized sources of information for the relevant indicators from previous research or secondary sources (e.g., CADMAC Measure Cost Studies).

The following paragraphs discuss our rationale for the priority and research methods assigned to each of the listed hypotheses.

1.5.1 Effects on Manufacturers

1. Utility efficiency programs accelerated manufacturers' investment in the development of improved products. The history of the market penetration of electronic ballasts and T-8 lamps suggests a strong role for utility incentive programs in the transformation of these markets. The electronic ballast was developed by manufacturers in the late 1970s and commercialized in the early 1980s. Due to high prices and technical problems, sales languished. The market penetration of electronic ballasts in 1988, at the beginning of large-scale DSM rebate activity, was 2 percent nationwide. Market penetration increased to 23 percent in 1993, to over 33 percent in 1995, and has now reached roughly 50 percent. Through the early 1990s, utility programs subsidized the sale of over 60 percent of all electronic ballasts. Similar patterns are evident in T-8 lamps. The key questions here concern the persistence of these gains in the face of reduced levels of utility incentives and development of a better understanding of the exact mechanisms by which these products successfully penetrated the market.

2. Utility programs contributed to manufacturers' decisions to increase production of efficient products. This second hypothesis is closely related to the first. Similar kinds of research will be used to test this hypothesis. In particular, we will examine the relative timing of program changes and changes in manufacturer product shipments.

3. Utility programs contributed to decreases in equipment prices. This hypothesis is derived from product life-cycle theories, which posit that manufacturers will intensify price competition as products mature and reduce production costs via economies of scale. Viewed in another way, the theory suggests that manufacturers will only engage in stiff price competition if the product is mature: It has a well-established market, product development costs have been amortized, and production has been rationalized. Incremental prices have indeed decreased between 1994 and 1996, as we shall illustrate in Section 7. The key questions to be addressed in this study focus on manufacturer and distributor motivations for lowering prices and the durability of the reduced incremental prices at the wholesale and retail levels.

4. Programs affected regional promotion of efficient lighting to retailers, distributors, and customers. This hypothesis is based on the logical premise that manufacturers would seek to market their high-efficiency products more intensively in regions in which utility programs were also promoting these products. These manufacturer-based promotions may have contributed to other market effects, such as increased promotional practices and knowledge and awareness on the part of downstream vendors and end users.

1.5.2 Effects on Designers

1. Utility programs have influenced changes in standard lighting design practices toward use of more efficient lighting. By providing information and incentives, it may be possible that utility programs induced designers to include more efficient technologies in their plans. Through our interviews, we assessed changes in the adoption of efficient design practices over time in the program area and the perceived impact of utility programs on design practices. We also compared design practices in the program against practices in nonprogram areas.

2. Utility programs have contributed to the perception that competitors and customers are moving toward more efficient lighting products. In our in-depth interviews, we probed designers' perceptions of customer interest in efficient lighting and how this interest has changed over time. We also assessed designers' perceptions about the use of energy efficient lighting designs as a competitive strategy. Perceptions of nonprogram area designers were used for comparison purposes.

3. Utility programs have contributed to changes in standards promulgated by professional groups. We reviewed changes in design standards presented by key professional groups, such as ASHRAE, and compared the timing of these activities to the sponsors' program activities.

Table 1-2
Market Effects Hypotheses & Research Approaches - Efficient Commercial Lighting

Hypotheses	Market Effects Indicators	Manufacturers			Other Bus.		Customers			Other
		Int.	Cat.	Shipt.	Int.	Surv.	Part.	Non.	NoP.	Research
MANUFACTURERS										
1. *Accelerate development of improved products.*	• Changes in quality and reliability of ballasts over time.	1	2		1	1	2	2	2	x
	• Improved fixture aesthetics over time.	2			1		2	2	2	
2. *Accelerate ramp-up of production of efficient equipment.*	• Trends in volume of shipments over time.	1		1						x
	• Priority of utility program activities vs. product standard and other market events in sequence of manufacturer production changes.	1			1					x
3. *Reduce prices.*	• Reduction over time in incremental prices for efficient equipment.	2	1		1	1				x
4. *Increase promotion to retailers, distributors, and end users.*	• Reports and examples of advertising and promotion.	1	1		2					x
	• Trends in promotion to designers and contractors.									

Key to Abbreviations: Int.= in-depth interviews; Cat. = analysis of manufacturers' catalog data; Shipt. = compilation and analysis of manufacturers' or government shipment data; Surv. = structured interviews with a representative sample of 30-90 establishments; Part .= program participants; Non. = program area nonparticipants, NoP. = survey of customers in areas where no utility DSM programs have operated.

Table 1-2, cont.
Market Effects Hypotheses & Research Approaches - Efficient Commercial Lighting

Hypotheses	Market Effects Indicators	Manufacturers Int.	Manufacturers Cat.	Manufacturers Shipt.	Other Bus. Int.	Other Bus. Surv.	Customers Part.	Customers Non.	Customers NoP.	Other Research
DESIGNERS										
1. *Change standard design practices in regard to lighting equipment specification.*	• Change in *standard spec* over time.	2			1		2	2	2	
	• Timing of changes related to utility programs.	2			1					
	• Self-reports on utility program and representative effects.				1					
	• Self-reports of promotion practices in absence of programs.				1					
2. *Perception of changes in practice by competitors and customers.*	• Perceived need to specify efficient products as competitive strategy.				1		2	2	2	
3. *Changes in standards promulgated by professional groups, e.g., ASHRAE*	• Timing of changes compared to program activity.				2		2	2	2	1

Key to Abbreviations: Int. = in-depth interviews; Cat. = analysis of manufacturers' catalog data; Shipt = compilation and analysis of manufacturers' or government shipment data; Surv. = structured interviews with a representative sample of 30-90 establishments; Part. = program participants; Non. = program area nonparticipants, NoP. = survey of customers in areas where no utility DSM programs have operated.

Table 1-2, cont.
Market Effects Hypotheses & Research Approaches - Efficient Commercial Lighting

Hypotheses	Market Effects Indicators	Manufacturers			Other Bus.		Customers			Other
		Int.	Cat.	Shipt.	Int.	Surv.	Part.	Non.	NoP.	Research
CONTRACTORS AND DISTRIBUTORS										
1. *Increase in level of stocking.*	• Change in number and variety of efficient products in stock over time.				2	1	2	2		x
	• Comparison to stocking patterns in nonprogram areas.				1	1			2	x
2. *Increase in independent promotion over time.*	• Perceived need to specify efficient products as competitive strategy.				2	2				
	• Self-reports of promotion practices in absence of programs.				1	1				
3. *Entry of new businesses.*	• Timing of establishment of energy service companies by utilities, distributors, and manufacturers.	2			1	1				
	• Changes in focus of business activities by relevant firms.	2			1	1				

Key to Abbreviations: Int. = in-depth interviews; Cat. = analysis of manufacturers' catalog data; Shipt. = compilation and analysis of manufacturers' or government shipment data; Surv. = structured interviews with a representative sample of 30-90 establishments; Part. = program participants; Non. = program area nonparticipants, NoP. = survey of customers in areas where no utility DSM programs have operated.

Table 1-2, cont.
Market Effects Hypotheses & Research Approaches - Efficient Commercial Lighting

Hypotheses	Market Effects Indicators	Manufacturers			Other Bus.		Customers			Other
		Int.	Cat.	Shipt.	Int.	Surv.	Part.	Non.	NoP.	Research
CUSTOMERS										
1. *Increased adoption of efficient lighting components.*	• Customer reports of purchases and installations.	2		1			1	1	1	**x**
	• Distributor reports of market penetration of efficient components.			2	1	1				**x**
2. *Increase in awareness and knowledge of the product.*	• Customer reports of awareness before and after program offerings.						1	1	1	
	• Supply-side actor observations of customer awareness.	2			2	2				
3. *Reduced perceptions of first cost as barrier to use.*	• Customer self-reports of program effects.	2					1	1	1	
4. Increased resources and procedures to evaluate opportunities provided by efficient lighting.	• Self-reports on use of investment criteria, adoption of purchase policies, and designation of energy managers.						1	1	1	
GOVERNMENT										
1. *Change building codes to stimulate the use of efficient technologies.*	• Changes in Title 24 to require the use of fluorescent fixtures in certain locations.	2			1		2	2		**x**
	• Changes in Title 24 allowed lighting power densities.				1		2	2		
2. *Change in local building code enforcement.*	• Increased calculation of power densities in permit approval.				1		2	2		**x**
	• Proactive recommendation of efficiency measures to help applicants meet requirements.				1		2	2		

Key to Abbreviations: Int. = in-depth interviews; Cat. = analysis of manufacturers' catalog data; Shipt. = compilation and analysis of manufacturers' or government shipment data; Surv. = structured interviews with a representative sample of 30-90 establishments; Part. = program participants; Non. = program area nonparticipants, NoP. = survey of customers in areas where no utility DSM programs have operated.

1.5.3 Effects on Contractors and Distributors

1. Utility programs have led to an increase in the number and variety of efficient products stocked in the program areas. To test this hypothesis, we developed data on stocking patterns within the sponsors' areas over time and in comparison to nonprogram areas.

2. Experience with efficient lighting gained through utility programs has encouraged contractors/distributors to undertake independent promotions of the product. We assessed this hypothesis through our surveys of contractors and distributors.

3. Utility programs have led to the entry of new businesses emphasizing efficient lighting technologies. ESCOs or other entities may increase their presence in an area in order to take advantage of program rebates. In interviews with ESCOs and lighting maintenance contractors, we explored the continued viability of this strategy and plans for continued incorporation of lighting retrofits into their projects.

1.5.4 Effects on Customers

We tested the following hypotheses in regard to the effects of the sponsors' programs on the demand side of the market.

1. ***The sponsors' programs led to net increases in purchases of efficient fluorescent equipment.*** We assessed the net effect of the sponsors' programs on purchases of efficient equipment in their service territories through comparisons of market share of electronic ballasts and T-8 lamps between the program areas and nonprogram areas. We also referred to program impact evaluation studies conducted by the sponsors to corroborate estimates of net effects.
2. ***The sponsors' programs increased customer awareness of efficient fluorescent components as well as their knowledge of the full range of product benefits (longer useful life, reduced lumen degradation, lower maintenance costs).*** We tested these hypotheses primarily by comparing the ability of program participants, nonparticipants, and nonprogram area customers to identify product benefits. We also used self-reports of program effects to assess this hypothesis.
3. ***The sponsors' programs reduced customers' perceptions of higher first cost as a barrier to efficient measure adoption.*** This hypothesis was explored through questions to program area customers regarding criteria applied to lighting purchases and reasons for not purchasing efficient components. Distributor, designer, and contractor interviews corroborated the results of the customer surveys.
4. ***The sponsors' programs induced customers to increase adopt procedures and establish resources to evaluate and implement lighting efficiency improvements.*** Specifically, we assessed the association among program participation, presence of energy managers and efficient purchase policies, and adoption of efficient components using the results of the customer surveys.

Information used to characterize customers in terms of decision processes, product knowledge, satisfaction, and product awareness was collected through the customer surveys. See Section 9 for more detail on sampling and data collection approaches.

1.5.5 Effects on Government

The key hypotheses regarding program effects on government involve increased stringency of energy codes and the increased enforcement of codes.

1. ***Utility programs have helped influence changes in standards toward more efficient technologies.***
2. ***Utility programs have influenced changes in building code enforcement to include energy components.***

Government entities and industry experts were interviewed to explore the impacts of utility programs on the institution of more stringent commercial lighting standards (e.g., lower LPD levels for Title 24). Local governments were queried on potential changes in the enforcement of energy-efficient components of building codes and their overall ability to provide applicants with product recommendations to meet code.

1.6 DATA COLLECTION SUMMARY

In this subsection, we present a brief summary of the numbers and types of interviews conducted for this study. More detailed discussions of the sampling methodologies and dispositions of these surveys is provided in Section 9 of this report. As part of the research conducted for the study, we conducted 866 end-user surveys and 273 supply-side and other market actor and expert interviews. A summary of the total number of interviews with supply-side and government actors is displayed in the table below. Our objective in this study was to conduct large enough samples of supply-side actor interviews so as to provide a more quantitative basis for conclusions than has been true in most previous studies of commercial lighting programs, while maintaining an in-depth focus on most of the interviews and the direct involvement in the survey process of a trained energy analyst. All of the supply-side and government surveys were conducted by in-house staff at XENERGY and Easton Consultants, except for 90 distributor surveys, which were conducted over the telephone by a market research house. The phone house-based distributor surveys were designed to complement the in-depth distributor surveys by providing a larger quantitative basis for a shortened subset of close-ended questions. Approximately 10 percent of the in-depth interviews were also conducted in person with the respondents.

Table 1-3
Summary of Supply-Side, Government, and Expert Interviews Conducted

Supplier Type	Program	Nonprogram	National/State	Total
Distributors - In depth	18	--		18
Distributors - Phone-house	60	30		90
Designers	57	25		82
Installers	30	8		38
Manufacturers	--	--	20	20
Government & Others	--	--	25	25
Total	165	63	45	273

A total of 579 surveys were completed in the program area (303 PG&E and 276 SDG&E) and 287 completed in the nonprogram area. A breakdown of the number of end-user surveys completed by area, business type, and size is provided in the table below. In addition, 10 in-depth interviews were conducted with Real Estate Investment Management firms (REIMs), which manage commercial property on behalf of owners. We also completed 10 in-depth interviews with facilities managers for chain retailers.

Table 1-4
End-User Sample Achieved by Area and Business Type

	Office	Retail	Grocery	Rest	Health	Lodging	Education	Wholesale	Other	Misc.
PG&E										
Small	23	19	3	5	5	5	10	10	7	5
Medium	20	23	2	2	6	4	17	12	7	9
Large	23	19	6	3	7	5	13	13	11	9
SDG&E										
Small	22	17	2	3	4	7	23	7	6	8
Medium	22	22	3	2	7	7	17	9	7	11
Large	9	19	2	4	6	5	3	8	6	8
Nonprogram										
Small	16	15	4	3	4	6	9	14	8	5
Medium	16	19	3	2	7	6	11	28	8	5
Large	19	16	3	3	8	6	11	19	8	5

1.7 GUIDE TO THIS REPORT

The remaining sections of this report are organized as follows:

- ***Section 2: Market Characterization: End Users*** - In Section 2 we provide a detailed demand-side market characterization. This end-user market characterization is developed from the results of our end-user surveys and includes market size estimation, decision making analyses, development of segments, analysis of market share by market events (retrofit, renovation, remodeling, replacement), and many other analyses.
- ***Section 3: Supply-Side Characterization*** - In this section we present a detailed supply-side market characterization based on results from our manufacturer, distributor, designer, and installer interviews. This section characterizes the relationships between supply-side actors, develops a variety of major market actor subsegments, and analyzes the business models of each of the entities.
- ***Section 4: Market Interventions: Utility Programs and Government Standards*** - In this section, a more exhaustive presentation of PG&E's and SDG&E's program activities is provided, as well as a presentation of government code and enforcement activities related to California's commercial lighting market.
- ***Section 5: Overview of Market Effects Analyses*** - This section constitutes a concise overview of our analysis of the effects of the sponsors' programs on their local and national markets for efficient fluorescent lighting components. It serves as a framework for the detailed reports of research results presented in Sections 6 and 7.
- ***Section 6: Demand-Side Market Effects*** - This section contains detailed primary research results and analyses related to *demand-side* market effects, program attribution, and durability.
- ***Section 7: Supply-Side Market Effects*** - This section presents detailed primary research results and analyses related to *supply-side* market effects, program attribution, and durability.
- ***Section 8: Lessons Learned and Recommendations*** - This section draws implications from the research findings for the design of continuing programs to promote efficient fluorescent lighting in the commercial sector.
- ***Section 9: Sampling Methods*** - This section provides details on the sampling methods employed for this study, as well as the processes for contacting respondents and discussions of the sample dispositions.
- ***Section 10*****:** ***Sources*** - This is a list of written sources and key informants used in this study.
- ***Appendix A: Survey Instruments*** and **Appendix B: Estimates of Sponsors' Market Size** - These are provided under separate cover in Volume II: Appendices.

2

MARKET CHARACTERIZATION: END USERS

2.1 INTRODUCTION

This section presents a detailed profile of the demand side of the commercial market for 4-foot fluorescent lighting equipment in the San Diego and Pacific Gas & Electric service territories. It is intended to serve as a baseline against which to assess the market effects of the sponsors' commercial lighting programs. We focus on the following sets of market characteristics:

- ***Market Size and Customer Characteristics***
  - Number of establishments and their distribution by basic characteristics: size, use, tenure arrangements, responsibility for electric bill, and lighting-related electric usage.
  - The number of 4-foot fluorescent fixtures, ballasts, and lamps in use in commercial buildings in the San Diego and Pacific Gas & Electric service territories, and the distribution of this stock in place among building types.
  - The volume of annual purchases of 4-foot fluorescent lighting equipment by commercial customers in the sponsors' territories.
  - The relative share of the market accounted for by the principal purchase events: new construction, remodeling, renovation, retrofit, and replacement.
- ***Saturation and Penetration of Efficient Technologies***
  - The percentage of the stock of fluorescent equipment accounted for by efficient technologies: electronic ballasts, T-8 lamps, and 2-lamp fixtures.
  - The percentage of current annual sales accounted for by efficient equipment.
- ***Market Segmentation***
  - Identification of groups of establishments (market segments) that share motivations and disincentives to the purchase and use of efficient fluorescent lighting equipment.
  - Examination of the behavior of the proposed segments in terms of the purchase of efficient fluorescent lighting equipment and other indicators of interest in energy efficiency, such as the adoption of policies to purchase only efficient equipment.

The presentation draws on information and data from a wide variety of sources including:

- Commercial End-Use Studies commissioned by the sponsors.

- Other summaries of customer data provided by the sponsors and by the California Energy Commission (CEC).
- Secondary literature, including a number of studies on the state and national markets for commercial lighting.
- Impact and process evaluations of commercial programs operated by the sponsors, as well as by other California utilities.
- In-depth interviews with supply-side market participants including contractors, designers, distributors, and manufacturers.
- In-depth interviews with key demand-side market actors including representatives of real estate management companies and retail chains.
- The telephone survey of a representative random sample of commercial establishments in the sponsors' service territories.

2.2 MARKET SIZE: STOCKS AND ANNUAL PURCHASES

2.2.1 Floorspace and Stock of Fluorescent Lighting Fixtures

We begin this profile of the market for commercial fluorescent lighting in the sponsors' service area by developing an estimate of the stock of 4-foot fluorescent equipment currently in use. The estimate of the total number of 4-foot fluorescent ballasts and lamps and their distribution among building types is an essential element in many of the analyses that follow. Specifically, we use inventory estimates to integrate the results from customer surveys, which are generally denominated in percentages of total square footage, with information that is denominated in units of equipment – for example, volumes of rebates or manufacturers' shipments.

Floorspace

Virtually all information about energy use in commercial buildings is denominated in square feet of floor space. This is particularly true for lighting; Energy Utilization Indices (EUIs), Lighting Power Densities (LPDs), and lumens per sq. foot are typical summary measures of equipment inventories and end-use energy consumption. Moreover, key lighting-related facility attributes such as LPDs, percentage of lighting wattage provided by fluorescent technologies, and market share of various kinds of fixtures all vary greatly by building type. Therefore, the foundation for the inventory profile is the distribution of building square footage by building type. Table 2-1 displays these figures, both in absolute and percentage terms, for the two sponsor territories and the United States as a whole.

Table 2-1
Distribution of Commercial Floorspace by Building Type

	San Diego Gas & Electric		Pacific Gas & Electric		U.S. (1995)	
Building Type	**mm sq. ft..**	**% of Total**	**mm sq. ft.**	**% of Total**	**mm sq. ft.**	**% of Total**
Office	132.2	29.2%	555.1	29.8%	10,478	18.6%
Retail	86.8	19.2%	256.4	13.8%	12,728	22.6%
Grocery	14.0	3.1%	58.2	3.1%	642	1.1%
Restaurant	16.5	3.7%	56.2	3.0%	1,353	2.4%
Hospitals	29.2	6.5%	63.2	3.4%	2,333	4.1%
Lodging	33.1	7.3%	110.3	5.9%	3,618	6.4%
Education	51.7	11.4%	186.6	10.0%	7,740	13.7%
Wholesale	34.6	7.7%	314.8	16.9%	8,481	15.0%
Other	1.7	0.4%		0.0%	1,004	1.8%
Miscellaneous	53.7	11.9%	263.7	14.1%	8,011	14.2%
Total	452.3	100.0%	1,864.5	100.0%	56,388	100.0%

Sources: San Diego Gas & Electric, Commercial End-Use Study (CEUS) 1992; Pacific Gas & Electric, CEUS, 1997; Energy Information Administration, *Commercial Building Energy Consumption Survey,* 1995; California Energy Commission, *Summary of Floorspace Stock Projections by Building Type.*

Table 2-1 supports the following observations about the sponsors' commercial markets.

- First, the market is very large. It accounts for over 4 percent of total U.S. commercial floorspace and over 40 percent of the California total.
- Percentage of floorspace accounted for by office is substantially higher in the sponsors' territory than in the United States as a whole. The difference is balanced by lower percentages in the retail and education categories. These sectors vary very little in terms of total Lighting Power Density and the market share of fluorescent technologies. Therefore, the difference between the composition of the sponsors' commercial market and the U.S. market in terms of distribution of building type should have little effect on the volume of lighting equipment purchases. See Appendix B for more detailed inventory information.

Stock of Ballasts and Lamps

Table 2-2 shows XENERGY's estimate of the stock of 4-foot ballasts and lamps in place as of 1996 by commercial building type. Altogether, we estimate that there are 22.6 million ballasts in place and roughly 46 million lamps.

Table 2-2
Estimated Stock of Fluorescent Ballasts and Lamps in 1,000s

	SDG&E		PG&E		PROGRAM AREA	
Building Type	# of Ballasts	# of Lamps	# of Ballasts	# of Lamps	# of Ballasts	# of Lamps
Office	1,495	2,989	6,349	12,697	7,843	15,687
Retail	880	1,759	2,084	4,169	2,964	5,928
Grocery	122	243	510	1,019	631	1,262
Restaurant	198	396	479	959	677	1,355
Hospitals	366	732	780	1,559	1,146	2,291
Lodging	57	115	1,643	3,285	1,700	3,400
Education	739	1,478	2,916	5,832	3,655	7,309
Wholesale	201	402	1,279	2,559	1,480	2,961
Other		-		-	-	-
Miscellaneous	749	1,499	1,746	3,493	2,496	4,991
Total	4,806	9,612	17,786	35,572	22,592	45,184

Estimation Method. The estimated number of ballasts in place is the product of the following factors and sources. Unless otherwise noted, we estimated factors by using indicators specific to the service territory and building type.

- ***Square feet of floorspace***. See Table 2-1 above.
- ***Lighting Power Density.*** We used estimates by building type, developed by Heschong Mahone Group and presented in the California Energy Commission's *Lighting Efficiency Technology Report.*[1] We chose to use these statewide figures rather than LPDs contained in the sponsors' *Commercial End-Use Studies* (CEUS) for a number of reasons. First, the most recent CEUS for SDG&E is based on data collected in 1993. We do not believe that these data accurately reflect current market conditions. While the PG&E CEUS study contains more recent data (1996), many of the LPDs for specific building types differed significantly from those contained in contemporaneous studies, and from consensus estimates of industry experts as well. Pending the availability of more detailed information about how these figures were estimated, we prefer to use the LPDs presented in the CEC report.
- ***Fluorescent share of installed lighting capacity.*** Data on the share of total installed lighting accounted for by fluorescent fixtures are provided by building category in the sponsors' CEUS.

[1] Heschong Mahone Group, *Lighting Efficiency Technology Report,* Sacramento, California Energy Commission, May 1997.

- ***Share of fluorescent installed capacity accounted for by 4-foot lamps.*** Data on this point are taken from the SDG&E CEUS.
- ***Average watts per ballast.*** This factor was developed using saturation estimates of magnetic, electro-magnetic, and electronic ballasts by building type presented in the *Lighting Efficiency Technology Report* and estimates of wattage per ballast type using the study *Draft Report on Potential Impact of Possible Energy Efficiency Levels for Fluorescent Lamp Ballasts*, prepared by Lawrence Berkeley National Laboratory.
- ***Number of lamps per ballast.*** Pending better saturation data on the number of lamps driven by electronic ballasts, we assumed two lamps per ballast.

For details about this and other population estimates, see Appendix B.

2.2.2 Annual Purchases of Ballasts and Lamps

XENERGY estimated the average number of ballasts and lamps purchased each year over the past five years by purchase event. Table 2-3 shows the definitions of purchase events used in this report.

Table 2-3
Definitions of Lighting Equipment Purchase Events

Purchase Event	Definition
New Construction	Lighting equipment purchased to fit out new buildings, additions, or total rehabilitation.
Remodeling	Lighting equipment purchased and installed in the process of refurbishing or reconfiguring existing space for new occupants.
Renovation	Lighting equipment purchased and installed in the process of refurbishing occupied space.
Retrofit	Lighting equipment purchased to replace operable equipment in spaces that are not undergoing remodeling or renovation.
Replacement	Lighting equipment purchased to replace failed equipment.

Estimation Method. XENERGY estimated the number of 4-foot fluorescent ballasts and lamps purchased by commercial facilities in the sponsors' territory using the following methods:

- ***New Construction.*** We estimated floorspace added each year as a percentage of stock in place using data provided by the sponsors. We then applied this percentage to the total estimated 1996 stock in place. Data for this estimate came from sponsors' estimates of commercial load additions and forecasts prepared by the California Energy Commission.
- ***Remodeling, Renovation, and Retrofit.*** We estimated the percentage of floorspace that underwent remodeling, renovation, and retrofitting during the period 1992-1997, using the results of the end-user survey. We then multiplied this fraction by the total stock in place and divided by the number of years in the period to arrive at the number of ballasts and lamps bought annually for each of these events.

- ***Replacement.*** We estimated the fraction of ballasts and lamps replaced each year by dividing the total inventory by the useful life of the respective lighting components. The useful ballast and lamp lives were calculated separately for each building type based on the saturation of different technologies (magnetic versus electronic ballasts; Energy Saver versus T-8 lamps) and estimated lighting operating hours.

Table 2-4 shows the results of these calculations. Altogether, we estimate that the sponsors' commercial customers purchase roughly 5 million 4-foot fluorescent ballasts per year and 13 million 4-foot fluorescent lamps. For further details of these calculations and sources for parameter estimates, please refer to Appendix B.

Table 2-4
Average Annual Purchases of 4-foot Fluorescent Ballasts and Lamps in Program Area: 1992-1997 By Purchase Event

	Components Purchased			% of Total Purchases	
Purchase Event	% of Floorspace	# of Ballasts (1,000s)	# of Lamps (1,000s)	Ballasts	Lamps
New Construction	2.9%	655	1,310	13%	10%
Remodeling	0.9%	203	407	4%	3%
Renovation	4.7%	1,062	2,124	21%	16%
Retrofit	5.2%	1,197	2,395	24%	18%
Replacement	n/a	1,966	6,732	39%	52%
Total		5,083	12,968	100%	100%

Table 2-4 also shows the percentage distribution of equipment sales by purchase event. Replacement of failed equipment accounts for 40 percent of ballast sales and half of lamp sales. Renovation and retrofit of existing space accounts for the next largest portion of sales, followed by new construction. Remodeling, in the absence of new construction, appears to happen relatively less frequently than other purchase events.

A note on the precision of market size estimates. Generally, the data sources used to prepare the estimates of market size above are of high quality. Information on square footage of commercial space, lighting inventories, and hours of operation were generally taken from the sponsors' *Commercial Energy Use Surveys*, which use well-constructed probability samples and on-site data collection methods. Average watts per fixture or other components were developed from the most recent and thorough engineering studies on the subject. Volumes of lighting installation activity by event were estimated from our telephone sample of customers, which was based on a stratified probability sample. The 90-percent confidence interval around these last estimates ranges between 3 and 5 percent. (See discussion in Section 6.) Unfortunately, the results from other studies generally are not reported with information on variance.

Despite these omissions, we do have confidence in the estimates of the relative size of the stock and annual purchases of lighting equipment presented above. Our confidence stems from the plausibility of the estimates in light of other data for which Census or accounting type data are available. For example, as discussed in Section 4, we estimate that the sponsors paid rebates on roughly 7 to 8 million electronic ballasts during the study period. This would be on the order of 30 percent of all ballasts purchased in the program areas during the study period. We also have estimates of the penetration of electronic ballasts from a number of sources, including our surveys of distributors and customers. These estimates center around 50 percent. We conclude from these figures that the programs provided rebates on 50 to 60 percent of all electronic ballasts sold in the program areas during the study period, a figure that is consistent with the results of the sponsors' evaluations of individual annual lighting programs, the results of our customer survey, and figures reported in a related commercial lighting study (Quantum, 1998).

2.3 TRENDS IN SATURATION AND PENETRATION OF EFFICIENT TECHNOLOGIES

2.3.1 Trends in Saturation

For purposes of this report, we define saturation as the percentage of connected fluorescent lighting load accounted for by a specific technology such as electronic ballasts or T-8 lamps.[2] Given the long useful life of fluorescent lighting equipment (35,000-40,000 hours for ballasts; roughly half that for lamps), the saturation of efficient fluorescent system components provides a good snapshot of the cumulative effect of equipment purchase over time.

The available sources of facility-level saturation data are described below:

- ***Commercial End-Use Studies (CEUS).*** Both PG&E and SDG&E conduct on-site equipment saturation surveys of large representative samples of commercial customers as part of periodic Commercial End-Use Studies. The data from these surveys are used to support market assessment, planning, and load forecasting. SDG&E most recently conducted CEUS surveys in 1992 and 1994; PG&E in 1993 and 1996. Given their large samples, careful sample design, and on-site data collection methods, the CEUS constitute the most reliable sources of equipment saturation data.
- ***Market Effects End-User Survey.*** The telephone survey of end users conducted for this study asked customers to estimate the current saturation of electronic ballasts, T-8 lamps and 2-lamp fixtures as a percentage of all ballasts, lamps, or fixtures in their facilities. We also asked respondents to estimate the saturation of these items in 1992. Only 50-55 percent of respondents were able to answer these questions, and most were not trained to recognize the various technologies. Moreover, analysis of the responses to saturation

[2] In some cases, survey data are collected and reported as percentages of floorspace or fixtures installed. We note these instances in the text. Given that fluorescent lighting layouts are fairly standardized, there should be some correspondence between saturations given in terms of connected watts, lighted floorspace, and pieces of equipment.

showed that there was a great deal of inconsistency between customers' perceptions and what we would expect, given the results of the CEUS on-site surveys and reliable Census figures on manufacturers' shipments of standard and efficient lighting components. We therefore decided not to use the saturation results of the end-user surveys for this market characterization.

Table 2-5 displays the results of the sponsors' CEUS studies as well as a projection to 1996 based on the results of the customer surveys. Specifically, we used estimates of the volume of lighting-related construction and the share of new installations accounted for by efficient components to adjust the 1994 observations.

Table 2-5
Results of CEUS Studies:
Lighting Equipment Saturations

Year Covered	Source	Area Covered	Customer Type	Saturation	
				Electronic Ballasts	T-8 Lamps
1992	CEUS Study	SDG&E	C&I	6%*	3.9%
1993	CEUS Study	PG&E	C&I	8.4%	7.5%
1994**	CEC, *Lighting Efficiency Technology Report*	SDG&E, SCE, LADWP	C&I	23.6%	23.6%***
1997	XENERGY Projection	SDG&E, PG&E	Commercial Only	51%	51%

* Collected as a percentage of facilities that had electronic ballasts installed.

** As reported in CEC study. Contains data from 1994 CEUS studies by SDG&E, Southern California Edison, and LADWP.

*** Figure includes T-8 lamps driven by electronic and high-efficiency electromagnetic ballasts.

The figures in Table 2-5 show that:

- The estimated current saturation of electronic ballasts and T-8 lamps in the sponsors' territory is around 51 percent.
- The huge growth in saturation from 1992 to 1994 coincides with the period of highest activity for the sponsors' programs. For example, during that period, SDG&E provided rebates for over 821,000 4-foot electronic ballasts. This is equal to 17 percent of the stock, exactly the difference between the 1992 and 1994 saturation.

2.3.2 Trends in Technology Penetration

For this study, we define penetration as the percentage of annual unit sales of ballasts, lamps, or fixtures accounted for by a particular technology (electronic ballasts or T-8 lamps). Table 2-6 shows sources of information on technology penetration by time periods covered, geographic areas covered, and level of aggregation.

Table 2-6
Sources of Technology Penetration Data

Component/Source	Years Covered	Areas Covered	Level of Disaggregation: Technology	Level of Disaggregation: Market Segments	Comments
Fluorescent Ballasts					
U.S. Census, Current Industrial Reports	1991-1997	United States	Type, but not length	No	Based on voluntary reports of shipments from manufacturers. Exports and imports available, but disaggregated by type.
PG&E, Evaluation of Non-Residential New Construction Program	1995	PG&E service territory	Electronic/ Magnetic	New Construction only	Based on on-site observations of samples of participating and nonparticipating customers.
PG&E CIA Evaluation	1992, 1993	PG&E, Comparison	"Efficient/ Standard"	No	Based on self-reports of distributors and contractors.
Market Effects Study, Distributors	1991, 1994, 1997	PG&E, SDG&E, Comparison	Type, 4-ft. only	No	Based on self-reports from a relatively small number of distributors.
Market Effects Study	1992-1997	PG&E, SDG&E, Comparison	Type, 4-ft. only	Yes	Based on self-reports from a large sample of customers.
Fluorescent Lamps					
U.S. Census, Current Industrial Reports	1960s-1994	United States	T-8 category started 199(?)	No	Based on voluntary reporting by manufacturers. Reporting suspended at end of 1994.
PG&E, Evaluation of Non-Residential New Construction Program	1995	PG&E service territory	Electronic/ Magnetic	New Construction only	Based on on-site observations of samples of participating and nonparticipating customers

Results from the Market Effects Distributor Survey

Information from distributors on the penetration of efficient fluorescent lighting technologies may be the most reliable source on this issue, at least for the sponsors' market area. Virtually all fluorescent lighting equipment passes through distributors' warehouses at some point along the chain from manufacturer to end-use customer. While it is not possible to gain documentary verification of the self-reports, tracking product sales is a key part of the distributors' business. The other strength of this source is that distributors' business radius is fairly small – about 30 miles. Thus, establishments located in the sponsors' service territories are likely to serve primarily the sponsors' customers.

The results of the distributor survey are discussed in greater detail in Section 3. Table 2-7 presents a summary of these findings to support discussion of penetration findings from the Customer Survey and other sources. Table 2-7 displays the average market share of efficient components in the years shown from a representative sample of more than 70 distributors in the sponsors' territories.

Table 2-7
Estimation of Efficient Technology Penetration:
Results of Distributor Survey: Program Area (Sponsors' Territories)

Technology	Current	1994	1991
Electronic Ballasts	55%	29%	17%
T-8 Lamps	51%	27%	11%
Efficient Luminaires	42%	20%	8%

Results from the Market Effects Customer Survey

To support estimates of the penetration of efficient technologies, respondents to the customer survey were asked the following sequence of questions:

- Had the facility undertaken build-outs of new space and remodeling, renovation, or retrofit projects involving the installation or replacement of fluorescent lighting systems over the past five years?

  Then, for each kind of project undertaken:

  - How many such projects had been completed in the past five years?
  - What portion of the facility's floorspace had been affected by the projects?[3]
  - Had electronic ballasts, T-8 lamps, or 2-lamp fixtures been used in these projects?

[3] For build-out of new construction and remodeling upon first occupancy, we assumed that the customer's entire space was remodeled.

- If so, in what year were these devices first used?

With this information in hand, we estimated the following:

1. Percentage of total floorspace that was first built-out or experienced remodeling, renovation, or retrofit over the six-year study period, 1992-1997.
2. Percentage of floorspace that was equipped with the efficient technologies.

Penetration was then estimated as the ratio of the second quantity above the first. Responses for individual sample facilities were weighted using a floorspace estimate calculated by multiplying the reported number of employees at the facility by a floorspace per employee factor derived from the Energy Information Administration's Commercial Building Energy Consumption Survey (CBECS).

This method was adapted to the replacement situation. We asked respondents whether they made a practice of replacing magnetic ballasts with electronic ballasts and T-8s upon failure of the ballast. We used the floorspace-weighted percentage of customers who answered yes to this question as the penetration estimate for T-8s and electronic ballasts in replacement of failed equipment. We did not estimate a replacement penetration for fixtures, since the concept of a useful life for fixtures cannot be consistently applied. Rather, projects that result in replacement of fixtures are counted in the renovation and retrofit categories. Because the level of remodeling activity, as defined above, was very small, we decided to combine reports of remodeling with build-outs of new construction to estimate penetration of efficient equipment, as well as for other aspects of the analysis.

Table 2-8 displays the results of the calculations described above. It shows the estimated penetration or market share of electronic ballasts, T-8 lamps, and 2-lamp fixtures by purchase event. The table shows one somewhat counter-intuitive pattern: the share of efficient components is somewhat lower in the new construction segment. Market observers have generally believed that the penetration of efficient components would be highest in new construction and remodeling versus other types of purchase events. The theory is that the incremental costs of using efficient components is lower in new construction than in other situations, given the opportunity for volume purchasing and the absence of complications due to existing circuitry and fixtures. Also, it was assumed that designers and electrical engineers are more frequently involved with new construction than with renovation or remodeling, and that these professionals are more likely to specify efficient components than contractors involved with renovation and remodeling. However, because our customer survey was not targeted at new construction, it is difficult to draw final conclusions from these self-reported data.

Looking at the relationship of new construction to non-new construction activity from the perspective of PG&E's programs we note the following. Approximately, 28 percent of the roughly 5 million ballasts that PG&E rebated during the study period occurred in new construction (see Table 4-1). The split for SDG&E was roughly the same. As a percentage of all ballast purchases in new construction (based on Table 2-4), this represents roughly over half.

Table 2-8
Penetration of Efficient Technologies by Event
1992-1997/Program Area

Event/Technology	% Efficient of all Category Purchases
New Construction/Remodeling	
Electronic Ballasts	37.8%
T-8 Lamps	17.3%
2-lamp Fixtures	47.9%
Renovation	
Electronic Ballasts	53.7%
T-8 Lamps	51.2%
2-lamp Fixtures	54.5%
Retrofit	
Electronic Ballasts	47.5%
T-8 Lamps	46.7%
2-lamp Fixtures	46.9%
Replacement	
Electronic Ballasts/T-8s	31.2%

Efficiency program designers have assumed for some time that the turnover of occupants gives rise to a "naturally-occurring" or "market driven" opportunity to affect lighting equipment choices. However, we found that:

- Only 39 percent of customers who moved into their current facilities during the study period reported that they remodeled the facilities.
- Only 20 percent who moved reported that they replaced or installed new fluorescent lighting fixtures.

We conclude from these findings that turnover of space does not necessarily imply the purchase and installation of new lighting equipment.

Table 2-9 summarizes the information presented in Table 2-8 by technology and compares it to current penetration estimated from distributors' reports. We calculated the overall penetration for the three technologies by weighting the efficient market shares for each of the events – remodeling, renovation, retrofit, and replacement – according to the share of total annual sales represented by each event (see Table 2-4). The end-user survey yields estimates of efficient technology penetration that are very similar to those found through the analysis of the distributor survey. One would expect to find the pattern observed in Table 2-9: namely, the penetration estimates from the results of the end-user survey, which cover the period 1992-1997, are slightly lower than those from the distributor survey for the current year (1997).

Table 2-9
Comparison of Penetration Findings/Program Area
End-User Reports 1992-1997 vs. Distributor Estimates 1997

Technology	End User Survey	Distributor Survey '97	Distributor Survey '94	Distributor Survey '91
Electronic Ballasts	47%	55%	29%	17%
T-8 Lamps	49%	51%	27%	11%
2-lamp Fixtures	50%	42%	20%	8%

2.4 END-USER MARKET SEGMENTATION

A great deal of research, as well as common sense, suggests that end-use customers vary a great deal in terms of their disposition towards energy efficiency and the purchase of energy-efficient products. This variation will be reflected in their response to programs designed to promote energy-efficient products. A serviceable market segmentation scheme that classifies customers as to their likelihood to use energy-efficient lighting is essential to an understanding of the workings of the market and the market effects of the sponsors' programs. In the paragraphs below, we describe the market segments we uncovered through analysis of the customer surveys and discuss the differences between those segments in terms of the adoption of efficient fluorescent lighting technologies and related practices.

2.4.1 Introduction and Definitions

For purposes of this report, we define market segments as groups of end-use customers who:

- Resemble each other in terms of their likelihood to purchase efficient fluorescent lighting equipment.
- Experience similar motivations and barriers to purchasing efficient fluorescent lighting equipment.
- Are distinguished by attributes such as size, energy use, building type, and tenure, which are readily identifiable by the sponsors.

For the sake of practicality, we also attempted to limit the number of segments to a manageable amount – no more than six.

We looked at a number of segmentation schemes and evaluated them in terms of the difference between segments on key indicators of acceptance of efficient technology and related behavior. These included purchase decision-making criteria and energy management staffing as well as saturation and purchase of efficient technologies. We found that the segmentation scheme shown in Table 2-10 provided the cleanest picture of the complex array of end users.

Table 2-10
Description of End-User Segments

Segment	Dun & Bradstreet Assigned SICs	Respondent's Description of Use	Tenure	Single/Multiple Locations
1. Office/Owner	Health, Misc., Office, Retail, Wholesale	Office	Own Part or All of Space	All
2. Office/Leased	Health, Misc., Office, Retail, Wholesale	Office	Lease or Don't Know	All
3. Retail/Sole	Grocery, Office, Restaurant, Retail, Wholesale	Retail, Food Sales/Service Restaurant	All	Sole Location
4. Retail/Multisite	Grocery, Office, Restaurant, Retail, Wholesale	Retail, Food Sales/Service Restaurant	All	Headquarters, Branch locations, Franchise
5. Institutional	Education, Health, Lodging, Misc., Office	College and Post-secondary, Primary or Secondary, Hospital, Restaurant, Religious, Government	All	All
6. Other	Wholesale, Other	Warehouse, Other	All	All

Qualitatively, our approach to segmentation was based on information received from supply-side actors in this and previous studies. We also made use of the market barrier framework put forward by Eto, Schlegel, and Prahl.[4] Basically, we attempted to capture the variation among commercial customers in their motivations and abilities to identify, value, and capture the benefits offered by efficient commercial lighting equipment in a few manageable market segments. Previous work in this area identified the following customer attributes as the most important for segmentation.

- ***Facility Ownership.*** Customers who own their facilities are more likely to be able to capture the full benefits of lighting system improvements – energy savings, capital appreciation, and deductions for equipment depreciation – than customers who lease their space. That is, the barrier of split incentives will not affect owner-occupants to the extent it does renters.

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

- ***Single- versus Multifacility Organizations.*** The larger the number of facilities an organization occupies, the more need it has of a facilities management department. Once the facilities management function is established, the organization has a formal area to which energy management activities can be assigned on an ongoing basis. These activities include gathering information on the advantages of various kinds of equipment and applying this information to equipment purchase decisions. Thus, multiple facilities under management of one customer or entity may indicate the presence of the organizational infrastructure needed to develop and implement energy efficiency initiatives.
- ***Size.*** Size is an important segmentation for a number of reasons. First, it is related to the ownership and single/multiple facility dimensions. Second, above a certain level, we would hypothesize that size, in and of itself, would be related to the amount of attention that customers pay to lighting efficient equipment. Finally, utilities have size-related data (energy usage) for all customers.
- ***Building Use.*** We know from work on the New England Market Effects Study and interviews with supply-side market actors that the priority of customer concerns in regard to lighting vary with building use. In particular, retailers are concerned with the appearance of lighting fixtures in the merchandising areas and quality of light they provide. In some cases, these concerns can override economic factors. In offices, customers generally believe that lighting has less of a direct impact on the operations underway.

2.4.2 Basic Characteristics of the Market Segments

Table 2-11 shows the estimated distribution of establishments and floorspace across our proposed market segments. We estimated the distribution of establishments by calculating the percentage of total population sampling weights represented by the establishments assigned to each segment. We estimated the floorspace distribution by calculating a floorspace estimate for each sample observation. The floorspace estimate for each sample establishment was calculated as the product of the following factors:

- Reported number of full-time-equivalent employees.
- Square footage per full-time-equivalent employee (this factor was developed from CBECS data for each facility type).
- Reported percentage of facility floorspace lighted by fluorescent equipment.[5]

[5] We did ask respondents for the square footage of their facilities in the customer survey. However, nonresponse for this item was around 40 percent, and many of the answers we got did not make sense given other information about the facility. Given the importance of this scaling factor in virtually all of the calculations, we decided to use a factor based on reported number of employees. Nonresponse on this item was less than 10 percent, and its behavior was less erratic than the self-reported square footage.

The sample population weights were then applied to this factor in estimating percentage distributions. Table 2-11 shows that the distribution of floorspace in the sample closely resembles the distribution of fluorescent-lit floorspace, which differs significantly from the floorspace distribution shown in Table 2-1 (based on the sponsors' customer research). The major divergence comes in percentage of weighted lit space in the institutional segment, especially in the San Diego service territory. This result probably occurred due to the high concentration of federal government and military facilities in and around San Diego. Utility studies do not distinguish government from private sector offices and warehouses. This may account for the large relative size of the institutional segment.

Table 2-11
Relative Size of Market Segments

	PG&E		SDG&E		PROGRAM AREA	
Sector	Percent of Estab's.	Percent of Floorspace	Percent of Estab's.	Percent of Floorspace	Percent of Estab's.	Percent of Floorspace
1. Office/Owner	18%	9%	11%	5%	17%	8%
2. Office/Leased	14%	26%	27%	6%	17%	22%
3. Retail/Sole	30%	8%	29%	4%	29%	7%
4. Retail/Multisite	10%	8%	8%	8%	8%	8%
5. Institutional	14%	34%	9%	71%	14%	43%
6. Other	14%	14%	17%	5%	15%	12%
Total	100%	100%	100%	100%	100%	100%

Table 2-12 shows the relationship among size, tenure, and market segment. Table 2-13 shows the relationship between size, segment, and single/multiple site ownership. The tables show that:

- Owner-occupied facilities are generally much larger than leased facilities.
- Sites occupied by multifacility organizations are larger than those occupied by single-facility organizations.
- As a group, institutional facilities are by far the largest among all other segments.

Table 2-12
Average Facility Size by Segment and Tenure/Program Area

Market Segment	Form of Tenure		
	Own	Lease	Own and Lease Some
1 Office/Corp. Own	147,578	n/a	33,713
2 Office/Lease	n/a	50,408	n/a
3 Retail/Sole	12,976	16,510	1,957
4 Retail/Chain	40,917	36,715	138,932
5 Institutional	551,184	152,650	1,476,525
6 Other	157,310	76,459	4,259
All Segments	322,874	53,247	700,216

Table 2-13
Average Facility Size by Segment and Single/Multiple Sites/Program Area

Market Segment	Only Location	Franchise Location	Headquarters Location	Branch Location	All Facilities
1 Office/Corp. Own	10,099	10,343	372,538	111,759	145,544
2 Office/Lease	28,511	191,509	89,970	24,105	51,432
3 Retail/Sole	15,336	n/a	n/a	n/a	15,336
4 Retail/Chain	n/a	35,027	23,840	49,871	41,373
5 Institutional	123,165	64,321	1,195,125	644,208	509,267
6 Other	32,799	55,098	413,027	76,214	112,285
All Segments	41,363	52,305	474,891	311,972	198,567

2.4.3 The Presence in the Market of Real Estate Investment Management Firms (REIMS) and Chain Retailers

REIMs

Real Estate Investment Management firms, or REIMs, manage commercial property on behalf of owners. Until recently, most of these companies managed leased real estate for absentee owners. However, as part of the “outsourcing” trend, a number of ventures have arisen to manage real estate on behalf of owner occupants, substituting contractors for facilities management staff. For example, the Marriott Corporation has developed an entire division that manages institutional properties on behalf of hospitals and universities.

REIMs compete heavily with each other for building owners' business, and boosting the profitability of leased properties is the primary dimension in which competition occurs. According to all but one of the 10 REIM representatives interviewed for this project, energy efficiency figures prominently in maintaining building profitability. First, roughly a quarter of leased office space is master metered. Tenants in these spaces pay a prorated portion of total building operating spaces in addition to their lease rates. To the extent that REIMs can contain energy costs, the buildings become more attractive to prospective tenants. In fact, nine of the 10 REIMS interviewed rated control of energy costs as very important in attracting and retaining tenants. Second, all of the REIMs interviewed reported that they thought the appearance of lighting equipment was very important in attracting and retaining tenants. Nine of the 10 REIMs interviewed had participated in the sponsors' energy-efficiency programs, most had established policies to purchase efficient lighting equipment, and several displayed a sophisticated knowledge of lighting equipment energy consumption and performance. Finally, most of the REIMs interviewed, especially larger organizations with major office accounts, reported that they offered tenants no choice in selection of fluorescent lighting equipment.

Clearly, REIMs display a distinctive approach to decision making regarding lighting equipment selection. Thus, facilities that are managed by REIMs constitute an important group that cuts across the six market segments described earlier. We used the results of the customer survey to estimate the portion of each market segment under REIM management. Table 2-15 shows the floorspace weighted distribution of the sample by segment and tenure. If we assume that most of the respondents who reported not knowing whether they leased or owned the space were tenants, Table 2-15 suggests that commercial space is fairly evenly split between owner-occupied and leased space. Only in the institutional sector is the space predominantly owner-occupied.

Table 2-14
Distribution of Commercial Floorspace by Tenure/Program Area

Market Segment	Own	Lease	Own But Lease Part of Facility	Don't Know
1 Office/Corp. Own	96.6%	0.0%	3.4%	0.0%
2 Office/Lease	0.0%	32.4%	0.0%	67.6%
3 Retail/Sole	28.0%	67.0%	4.9%	0.0%
4 Retail/Chain	23.6%	69.8%	5.6%	1.0%
5 Institutional	78.0%	6.0%	15.5%	0.5%
6 Other	42.6%	57.3%	0.0%	0.0%
All Segments	50.4%	27.0%	7.7%	14.9%

As discussed above, we cannot assume that REIMs make the lighting equipment purchase decisions in all leased space or, for that matter, that owners are the primary decision makers in owner-occupied space. To assess the extent of REIM influence on lighting purchases, we asked all customers "when your organization builds or remodels its facilities, who has the most influence on the selection of lighting equipment?" Table 2-15 displays the responses to this question, weighted by floorspace.

Table 2-15
Most Influential Parties in Lighting Selection Decisions in Percentage of Total Commercial Floorspace/Program Area

Market Segment	Local Staff	Designer Supervised by Local Staff	Corporate or Franchise Facility Staff	Landlord or Landlord's Contractor	Other	Segment Total
1 Office/Corp. Own	3.3%	0.5%	0.5%	3.8%*	0.2%	8.3%
2 Office/Lease	3.2%	1.0%	1.9%	15.3%	0.2%	21.5%
3 Retail/Sole	4.4%	0.0%	1.1%	0.4%	1.5%	7.3%
4 Retail/Chain	1.4%	0.9%	3.8%	1.6%	0.0%	7.8%
5 Institutional	10.5%	2.2%	8.6%	17.7%	3.5%	42.6%
6 Other	5.0%	0.3%	1.3%	4.6%	1.2%	12.3%
All Segments	27.9%	5.0%	17.2%	43.3%	6.5%	100.0%

* Includes facilities in which occupants own a part of the space and lease the remainder.

Overall, respondents who represent 43 percent of the sponsors' total commercial floorspace reported that their landlord or a contractor hired by the landlord exercised the most influence over lighting purchase decisions. Most of this floorspace is concentrated in the leased office and institutional segments. Unfortunately, we could not tell from the responses what percentage of these landlords and contractors could be characterized as REIMs, versus landlords who manage their own properties. Nonetheless, the results summarized in Table 2-16 highlight the importance of landlords and property managers as lighting purchase decision makers.

Chain Retailers

Utility marketing departments and efficiency program managers have operated under the assumption that key accounts – national corporations with central facility management divisions – exercise control over a significant portion of the commercial market. The findings from the customer survey suggest that this generally is not the case. First, as Table 2-16 shows, the portion of floorspace occupied by organizations in the sponsors' territories that also operate in states other than California is small: 3.5 percent overall; 8.9 percent for facilities in the retail/chain segment. Second, as Table 2-15 shows, corporate or franchise facility managers exercise the largest influence on lighting selection in only half of the floorspace in the retail/chain segment. This is less than 4 percent of commercial floorspace overall.

Table 2-16
Percentage of Commercial Floorspace Occupied
by Organizations in the Program Area that Also Operate Outside of California

Market Segment	Percentage of Floorspace in Facilities Occupied by Organizations with Operations Outside California
1 Office/Corp. Own	4.4%
2 Office/Lease	0.7%
3 Retail/Sole	3.2%
4 Retail/Chain	8.9%
5 Institutional	4.1%
6 Other	2.4%
All Segments	3.5%

2.4.4 Comparison of Segments on Indicators of Measure Adoption

Table 2-17 shows that there were clear differences between the market segments in terms of level of construction activity involving lighting during the six-year study period. The institutional segment led the way: Institutional facilities managers reported that over 70 percent of their floorspace underwent some kind of construction involving the installation of fluorescent lighting systems, with virtually all of this activity concentrated in the renovation and retrofit categories. A similar pattern held for leased office space, which had the second-highest level of installation activity. The retail segments showed considerably less activity than the office or institutional segments, with single-facility retail establishments recording only 25 percent of their floorspace affected over the six years. Moreover, in the retail segments, most activity was in new construction and remodeling, as opposed to renovation and retrofit.

Table 2-17
Volume of Remodeling, Renovation, and Retrofit Activity: 1992-1997
As Percentage of Total Floorspace in the Program Area

Market Segment	New Construction/ Remodeling*	Renovation	Retrofit	Percentage of All Space**
1 Office/Owner	11.2%	31.6%	8.4%	51.2%
2 Office/Leased	2.8%	22.5%	39.0%	64.3%
3 Retail/Sole	12.9%	5.5%	6.6%	25.0%
4 Retail/Multisite	19.9%	12.6%	10.9%	43.5%
5 Institutional	1.1%	40.5%	30.7%	72.3%
6 Other	8.9%	11.0%	4.1%	23.9%
All Segments	4.7%	25.9%	28.9%	59.5%

* Calculated as weighted percentage of respondents who reported moving into current space and remodeling since 1991. Assumes 100% of affected space remodeled. Does not include new construction in which customer did *not* participate in lighting decision. This is 2.5-3.0 percent of the stock each year.

** Space in which some kind of construction, renovation, or retrofit activity occurred as a percentage of total space. Assumes no double counting of space affected by different reported events.

Table 2-18 displays the market penetration of efficient equipment in the six market segments and in the overall program area for the six-year study period. The penetrations for each technology and segment were calculated using the same method applied to the population as a whole. Owner-occupied office space showed the highest market share for all three efficient technologies, with electronic ballasts holding a 71 percent market share and T-8 lamps 48 percent, followed by institutional buildings with 53 percent market share for ballasts and 41 percent for lamps. Leased office space also reported high shares for electronic ballasts and T-8s. The market share for efficient components was generally much lower in the retail and “other” segments. The reported market shares for T-8s among the segments closely tracked that of electronic ballasts. The overall distribution of efficient lighting equipment purchases among the segments reflects the general pattern of program participation.

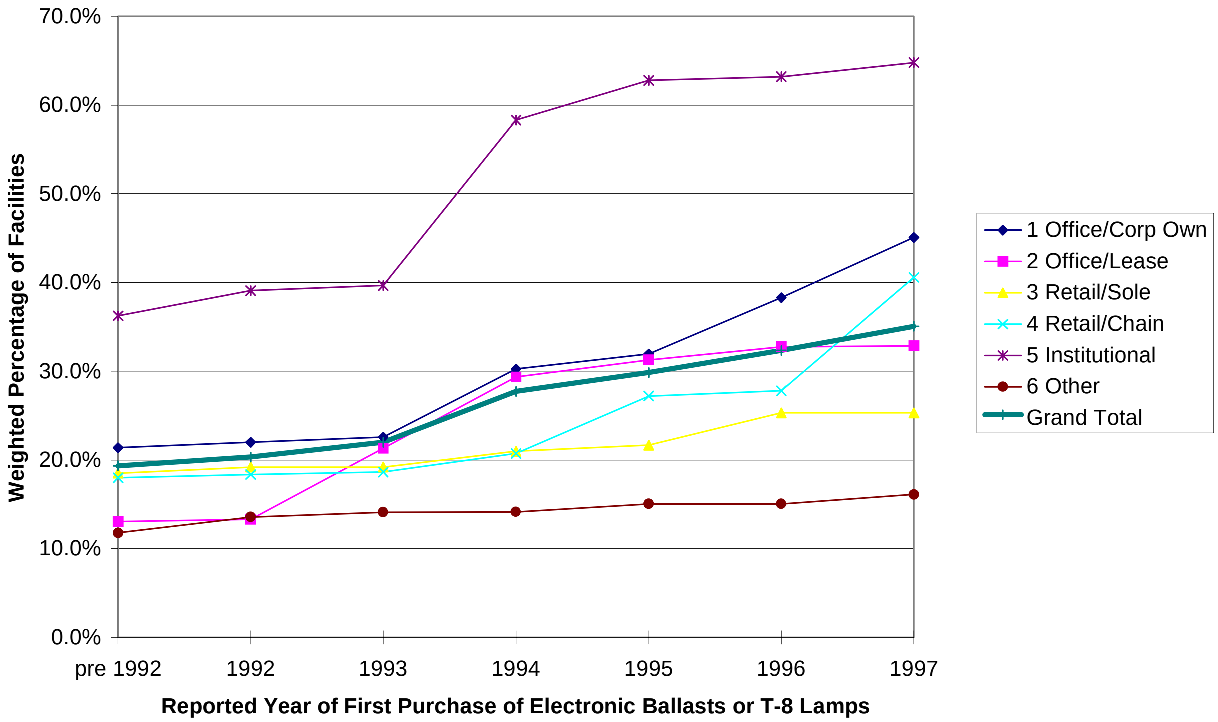
Table 2-18
Penetration of Efficient Technologies: 1992-1997
by Market Segment: All Events/Program Area

Segment	Electronic Ballasts	T-8 Lamps	2-Lamp Fixtures
1 Office/Corp. Own	71%	48%	65%
2 Office/Lease	48%	46%	54%
3 Retail/Sole	25%	16%	29%
4 Retail/Chain	30%	29%	41%
5 Institutional	53%	41%	51%
6 Other	12%	10%	10%
All Segments	47%	41%	50.0%

2.4.5 Comparison of Market Segments: Timing of Efficient Product Adoption

Figure 2-1 displays the cumulative percentage of *establishments* (not floorspace) by segment who had adopted electronic ballasts and T-8s for the first time in the year (or time period) shown on the horizontal axis. From this chart, it is clear that institutional users were both the earliest and most frequent adopters. The chart also shows that the most rapid increase in first adoptions of efficient technologies among virtually all segments coincided with the highest levels of program activity. This is particularly apparent among institutional users. Single-facility retailers and facilities in the "Other" category show relatively low levels of adoption over the six-year study period.

Figure 2-1
Timing of Adoption of Electronic Ballasts and T-8 Lamps by Market Segment
Cumulative Percentage of Facilities by Year of First Adoption



2.4.6 Comparison of Market Segments: Product Knowledge and Purchase Practices

Beyond the actual purchase of energy-efficient equipment, there are many potential indicators of customer interest in and disposition towards investments in energy efficiency. Some of these indicators, such as participation in utility-sponsored energy efficiency programs or the establishment of purchasing policies for efficient lighting equipment refer to actions that are associated with efficient equipment purchases. Others, such as the establishment of an energy management function or office or the use of investment analyses in regard to lighting purchases refer to the development of organizational infrastructure to support ongoing activities to reduce energy costs.

The following paragraphs examine the prevalence of such activities among the sponsors' commercial customers. In particular, we were interested in assessing the extent to which indicators of interest in efficient lighting were associated with actual purchasing behavior. Generally, we found that customer segments with the highest penetration of efficient equipment showed the highest levels of such "proximate" indicators.

Program Participation

Table 2-19 shows the percentage of establishments that reported participation in the sponsors' commercial lighting programs along with the percentage of floorspace they represent.

Table 2-19
Participation in DSM Programs by Market Segment

Market Segment	SDG&E		PG&E	
	% of Establishments	% of Floorspace	% of Establishments	% of Floorspace
1 Office/Corp. Own	4%	36%	19%	58%
2 Office/Lease	11%	15%	29%	89%
3 Retail/Sole	2%	14%	8%	20%
4 Retail/Chain	30%	66%	23%	18%
5 Institutional	67%	95%	44%	82%
6 Other	4%	25%	21%	27%
All Segments	13%	77%	21%	64%

Based on Table 2-19, we observe that:

- Generally, the market segments with high participation rates also showed high penetration of efficient equipment.
- In the San Diego territory, over two-thirds of all institutional facilities reported participating in the programs, and these facilities accounted for 95 percent of the floorspace in the segment. This very high participation rate reflects the level of effort to target federal government, military, and municipal sites. For example, in 1995 program staff aggressively marketed to the Navy and to 200 schools. Participation among institutional users in the PG&E territory was similarly high. As a percentage of establishments, the participation rate was 44 percent; the participation rate was 82 percent as a portion of floorspace.
- The PG&E programs reached an extraordinarily high percentage of office space, and particularly leased office space (89 percent). This record may reflect special outreach efforts towards property management firms through the new construction, custom rebate, and Energy Center elements of PG&E's programs. The office participation rates in the San Diego territory were considerably more modest. Program staff reported that they had encountered difficulties in approaching property management firms due to split incentives and the assignment of lighting equipment selection to the site-level manager.
- The proportion of floorspace encompassed by participating facilities was far higher than the participation rate measured as a percentage of establishments or customers. This result points out the strong correlation of participation with size, which, in turn, is associated with higher motivation and capability to manage energy costs.

Energy Management Personnel and Policies

Table 2-20 shows the population-weighted and floorspace-weighted percentage of customers who reported that they had "assigned the responsibility for controlling energy usage and costs to a specific staff person, group of staff or contractor." The high percentage among institutional customers is part of a consistent pattern of indicators of high interest in energy efficiency and control of energy costs. The high percentage among office lease holders likely reflects the presence of property management firms in this market segment.

Table 2-20
Percentage of Customers with Energy Managers

Market Segment	% of Establishments	% of Floorspace
1 Office/Corp. Own	22%	53%
2 Office/Lease	24%	74%
3 Retail/Sole	21%	30%
4 Retail/Chain	38%	51%
5 Institutional	43%	77%
6 Other	14%	36%
All Segments	25%	67%

Table 2-21 shows the percentage of customers, by establishment and floorspace, who report having established policies to purchase the efficient fluorescent lighting components shown on the top row. The interesting result here is that except in the case of institutional customers, the percentage of establishments with standing policies to purchase efficient fluorescent components is significantly lower than the percentage of establishments with energy managers. These results suggest that, for the most part, users have not established consistent policies to choose efficient components, or that they evaluate these selections on a project-by-project basis.

Table 2-21
Percentage of Customers with Policies
to Purchase Efficient Fluorescent Lighting Equipment

	Electronic Ballasts		T-8 Lamps		2-Lamp Fixtures	
Market Segment	**% of estab.**	**% of sf**	**% of estab.**	**% of sf**	**% of estab.**	**% of sf**
1 Office/Corp. Own	10%	29%	9%	31%	7%	29%
2 Office/Lease	6%	22%	7%	22%	7%	22%
3 Retail/Sole	1%	8%	1%	7%	1%	2%
4 Retail/Chain	25%	14%	16%	12%	2%	10%
5 Institutional	16%	69%	15%	70%	5%	41%
6 Other	1%	7%	1%	6%	1%	7%
All Segments	7%	34%	6%	34%	3%	25%

Table 2-22 shows the percentage of customers by establishment and floorspace who report that they apply investment criteria, such as payback periods or more formal return on investment calculations, to selecting lighting equipment. As a percentage of customers, the prevalence of this practice is low – about 11 percent. As a percentage of floorspace, it is roughly one-third, with high concentrations among institutional and office owner occupants. This would be expected given the strong incentives to energy savings that members of these segments experience.

Customers who reported using such investment criteria were asked, in an open question, to describe the criteria they used. Seventy-five percent of the 83 customers who answered this question reported that they used simple payback as their investment criterion. About one-third of customers who reported using a payback criterion did not specify an acceptable payback period. Among those who did specify an acceptable period, responses ranged fairly evenly from less than two to six years. A sizable portion of customers also named life-cycle cost (or described something very much like it) as the criterion they applied.

Table 2-22
Percentage of Customers Who Apply
Investment Criteria to Lighting Purchases

Segment	% of Establishments	% of Floorspace
1 Office/Corp. Own	19.6%	62.3%
2 Office/Lease	14.2%	24.4%
3 Retail/Sole	3.8%	7.6%
4 Retail/Chain	22.3%	29.8%
5 Institutional	9.1%	56.0%
6 Other	2.3%	11.6%
Total	10.5%	34.0%

2.4.7 Lighting Efficiency Practices and Motivations Among REIMs

As discussed earlier, the representatives of Real Estate Investment Management firms whom we interviewed presented a distinctive profile with regard to energy management and purchase of efficient lighting products. This profile can be summarized as follows.

- Most REIMs that manage leased office space reported that they, as opposed to their tenants, paid electric bills directly. In retail space, it is the tenant who is most often responsible for the electric bills. By way of contrast, our customer survey found that establishments accounting for 75 percent of floorspace in the leased office segment reported paying their own electric bill.
- All but one of the REIMs interviewed reported that they believed that energy efficiency and containment of utility costs (which are passed on to customers through operating assessments) were *very* important to attracting and retaining tenants.
- REIMs reported that they made virtually all lighting equipment design and specification decisions for the properties they manage.
- Finally, the representatives of the REIMs we interviewed were very knowledgeable concerning all aspects of efficient lighting, including relative capital and operating costs, differences in useful life from standard technology, and even differences in the pace of lumen degradation.
- On average, the REIMs reported that they renovate or retrofit about 15 percent of space each year, and replace fluorescent lighting in about 7 percent of space each year.
- Seven of the 10 interviewed report that they have base specifications for electronic ballasts; five of 10 report base specifications for T-8s.
- All rate appearance and quality of fixtures as very important in attracting and retaining tenants; nine rate controlling energy costs very important.
- Nine of the 10 have participated in DSM programs.

3 SUPPLY-SIDE CHARACTERIZATION

3.1 INTRODUCTION

In this section we present our characterization of the supply side of the commercial lighting market. The analysis framework for this characterization utilizes a segmentation scheme that explicates the competitive motivations and dispositions toward energy efficiency of the diverse and numerous market actors that characterize the California market. The purpose of this section is to provide the reader with an understanding of the market structure, the motivations of market actors, and the changes the market has undergone over the past several years. This characterization creates the analytical framework needed to form and support our conclusions made in Section 6 regarding supply-side market effects.

The remainder of this section contains an overview summarizing the supply-side market in aggregate, followed by subsections that characterize each of the segments of the supply chain. The segments examined are:

- Manufacturers.
- Distributors.
- Designers.
- Installers.

Within each of the supply chain subsections, we present:

- A description of the number and types of entities contacted.
- An overview of the market segment.
- A detailed characterization of each subsegment, focusing on motivations, efficiency disposition, and specification influence.

3.2 MARKET OVERVIEW

In this subsection we provide a characterization of the supply-side market in aggregate, which includes a summary of the following aspects of the industry:

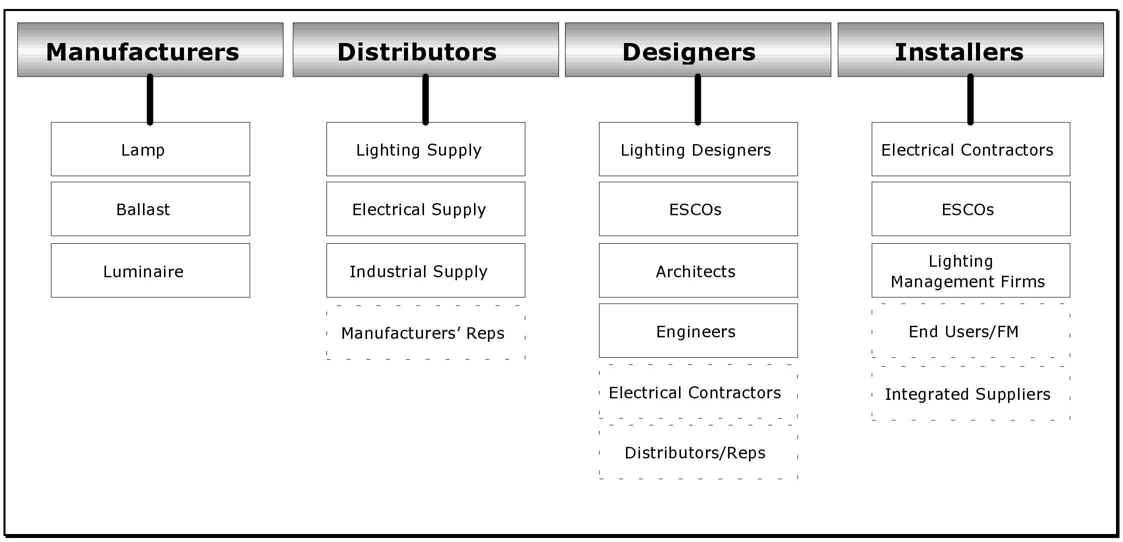
- Market actor segmentation.
- Market influences.
- Product flows and market sizes.

3.2.1 Segmentation

The supply side of the commercial lighting market is characterized by a wide range of business models found along the supply chain. Changes both within the industry as well as through external forces have significantly altered the landscape of the commercial lighting market over the past five years, in California as well as the nation. For a variety of reasons, including rapid technological evolution, changes in utility program funding, and increasing pressures to reduce costs, the changing commercial lighting industry has forced businesses to adapt and seek new markets and submarkets. As a result of the market change and the uncertainty that accompanies it, new business models have evolved, some focusing heavily upon energy efficiency as a tool for boosting revenues. The segments defined in this analysis attempt to account for this variation and diversity.

In order to understand the structure of the supply side of the commercial lighting market, it is important to identify and understand the motivations and dispositions of its component parts. The supply-side analysis contained in this section identifies four primary segments, 13 total subsegments and five quasi-segments that do not clearly fall under the primary segments. Figure 3-1 summarizes the segmentation used in our analysis. A detailed description of each of the subsegments shown in the figure below is contained in the segment subsections following the overview.

Figure 3-1
Supply-Side Segmentation Scheme



The solid boxes represent discrete subsegments that fall under the primary segment identified in the shaded box above it. The broken boxes represent quasi-segments that do not clearly fall under any one segment. For example, the End User/FM (facilities maintenance) subsegment falls under installers; however, they are not a component of the supply side. Nevertheless, since End Users/FMs represent a significant share of the replacement market and, to a lesser degree, the retrofit market, they must be included in an analysis of installation practices. Integrated suppliers span all four segments, but for our analysis (primarily to avoid duplication) we have grouped this subsegment under installers. Another quasi-segment is Manufacturers' Reps. These entities have the function of acting as sales conduits for manufacturers, providing design and layout services as a sales tactic. These firms, whether independent or manufacturer-owned, do not definitively fall under any single primary segment as defined; yet, as described later in this section, they have a significant market presence and therefore merit recognition in the segmentation scheme. Finally, electrical contractors and distributors/reps fall under the designer segment because these are secondary services offered by these groups.

Although this discrete segmentation of the supply-side market is generally appropriate and useful, it is also important to recognize, as will be made evident in the results that follow, that many supply-side lighting firms engage in multiple levels of the supply chain.

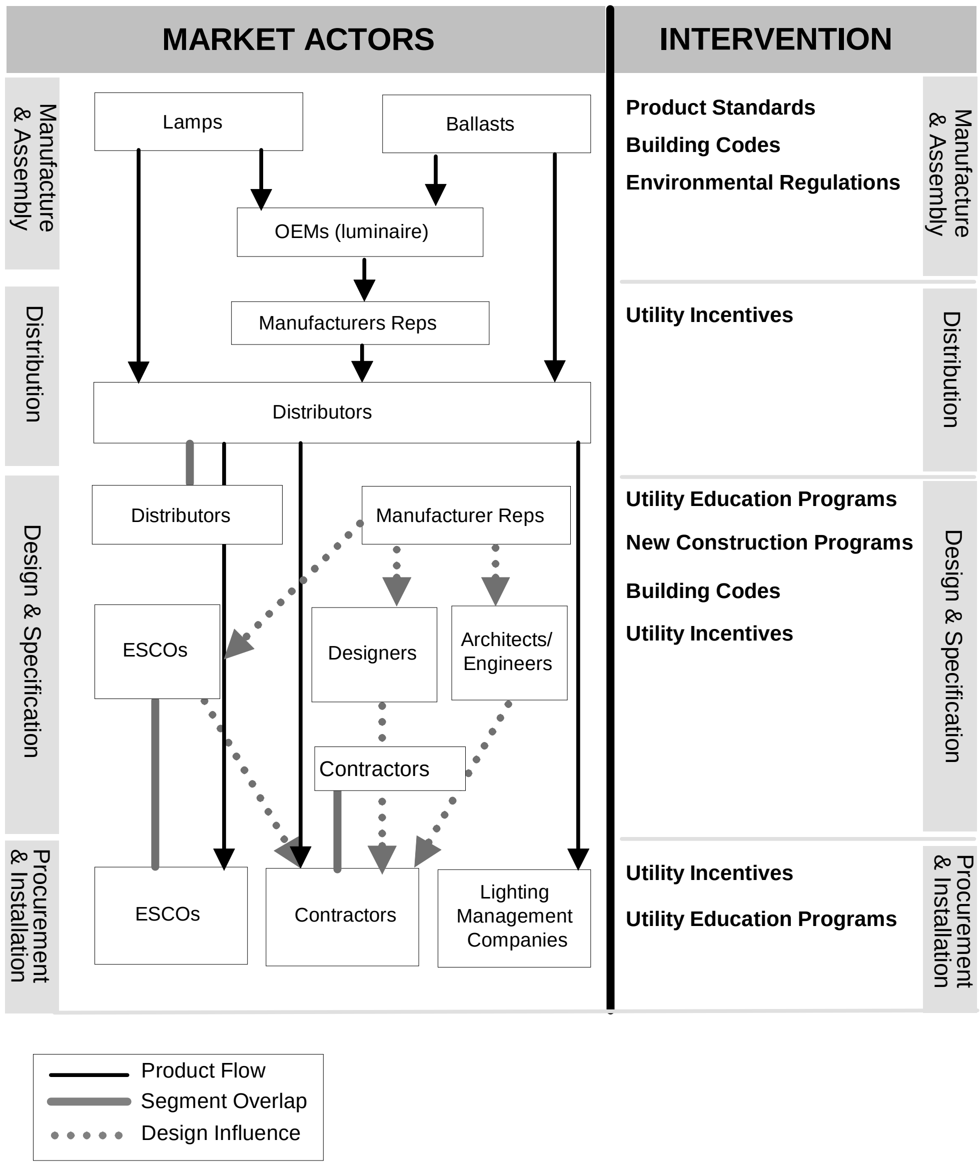
3.2.2 Market Influence

This subsection presents influence diagrams for major sectors of the market. Figure 3-2 below graphically depicts the overall structure of the commercial lighting market and identifies major intervention efforts for each segment. Arrows generally indicate product flows and design influence; boxes represent major segments. Not all possible product flows and influences are shown in the diagram because we prefer to avoid the unnecessary risk of overcomplication. Consequently, the diagram represents the primary market relationships as a simplification, rather than an exhaustive depiction of all relationships we identified in our research.

The two subsequent influence diagrams, Figure 3-3 and Figure 3-4, dissect the overall market diagram into a manufacturer and design and specification diagram. These two segments of the market structure, which we deem most important to the adoption of energy-efficient technologies, illustrate the "external" pressures affecting the decision-making of both groups.

Primary influences are identified in all of the diagrams, with the purpose of simplifying the complex relationships that characterize a large, multilevel market. In creating the subsequent market influence diagrams, we have not attempted to assess the relative magnitude of the various influences. See the market effects sections of this report for an assessment of the magnitude of influence of utility programs.

Figure 3-2
Commercial Lighting Market and Intervention Diagram



As depicted in Figure 3-3, manufacturers are generally influenced by market conditions (i.e. customers, competitors, and aggregate economic conditions), industry standards and government regulation, and are relatively insulated from downstream pressures from lighting vendors. See the market intervention section of the report, Section 4, which contains more detail on codes and standards.

Of all downstream supply-side actors, designers probably have the strongest influence on manufacturers—particularly luminaire manufacturers, although their influence is relatively weak compared to the other factors depicted in the diagram. Often designers work directly with luminaire manufacturers to create custom lighting products. On the other hand, several of the lamp and ballast manufacturers indicated that distributors and contractors exhibit little influence in their design and production decision-making process. However, some manufacturers also stated that contractors and distributors are often resistant to “high end” and energy-efficient products because of the (manufacturer’s perceived) focus on initial cost in these sectors. There is perhaps a self-reporting problem here, since manufacturers claim there is no downstream influence, yet they assert that the downstream actors resist certain technologies - a seemingly direct impact upon the manufacturers’ sales and production. Our interpretation is that manufacturers, especially lamp and ballast makers, are relatively insulated from downstream actors, particularly contractors and distributors, but follow and respond to product sales trends.

Figure 3-3
Manufacturer Influence Diagram

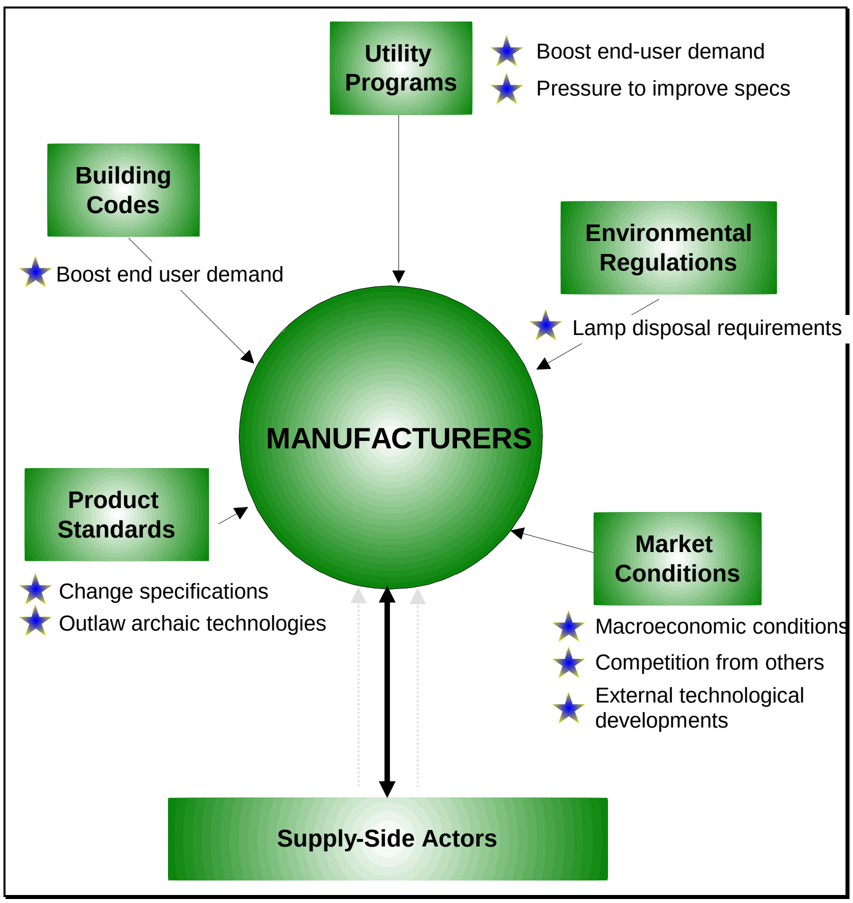
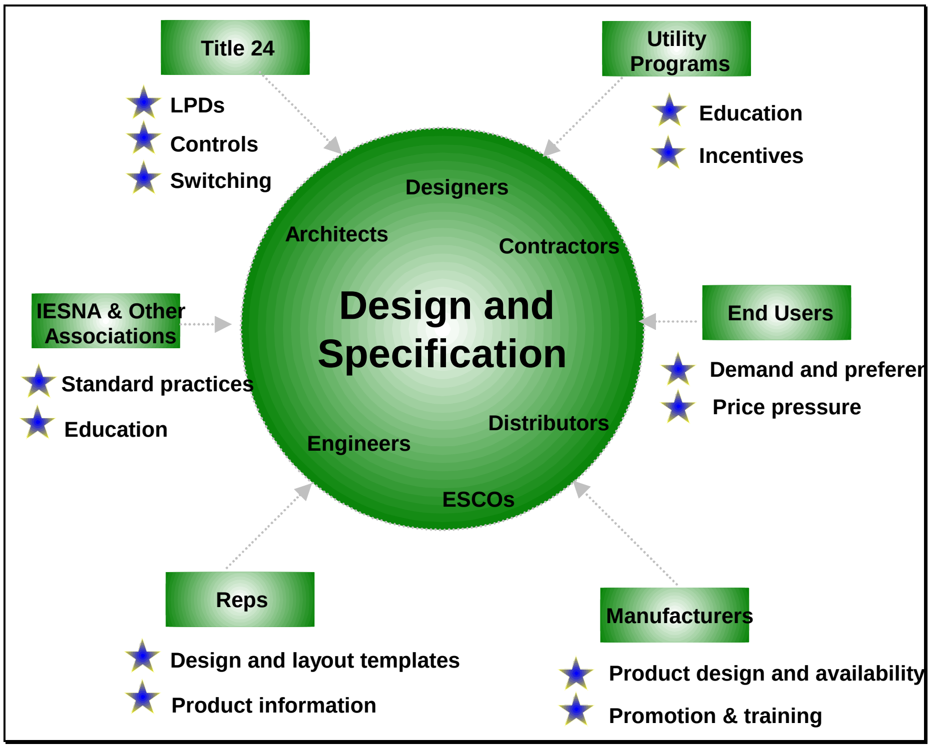


Figure 3-4 depicts the external influences on design and specification decision makers. We identified six general categories of actors or standards organizations that impact the design and specification process. Based on our interviews with designers, we believe that *all* of the categories shown in this figure are important to designers' core business decisions.

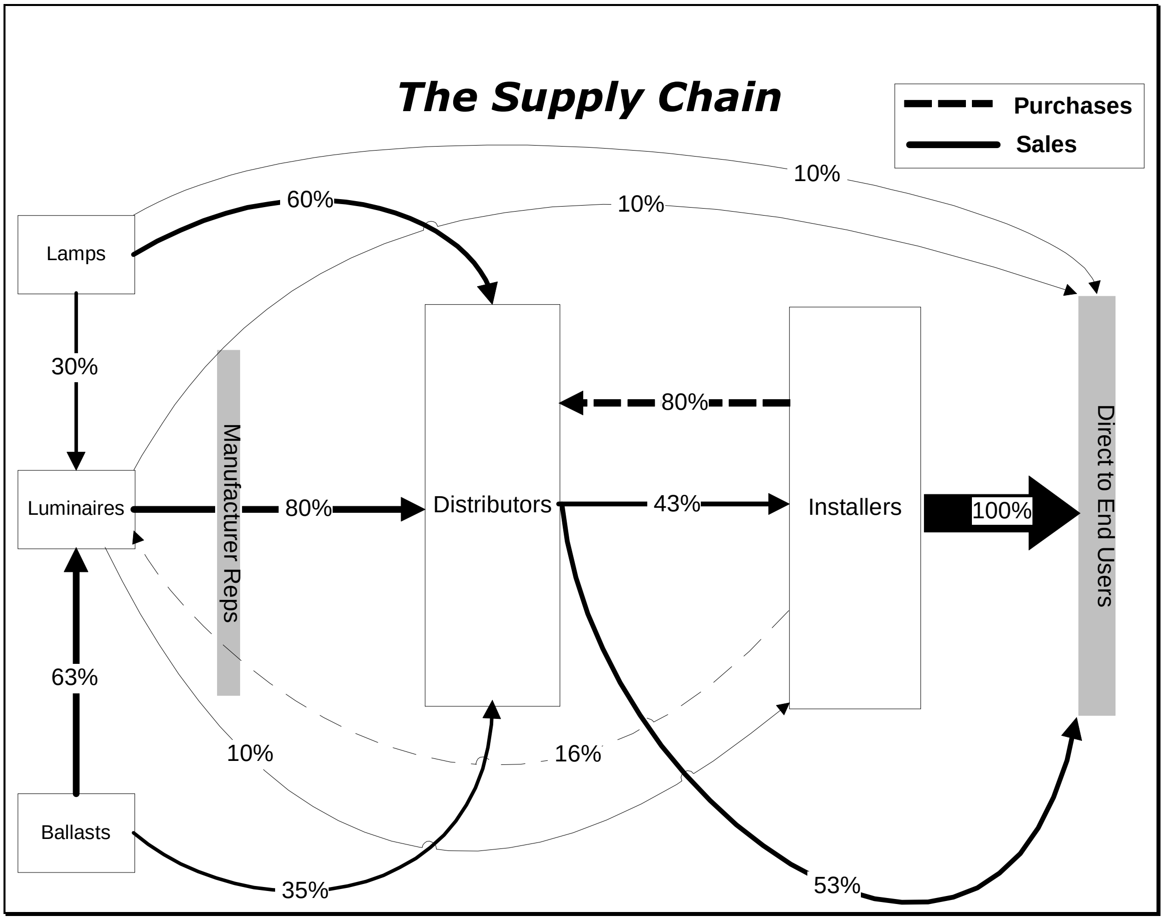
Figure 3-4
Design & Specification Influence Diagram



3.2.3 Product Flows

Figure 3-5 below displays the product flows within the commercial lighting market for major categories of market actors. Estimates of the magnitude of the distribution channels are based on our survey research. We believe that this diagram provides the first comprehensive, quantitatively based analysis of product flows throughout the commercial fluorescent lighting supply chain. Our secondary research, which was extensive, did not turn up any other integrated analyses of product flow.

Figure 3-5
National Product Flows in the Commercial Lighting Market



Source: XENERGY Supply Side Interviews

Manufacturing Sector. As displayed in Figure 3-5 above, the primary distribution channels for manufacturers are wholesale distributors and OEMs. According to our survey results, ballast manufacturers sell two-thirds of their product to luminaire manufacturers or OEMs, while the remaining share is sold to wholesale distributors. The major lamp manufacturers sell 30 percent of their 4-foot fluorescent tubes to luminaire manufacturers and OEMs, 60 percent to wholesale distributors, and 10 percent to end users. Luminaire manufacturers sell primarily to wholesale distributors, often using independent reps as the sales conduit.

Distributor Sector. Distributors, for the most part, sell to two sectors, installers and end users, and account for most of the purchases by these groups. According to one source, consistent with our analysis, over 75 percent of national commercial lighting sales were through wholesale distributors[1]. The remaining share at the national level is accounted for by manufacturer reps, factory direct sales, and other channels. According to our survey data, the corresponding distribution channel is higher in California; approximately 95 percent of installer and end-user

[1] Electrical Wholesale magazine, November 1997.

lighting purchases are made through wholesale distributors, indicating that other channels are insignificant in the marketplace.

Installer Sector. Installers, of course, sell all of their services to end users, since they are at the end of the supply chain. According to the installers interviewed, they purchase 80 percent of their equipment from wholesale distributors, while the remaining share is purchased directly from manufacturers. Interestingly, we discovered through our survey research that, contrary to our expectations, installers rarely use home centers, such as Home Depot, for procurement of 4-foot fluorescent lighting.

It is important to note that manufacturer reps, although having a small direct presence among installers and end users, have a large influence upon wholesale distributors, as elaborated in the designer subsection below.

3.3 MANUFACTURERS

3.3.1 Overview

The manufacturing industry resides at the top of the commercial lighting market "product chain," dictating, for the most part, product design, distribution patterns, and energy-efficiency features for the commercial lighting industry. Although manufacturers are exposed to significant external forces, little influence originates from downstream in the supply chain, as Figure 3-3 in the previous subsection illustrates.

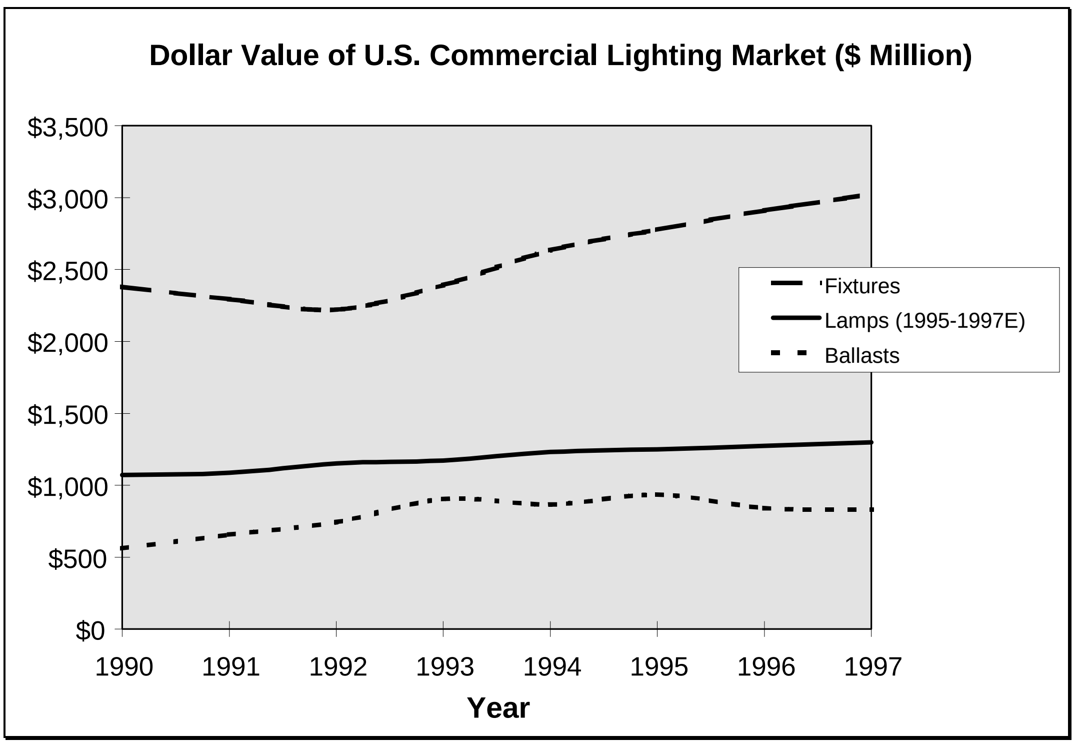
With respect to energy efficiency, lamp and ballast manufacturers have over the past five years been the key drivers in improving 4-foot lighting efficiency. Compared to competing efficiency improvements, such as controls or daylighting, the combination of decreasing production costs and utility rebates has made the T-8 EB system a very cost-effective option for improving fluorescent energy use in the typical application. As a result, efficiency is currently one of three or four primary selling points for manufacturers (price, color rendition, and lifetime are other points manufacturers rely upon heavily for sales). Simply examining the product catalogs of lamp, ballast, and luminaire manufacturers illustrates the significance that energy efficiency has in the manufacturer's mindset.

An additional indicator of the importance of efficiency in the competitive mindset of manufacturers is the position that lamp manufacturers took with respect to the Energy Policy Act of 1992. The fact that all three lamp manufacturers supported the lamp energy-efficiency provision in the law indicates the significance of energy efficiency to these firms' success in the market.

One indicator of market structure is the fact that the manufacturing sector of the commercial lighting market is highly concentrated, particularly the ballast and fluorescent lamp industries, where no more than five and three firms, respectively, account for over 95 percent of the market share. The luminaire industry is also highly concentrated, but not to the same degree. Although it is highly concentrated, the manufacturing sector is also highly competitive. Since lamps and ballasts are considered commodities, price is the primary selling point within any particular class of lamp or ballast. The luminaire market is somewhat split in this regard. Generally, 4-foot troffers, striplights, and surface-mounted models - the standard 4-foot fluorescent models - are commodity products, but there is also a large market for specialty lighting, such as indirect luminaires and designer products that are more differentiated and less price-sensitive.

According to U.S. Census data, the size of the national market in terms of commercial lighting sales was approximately $5.2 billion in 1997. Over the past five years, the manufacturing sector at the national level has experienced relatively small growth in product sales. As shown in Figure 3-6 below, the dollar value of the luminaire market has experienced the most significant gains in absolute terms since 1990, but the ballast industry has experienced the largest growth, approximately 6 percent, in terms of average annual growth. The luminaire industry experienced an average annual growth rate of approximately 4 percent and lamps a rate of 3 percent.

Figure 3-6
Size of the U.S. Commercial Lighting Market



3.3.2 Lamp Manufacturers

Sample Characterization

A total of three interviews were conducted with lamp manufacturers. The three interviewed are currently the largest manufacturers of 4-foot fluorescent lamps, representing approximately

95 percent of total domestic sales. Of the individuals interviewed, the average years of experience was 15, and all interviews were with either regional or national product managers. On average, roughly 40 percent of the revenues of the companies interviewed came from lighting, and about 78 percent of total lighting revenues were attributable to fluorescent lighting.

Market Overview

A tremendous amount of technological innovation has characterized the fluorescent lamp industry over the past five years. The reduction in production costs for T-8 lamps due to improved processes and ramped-up consumer demand led to its establishment as a mainstream technology in the commercial lighting market. Over the past five years, the T-8 lamp, a technology developed in the early 1980s, began replacing, in significant quantities, the 40-watt T-12, a technology dating from the 1940s. In addition to the technological improvements in the production process of T-8 lamps, the fluorescent lamp market has seen the introduction of hundreds of new products and technologies to the market, such as low mercury lamps, improved color rendering through phosphor technology, and miniaturization with T-5 lamps. For a variety of reasons, including utility programs, our research period coincides with the most significant evolution of the lamp market since the commercial introduction of the fluorescent lamp roughly 50 years ago.

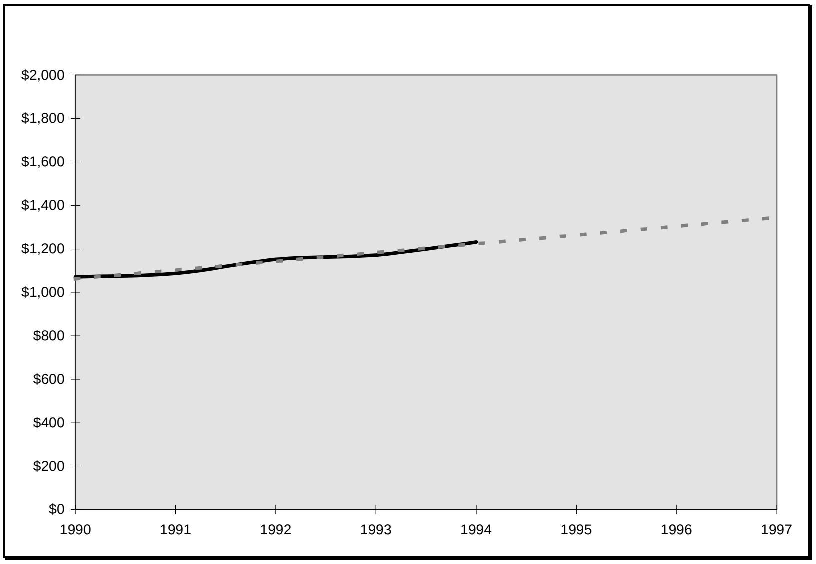
A significant milestone during the research period occurred in October 1995. when the most popular fluorescent lamp of all time, the 40-watt T-12 halophosphor, was banned by the Energy Policy Act of 1992, ushering in a new competitive dynamic - the fight between 34-watt T-2 ES lamps and 32-watt T-8 lamps as the “standard” technology. The T-12 ES lamp replaced the banned T-12 lamp as the least expensive option, while the T-8, ranging from 15 to 50 percent more in price, offered the best life-cycle cost economics.

Although fluorescent lamp technology has experienced rapid development over the past five years, the structure of the market has remained relatively stable. The fluorescent lamp manufacturing industry is characterized by a high concentration of firms - three companies account for approximately 95 percent of the market share. The firms are highly competitive with each other, often imitating rival new products, such as phosphor technologies and low mercury lamps, thereby creating commodity products differentiated solely by price (within any particular product class).

Market Size and Market Share

The fluorescent tube lighting market is estimated to be approximately $1.3 to $1.4 billion nationwide, and $150 million in California annually. Data on lamp shipments have been unavailable since 1995, when the National Electrical Manufacturer’s Association - the data collecting body - stopped reporting to the U.S. Census. Therefore, the estimates are based on a linear extrapolation of the data available from 1990 to 1994, as shown in Figure 3-7.

Figure 3-7
Estimated Size of the U.S. Fluorescent Lamp Market



As shown in Table 3-1 and indicated earlier, three manufacturers dominate the fluorescent tube lamp market.

Table 3-1
Estimated National Market Share of Fluorescent Lamp Sales

Company	Estimated Market Share
Osram Sylvania	35%
GE Lighting	30%
Phillips	30%
Durotest	2%
Others	3%
Total	**100**%

Source: Easton Consultants (1997)

Importance of Energy Efficiency

Above all else, lamp manufacturers are concerned with profitability. To the degree that energy-efficient technologies contribute to their bottom lines, manufacturers will design and produce energy-efficient technologies. We were able to find some evidence that energy-efficient product lines are profitable. When asked why they would promote T-8 lamps to compensate for perceived demand reductions due to reduced utility program spending, one manufacturer told us that T-8 lamps are more profitable than T-12 energy saver lamps. The interviews with the other two manufacturers neither confirm nor deny this response. Granted that a single interview may not clearly show that T-8 lamps are more profitable, it is nonetheless an important anecdote that may explain lamp manufacturers' position on energy-efficient technologies. As mentioned previously and as further evidence, the fact that all three manufacturers supported the banning of 40-watt T-12 lamps - one even stated that "EPACT did not go far enough" - shows that energy efficiency, at least with fluorescent lamp technologies, is a profitable business vein.

Regarding the penetration of T-8 lamps, one major manufacturer stated that 60 percent of its current 4-foot fluorescent sales nationwide are accounted for by T-8 lamps and 75 percent in California. By contrast, the same manufacturer stated that in 1994 the nationwide penetration was 20 percent and the California penetration was 35 percent. A second manufacturer stated that 40 percent of their national sales are T-8 lamps and the penetration is 45 percent in California, compared to 30 and 33 percent, respectively, in 1994. The third manufacturer, citing confidentiality, refused to answer.

Production & Operations

T-8 and T-12 lamps involve distinct production processes. Key characteristics of these production differences include the following:

- The estimated difference in production cost between T-8s and T-12s is 15 percent. Five years ago, the cost of producing a T-8 was twice as much as a T-12. [The difference in price between T-8s and T-12s is approximately 35 to 50 percent].
- The production process for T-8s and T-12s is significantly different because different machinery and tooling are required. As a result, separate production lines are required.
- It takes two years to build a T-8 production line, costing $50 to $60 million in capital investment.

Distribution Channels

As illustrated by Table 3-2, approximately two-thirds of fluorescent lamps are sold directly to distributors, while most remaining lamps are sold to OEMs for assembly into luminaires. A small share of lamps are sold to end users and retailers, circumventing the wholesale link in the supply chain.

Table 3-2
Manufacturers' Lamp Distribution

Channel	A	B	C	Average
Distributors	40	65	75	60
OEMs	30	35	25	30
Other (retailers & end users)	30	0	0	10

3.3.3 Ballast Manufacturers

Sample Characterization

A total of six ballast manufacturers were interviewed for the study. We interviewed the five largest manufacturers of ballasts in terms of market share. Besides ballasts for fluorescent tubes, all five of these firms offer full product lines, including HID and CFL ballasts. The sixth firm initially manufactured only electronic ballasts, but is currently expanding operations to produce magnetic ballasts. Of those interviewed, the average years of experience was 14. Lighting product revenues attributable to fluorescent ballasts averaged 82 percent among five respondents; the remaining share of revenues is attributable primarily to HID ballasts. Of the six manufacturers interviewed, the amount of sales accounted for by lighting averaged 73 percent.

Market Overview

The electronic ballast was first introduced in the U.S. market in 1981. Based on a range of responses from 1981 to 1994, the average year that manufacturers began production of electronic ballasts was 1987. Significant sales levels and widespread availability of electronic ballasts did not occur until the early 1990s. However, over the past five years, the annual average increase in penetration of electronic ballasts has been 7 to 8 percent. As a result, electronic ballasts have captured significant market share over this period, though not without some initial difficulties in meeting market demand. Stimulated by utility rebate programs, demand for electronic ballasts increased dramatically between 1991 and 1993, causing a supply shortfall. Section 6 contains an analysis of utility program impact on the demand for electronic ballasts. In many cases, component suppliers could not meet ballast manufacturer orders within the desired time frame. The combination of high demand, a developing technology, low production capacity, and a poor component distribution system contributed to a relatively high failure rate in the shipments of electronic ballasts during this time period.

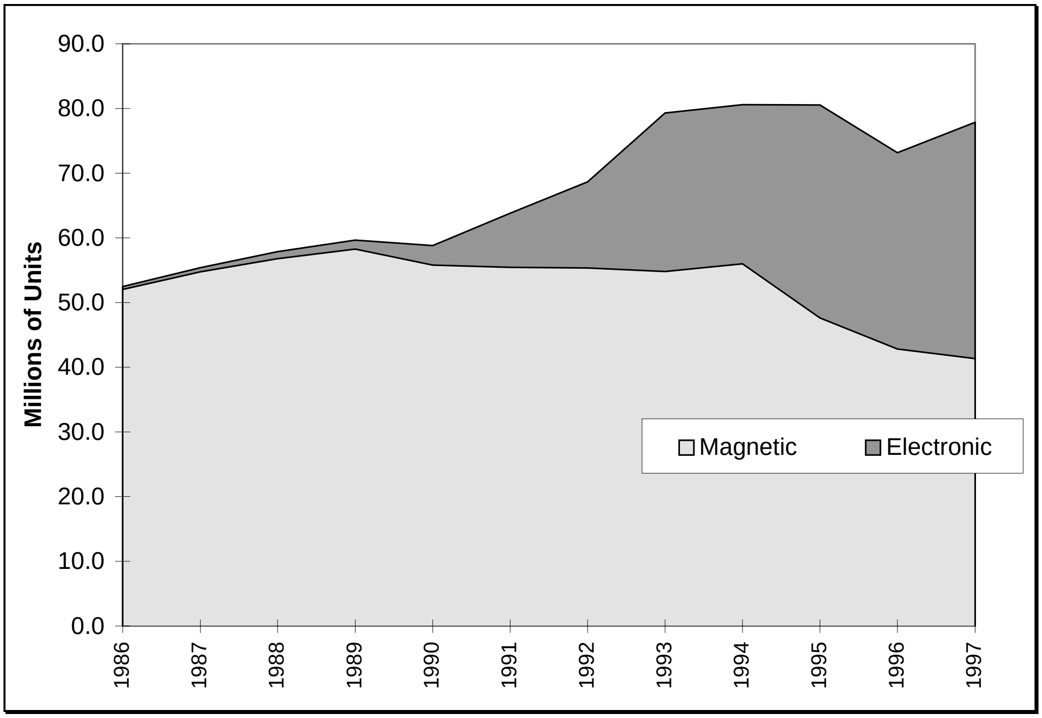
Almost all domestically produced fluorescent ballasts are shipped within the United States. (98 percent on average). This share may decrease, considering the recent announcements by at least two major ballast manufacturers that plants are moving to Mexico.

Profitability in the ballast industry has decreased in recent years, as evidenced by several firms exiting the market, including Monnex Technologies and Canterra. Another firm, Etta Industries, with production capacity of 250,000 units/year, has filed for Chapter 11 bankruptcy protection, but continues to produce electronic ballasts. As a means for securing name recognition and market clout, two of the top three ballast manufacturers are aligned with two of the top three lamp manufacturers. Magnetek is aligned with GE and Phillips owns Advance.

Market Size and Market Share

National sales of electronic and magnetic ballasts between 1986 and 1997 are shown in Figure 3-8 below. The figure clearly displays the dramatic increase in sales of electronic ballasts. Since we used end-use data to calculate estimates, data of ballast shipments in the sponsor program areas are contained in the end-user section.

Figure 3-8
U.S. Ballast Sales (in Units), 1986-1997



Source: U.S. Census (Magnetic are total corrected power factor units; electronic are total electronic units). Data are available for the first three quarters of 1997; the fourth quarter of 1997 has been estimated by XENERGY.

Other observations regarding the size of the electronic ballast market offered by respondents are provided below:

- One ballast manufacturer claimed that the decline in electronic ballast sales in 1996 was a "glitch" attributable to the decline in utility rebates. (*However, no explanation was offered as to why electronic ballast sales then rebounded in 1997*).
- One major manufacturer is currently moving much of its production to Mexico. The company lost $80 million in 1996, due in large part to decreased ballast sales. Another company announced that it will move some of its operations to Mexico.

- Electronic ballasts spurred several companies to enter the ballast market, including Motorola. Several of the new ballast manufacturers that specialize in electronic models expanded from other sectors in the electronics industry.

The bulk of the national ballast market is highly concentrated among a small number of manufacturers. As shown in Table 3-3 below, four manufacturers account for roughly 90 percent of the market. All ballast manufacturers produce electronic ballasts, while roughly half of the total number of firms produce magnetic ballasts. One company that has been producing solely electronic ballasts is currently building a plant to begin magnetic ballast production, suggesting that magnetic ballasts remain a viable and profitable technology.

Table 3-3
Estimated National Market Share of Fluorescent Ballast Sales

Company	Estimated Market Share
Advance/EBT	35%
Magnetek	35%
Motorola	12%
Power Lighting Products, Inc. (Valmont)	8%
Kingtec	2%
Others	8%
Total	**100%**

Source: Easton Consultants (1997)

Importance of Energy Efficiency

Like lamp manufacturers, the profit motive is the supreme influence on production and design decisions of ballast manufacturers. Our research indicates that there are forces working against efficiency within the ballast industry, even though we have seen tremendous growth in electronic ballast sales since their commercialization. These forces originate primarily from the evolving structure of the industry. The electronic ballast industry is intensely competitive. Although it is dominated from a market share perspective by five or six companies, we identified over 40 firms actively producing electronic ballasts. In contrast, there are half as many firms actively producing magnetic ballasts. Two manufacturers directly stated that magnetic ballasts generate a higher margin than their electronic counterparts. Moreover, as a result of this difference in competitive intensity, ballast manufacturers receive less profit from electronic models than magnetic. Although the competitive intensity has led to price reductions in electronic ballasts, the problem lies in that there may be a competitive backlash. Since magnetic ballasts are more profitable, a few new manufacturers are entering this market. One company that started out solely as an electronic ballast manufacturer is currently building a plant that will produce magnetic models. Although we have been unable to conclude whether promotional practices of magnetic ballasts has increased in recent years, it is possible that some reversion on the manufacturer's efficiency disposition may take place. At the national level, sales of electronic ballasts experienced a decline after annual increases in every year since commercialization[2] but, as mentioned above, rebounded in 1997 to their highest levels on both an absolute and share basis. Although we are not asserting that a reversion to magnetic ballasts is imminent, we do assert that the difference in profitability between electronic and magnetic ballasts, other things being equal, presents manufacturers with an incentive to sell magnetic models. See the market effects analysis section at the end of Section 6 for further discussion of this issue.

Another indicator of ballast manufacturer disposition is their stance regarding the proposed ban of magnetic ballasts through an ongoing DOE rulemaking. Only one out of six manufacturers supported banning magnetic ballasts. It should be noted that the single company supporting the ban is primarily an electronic ballast manufacturer. Besides this one firm, the other five were strongly opposed. The strength of the opposition is reflected in NEMA's lobbying effort, which has successfully deflected efforts to ban magnetic ballasts.

Evidence suggests that there is a significant difference between national and California penetration levels. Of total fluorescent ballasts sales, electronic ballasts account, according to survey data, for 57 percent of the total. The share of sales attributable to electronic ballasts in California is 88 percent. In 1994 the corresponding estimates were 45 percent nationally and approximately 82 percent in California. Since the 57 percent average market share of electronic ballasts provided by manufacturers is relatively close to the 47 percent share provided by national census data, we conclude that these self-reports are reasonably good indicators, particularly, of the *relative* difference between the California and national shares. According to one manufacturer, if measured by the number of lamps controlled, electronic ballasts would account for 60 percent of the current market. (*Note, however, that this would require that each electronic ballast sold in 1997 controls roughly three lamps on average. We know that the average number of lamps controlled is greater than two, but we do not have quantitative data to support an estimate of the actual average.*)

Production & Operations

Electronic ballast production has matured since the early 1990s, when the industry experienced significant growing pains. The upstream distribution channel is established and the assembly process is relatively efficient. The production process is highly automated, with labor accounting for approximately 10 percent of the total ballast cost. Electronic ballast technology is still being improved, but the rate at which processes or components are becoming obsolete has decreased. In the early 1990s components often became obsolete within three to six months, as the technology was rapidly evolving.

[2] Note that utility programs most likely had an impact on this decline. However, the fact that sales rebounded in 1997 may indicate that vendors and end users were "holding out" for rebates in 1996, which was a transition year in terms of decreases in rebate programs around the country. By 1997, vendors and customers may have decided to pursue targeted projects without considering rebates as much in the timing and implementation process.

Electronic ballasts contain more components than their magnetic counterparts and involve a more complicated assembly process. One manufacturer states that electronic ballasts have 25 to 30 components and magnetic ballasts have three or four. Another stated that there are “10 times the number of parts in an electronic ballast.” Initially, the production cost of electronic ballasts was two to three times that of magnetic ballasts. The current cost ratio estimate of electronic to magnetic is roughly 1.5:1 (based on responses from two of the major manufacturers; others declined to provide an estimate). One manufacturer claimed that the production cost of electronic ballasts will always be higher than that of magnetic because of the larger number of components and a more complex assembly process. All manufacturers who responded stated that production efficiencies increased dramatically and the production process has been significantly improved for electronic ballasts.

Distribution Channels

As shown in Table 3-4, roughly two-thirds of ballast sales are to fixture manufacturers, with almost all of the remaining share going to distributors. As a result, much of the marketing is targeted to OEMs. Note that fixture manufacturers represent the primary distribution channel for both magnetic and electronic ballasts.

Table 3-4
Reported Ballast Shares by Distribution Channel (Percent of Sales)

Company	Distributors	Fixture Manufacturers	Others
A	50%	50%	0%
B	40%	60%	0%
C	25%	75%	0%
D	30%	67%	3%
E	35%	55%	10%
Weighted Average	**35%**	**63%**	**2%**

Source: XENERGY Manufacturer Interviews

3.3.4 Luminaire Manufacturers

Sample Characterization

A total of 12 luminaire manufacturers were interviewed for the study. Five of the interviews were with major manufacturers that offer full product lines and have estimated market shares of over 10 percent. The remaining seven interviews were with smaller manufacturers that, for the most part, target niche markets. Of those interviewed, the average years of experience of the interviewee was 15. The average size of the companies interviewed in terms of sales was $194 million. For the average luminaire manufacturer we interviewed, based on nine responses, 4-foot fluorescent luminaires account for 53 percent of total revenues. And out of 12 responses, the amount of sales accounted for by lighting equipment averaged 79 percent.

Market Overview

The luminaire industry is a diverse market segment with numerous firms and a relatively diffuse market for a manufacturing industry.[3] Although the commercial lighting market is dominated by the largest six or seven firms with respect to sales of traditional 4-foot luminaires, numerous niche markets exist, offering a variety of new and designer products. The largest luminaire manufacturers offer a full product line, including architectural and designer products as well as standard 4-foot luminaires (e.g., troffers, striplights, and wraparounds). The largest manufacturers currently sell mass quantities of both efficient and inefficient systems. Smaller luminaire manufactures - niche firms - provide specialty products or focus on a particular aspect of fluorescent applications, such as energy efficiency or aesthetics.

In recent years, a significant focus of luminaire manufacturers, both in terms of marketing and new product development, has been on reducing glare and improving light distribution. Spurred in part by the increasing number of computer terminals in office space, these products include indirect lighting and luminaires with newly designed veils, lenses, and baffles. Often these glare reduction components and technologies can reduce energy efficiency, since light is diffused or deflected.

Luminaire manufacturers are often involved in other aspects of the lighting industry. Typically, the larger firms are involved in manufacturing within other segments, and the smaller firms tend to branch out into a service segment, such as installation or design. Counts of other services and products offered by 10 of the luminaire manufacturers we interviewed are presented in Table 3-5.

Table 3-5
Other Products and Services Offered by Luminaire Manufacturers

Product or Service	Count
Ballast manufacture	1
Distribution	4
Installation	1
Design	7
Importing/Exporting	3
Total Respondents	**10**

Market Size and Market Share

The commercial and institutional luminaire market is dominated by domestic firms, with competition for standard luminaires (e.g., troffers, striplights, and wraparounds) concentrated among the top six or seven manufacturers. Since 1992, the commercial and institutional sector of the luminaire market has seen 35 new firms enter the market. Many of these firms specialize

[3]From our analytical perspective, luminaire manufacturers are the conceptual equivalent to OEMs, since lamps and ballasts are included in the assembly process and these components are the primary drivers of lighting energy efficiency.

in architectural luminaires or specialty products, such as reflectors or security lighting. As shown in Table 3-6, several dozen firms compete within each of the luminaire markets. Like the other lighting sectors, however, a handful of firms account for the bulk of the market share (see Table 3-7). The total annual market for commercial and institutional luminaires was approximately $2.9 billion nationally in 1997, while sales for solely commercial fluorescent luminaires were roughly $1.8 billion, as shown in Figure 3-9. Sales by luminaire type over the 1991 to 1997 period are provided in Table 3-8. Commodity-type luminaires make up the large majority of the commercial lighting market, accounting for approximately 84 percent of the total over the past three years. Indirect lighting accounted for roughly 12 percent of the lighting over the same period, up slightly from 10 percent of total sales in 1990.

According to U.S. Census data, there are roughly 300 plants in the United States. that manufacture commercial luminaires. California accounts for 21 percent of the plants.

Table 3-6
Number of U.S. Fluorescent Luminaire Manufacturers by Luminaire Type, 1995

Luminaire Type	Number of Firms
CFL Downlights	18
Recessed Troffers	8 - 40*
Striplights	53
Surface & Pendant	53
Wall Mounted	60
Wraparounds	42

Source: Lighting Fixtures Market Study, 1997

** Number of Recessed Troffer manufacturers varies by subcategory (i.e., size, number of lamps and lens).*

Table 3-7
Estimated National Market Share of Fluorescent Luminaire Sales

Company	Estimated Market Share
Lithonia	15-20%
Cooper	15-20%
Metalux	15-20%
USI/Columbia/Prescolite	5-10%
Genlyte/Crescent/Lightolier	5-10%
Thomas	5-10%
Luma	<5%
Williams	<5%
Simkor	<5%
Others	<5%
Total	**100%**

Source: Easton Consultants (1997)

Figure 3-9
Fluorescent Luminaire Annual Sales

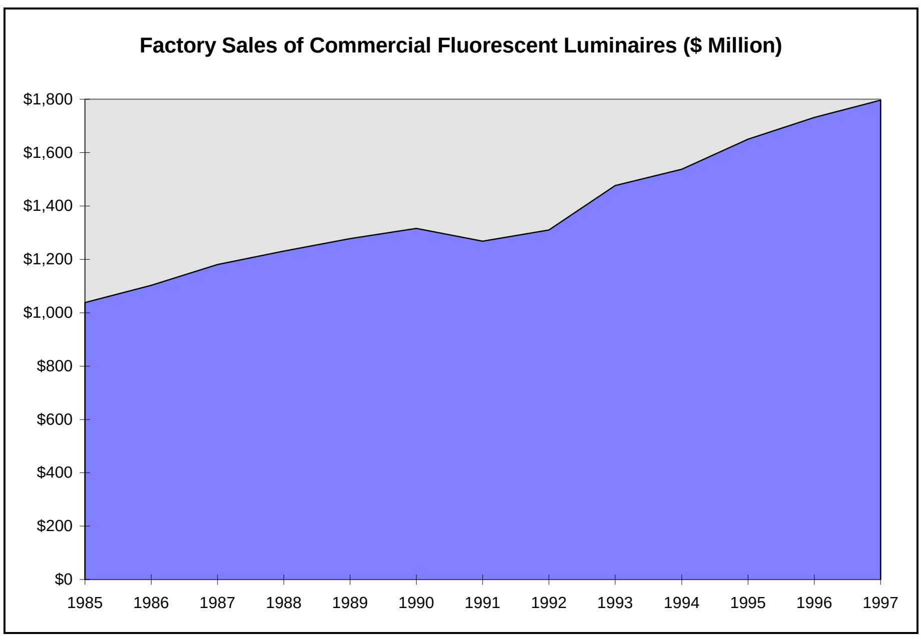


Table 3-8
U.S. Factory Sales of Commercial & Institutional Luminaires by Type (thousand units)

Luminaire Type	1991	1992	1993	1994	1995	1996E	1997E
Recessed troffers	15,635	15,534	17,768	17,161	17,595	18,057	18,199
Striplights	10,513	12,527	12,013	12,323	11,693	11,145	11,020
Plastic wraparounds	4,946	4,632	4,487	4,344	4,432	4,510	4,420
Wall mounted fixtures	1,076	1,341	1,532	1,390	1,232	1,200	1,250
Under cabinet mount task light	757	979	1,723	1,846	1,721	1,700	1,760
Surface & pendant, all other	2,516	2,430	3,121	3,847	3,650	3,685	3,680
Total	**35,443**	**37,443**	**40,644**	**40,911**	**40,323**	**40,297**	**40,329**

Source: U.S. Lighting Fixture Market Study, Market Studies, 1997.

Importance of Energy Efficiency

Generally, larger luminaire manufacturers tend to *respond* to market conditions, particularly the increased demand for efficient products, whereas smaller luminaire manufacturers tend to seek out new markets and product designs. Like most industries, the largest manufacturers have tended to lag behind the smaller firms with respect to technological innovation and new product introduction. Consequently, there is some evidence to suggest that the major luminaire manufacturers have tended to be less inclined to offer efficient designs relative to smaller, niche firms when these products were not in the mainstream. According to at least one niche manufacturer and an industry observer, the major luminaire manufacturers tend to wait for significant growth in demand for particular attributes before committing to add a product line with those attributes. As additional evidence, of the companies we interviewed, the first companies to integrate T-8 EB systems into their products were smaller, niche companies. Based on a range of responses from 1981 to 1994, the average year manufacturers began to integrate T-8 electronic ballasts systems was 1988. The two earliest adopters, occurring in 1981, were smaller, niche firms. This is consistent with behavior in other markets, such as software, where larger firms tend to be less innovative. Note that the underlying evidence is rather scarce for this observation, but it provides some insight on where viable efficient designs may be originating.

Of those surveyed in this study, the four largest manufacturers estimate that roughly 50 to 55 percent of their current fluorescent luminaires are equipped with T-8 electronic ballast systems. The smaller firms provided an even higher share of T-8 electronic ballast systems, ranging from 70 to 100 percent. The corresponding estimates for 1994 ranged from 20 to 40 percent for the four largest manufacturers, and 45 to 98 percent for the smaller firms.

Besides lamps and ballasts, manufacturers view reflectors as an effective component for improving energy efficiency. Table 3-9 displays the number of manufacturer responses when asked what features, in addition to the lamp and ballast, contribute most to the efficiency of a commercial fluorescent lamp installation. Interestingly, the number of lamps used in the luminaire was only cited by one manufacturer as a primary factor in contributing to energy efficiency.

Table 3-9
Features Other Than Lamps and Ballasts That Contribute to Efficiency

Feature	Primary Importance	Secondary Importance
Appropriate controls	2	1
Reflective materials	9	2
Use of one ballast to drive three to four lamps	1	3
Shape of fixture/reflector	0	4
Use of lenses, no lenses	0	7
Number of lamps in the fixture (2-lamp configuration)	1	2
Use of indirect configurations	0	4

Production and Operations

Luminaire manufacturers design and produce a variety of fluorescent luminaires that vary widely in terms of energy efficiency. For the most part, the lamps and ballasts used in assembling 4-foot luminaires have essentially the same footprint, whether T-8 electronic ballast or T-12 magnetic ballast systems. Additionally, only for specialized applications are electronic ballasts inappropriate (primarily a THD issue). Therefore, luminaire manufactures do not incur substantially higher production costs from T-8 EB products relative to T-12 MB products.

Almost all luminaire manufacturers design their products with integrated ballasts. All 11 manufacturers interviewed stated they sold only luminaires with integrated ballasts (two companies estimated 98 and 99 percent, with the remainder accounting for special orders).

According to manufacturer interviews, there are some minor differences in the production process between T-8 EB systems and T-12 MB systems, although the interview results were somewhat mixed on this question. Of the luminaire manufacturers interviewed, four out of 11 stated that there are minor adjustments in the production of T-8 EB systems, relative to T-12 MB systems. The other seven manufacturers stated that there were no differences in production. One of the major manufacturers stated that some luminaires are specifically designed for T-8 lamps, which creates a production cost difference, since new equipment is needed. The following explanations were provided:

- The T-8 electronic luminaire “requires a different reflector system. It's mainly the fixture design that must be changed since it is a different shape of ballast.”
- The “wiring method and wiring material are different.”
- Differences in production are “not an issue.”

- There is a difference "to a minor degree, such as shunted sockets, and a few fixtures are specially designed for T-8s."

When asked if they encountered any difficulties producing fixtures with integrated T-8 electronic ballasts, eight out of 11 said no. For those that have encountered difficulties, the primary reason was the ballast shortage during the early 1990s.

According to the nine manufacturers that responded, the production cost of luminaires with T-8 electronic ballasts has decreased relative to T-12 magnetic ballast systems. At the time manufacturers introduced fixtures with integrated T-8 electronic ballasts, the production cost of T-8 electronic ballast systems averaged 23 percent higher than T-12 magnetic ballast systems. The current production cost difference averages 14 percent.

Distribution Channels

Luminaire manufactures sell primarily to lighting distributors, with a small portion of total luminaire sales going through alternate channels. Seven of the 12 manufacturers interviewed estimated that at least 80 percent of their sales were to distributors, including the four largest companies.

Smaller, specialty manufacturers use a wider variety of distribution channels, including sales to contractors, retailers, and directly to end users. Manufacturer reps account for a small share of the distribution channel. Generally manufacturer reps, whether independent or not, do not take on inventory and therefore are not considered part of the distribution chain. Rather, manufacturer reps act, as previously stated, as sales agents.

3.4 DISTRIBUTORS

3.4.1 Sample Characterization

As shown in Table 3-10 below, a total of 109 distributor interviews were conducted for this study, 79 in the sponsors' service territories and 30 from other areas of the country with little if any program activity. The breakdown of states included in the nonprogram sample is presented in Table 3-11.

Nineteen of the 109 interviews were in-depth surveys conducted by project team analysts with distributors in the sponsors' service territories, whereas the remaining 90 surveys were conducted by a telephone survey house. For program area distributors, results are presented in this subsection by the subtypes shown in Table 3-12. Because of the smaller sample size for the nonprogram area distributors, these results are not presented by subtype.

Since the in-depth interviews included more questions than the phone-house instruments, some results presented in this section are for only the in-depth respondents, while in cases where a question was asked by both instruments, the responses of the in-depth and phone-house surveys are combined.

Table 3-10
Interview Sample by Distributor Type and Program Area

Distributor Type	Program	Non-program	Total
Industrial Supply	16	14	30
Electrical Supply	38	13	51
Lighting Supply	16	1	17
Manufacturer Rep	9	2	11
Grand Total	**79***	**30**	**109**

*Includes 19 in-depth interviews.

Table 3-11
Breakdown of Nonprogram Distributor Sample by State

State	Percent of Sample
Texas	52%
Pennsylvania	34%
Missouri	10%
Louisiana	3%

A few basic statistics on the business characteristics of the distributors included in our samples are provided in Table 3-12. Because many firms refused to provide revenue figures, we provide sample sizes within each cell in the table. Lighting equipment represents approximately 25 percent of electrical and industrial suppliers' business, versus virtually 100 percent for those whose businesses are exclusively lighting-focused, i.e., the lighting suppliers and manufacturer reps. Interestingly, most of the suppliers have been in business for over four decades, the exception being lighting supply houses in the program areas. Given the small sample size, it is difficult to assess whether the younger age of these firms has to do with program activity, e.g., more competitors may have entered the lighting supply market over the past 10 years because of activity in the high-efficiency lighting market.

Table 3-12
Distributor Sample - Business Characteristics

Distributor Type	Average Age of Company	Average Number of FT Employees	Average 1996 Revenue ($million)	Average Percentage of Revenue Related to Lighting Work
Electrical Supply	43 (n=31)	16.1 (n=32)	12.8 (n=13)	23% (n=13)
Industrial Supply	57 (n=14)	24.9 (n=15)	3.7 (n=7)	25% (n=6)
Lighting Supply	20 (n=10)	14.4 (n=10)	2.8 (n=4)	100% (n=4)
Manufacturer Rep	55 (n=3)	3.3 (n=3)	31 (n=1)	100% (n=1)
Program Total*	43 (n=58)	17.4 (n=60)	9.4 (n=25)	37% (n=24)
Nonprogram Total	52 (n=29)	40.8 (n=28)	42.8 (n=10)	15% (n=7)
Overall Total	**46 (n=87)**	**24.8 (n=88)**	**18.9 (n=35)**	**24% (n=31)**

*Note: In-depth program results are similar.

Market Overview

Lighting distributors are primarily wholesale and retail distributors of lighting technologies, but offer other services as well. The industry is characterized by strong competition on price and diverse corporate structures, including single-location, local chain, regional chain, and national chain stores. Lighting distributors are generally either an electrical supplier, an industrial supplier, or a lighting specialty firm, although there are other less significant distribution channels, such as catalog and on-line stores, home stores. and the direct manufacturer channel.

Market Structure

Unlike the manufacturing sector, the distributor industry is relatively diffuse and characterized by numerous local businesses. Market concentration is relatively low. As a minimum indicator, we identified over 150 wholesale distribution companies, ranging from small, locally owned, one-location shops to large national chains. According to the November 1997 issue of Electrical Wholesaler Monthly, nearly 60 percent of the $62 billion sold nationally through electrical distributors in 1996 went through firms with sales of under $20 million, indicating the presence of a market structure characterized by numerous small firms.

At the national level, there have been numerous recent mergers and acquisitions among the largest 250 electrical distributors. Despite this activity, there has been little impact on the structure of the electric wholesale industry. The top 250 had $26.3 billion in sales nationally in 1996, up 7 percent, capturing 42.6 percent of total market (which was the same market share as in 1995, despite the numerous mergers and acquisitions).

We asked about other lighting businesses in which distributors were involved. Results of this inquiry are presented in Table 3-13. A large percentage of respondents indicated that they also engaged in lighting design, while smaller, though significant percentages stated that they also provided installation and financing services. Of the four distributor subtypes identified, the electrical supply firms were the least likely to engage in design services. The overall results were similar for both program and nonprogram areas.

Table 3-13
Percent of Distributors Offering Other Services (Program and Nonprogram)

Distributor Type	Design	Installation	Financing	Number Interviewed
Industrial Supply	70%	10%	10%	30
Electrical Supply	33%	16%	20%	51
Lighting Supply	65%	18%	18%	17
Manufacturer Rep	82%	27%	9%	11
Total	**53%**	**16%**	**16%**	**109**

In order to better characterize the lighting supply chain, we asked in-depth respondents to estimate the percentage of their sales to other market actors. These results are presented in Table 3-14 by equipment type. Roughly 85 percent of equipment sales are relatively evenly split between sales directly to end users and those to contractors. Sales to “Other” purchasers make up the remainder. Note that three of the manufacturer reps interviewed indicated that most of their sales (over 80 percent) went to other distributors. If these two respondents are excluded, the percentage of sales to “Other” purchasers declines to roughly 5 percent.

Table 3-14
Breakdown of Distributor Sales by Customer Type [In-depth Only/Program Area]

	Direct to End User	To Contractor	To Other Purchasers
Lamps	47%	36%	17%
Ballasts	50%	37%	14%
Fixtures	44%	41%	16%

Importance of Energy Efficiency

Before asking about the importance of efficiency to the distributors’ business, we attempted to better understand what are the underlying incentives that drive distributorships. We asked in-depth respondents to provide the most important keys to success in their business. As shown in Table 3-15, excellent customer service, highly knowledgeable staff, and good stocking and inventory practices were the most cited keys to a profitable business. With that in mind, we then asked how or where energy efficiency fit into their situation.

Table 3-15
Most Important Factors to Running Profitable Distributorship
[In-depth Only/Program Area]

Factor	Percent Reporting*
Customer Service	53%
Knowledgeable Staff	42%
Good Stocking	26%
Creativity/Marketing	10%
Discounts/Pricing	10%
Good Specifications/Quality of Products	10%
Other	10%

*Note: Sums to greater than 100, includes multiple responses.

Energy efficiency is currently regarded as an important component in the success of distributors. In response to our probe on the importance of stocking efficient equipment, 11 of 16 respondents indicated it was Very Important to their competitive position. Table 3-16 displays the full distribution of responses.

Table 3-16
Importance of Stocking EE Equipment to Distributors' Competitive Position

In terms of maintaining your firm's competitive position, how important is the stocking of energy efficient equipment? Is it ...		
Response	**Program Area (# of Responses, & %s)**	**Nonprogram Area (# of Responses, & %s)**
Very Important	69%	67%
Somewhat Important	19%	30%
Not Very Important	13%	3%
Total Responses	**100% (n=16)**	**100% (n=30)**

A good way to get a sense for the distributor perspective on energy efficiency is through their own words. Table 3-17 below presents distributors' responses after we asked why they think energy efficiency is or is not important to their competitive position.

Table 3-17
Distributors' Verbatim Reasons for Importance of EE Equipment to Their Competitive Position [In-depth Only/Program Area]

In terms of maintaining your firm's competitive position, how important is stocking of energy efficient equipment? Is it ...	
Response	**Verbatim on "Why"**
Very Important	We will not retain our customers if we do not have the products they need in stock.
	So we can give the customer what he needs right away and they are not delayed. If customer is satisfied, they will come back and tell others about them.
	People want to walk out w/ products, there is demand for EE.
	Our competitors stock efficient equipment.
	Otherwise, it takes too long to fill orders; 2-3 weeks.
	Knowledgeable sales staff can provide $ savings.
	[There is] Demand for these technologies.
	Demand for it, some equipment is going to sell because it is on the shelf, but demand for quality efficient equipment requires that we stock it.
	Client/customer demand.
	Because there is demand for these products.
Somewhat Important	Competitive market, demand for EE products.
Not Very Important	Manufacturers have an abundance of EE lighting equipment and shipping is incredibly fast today so they do not have to rely on having everything in stock.
	Customers have low awareness.

Most distributors stock efficient components other than lamps and ballasts. Stocking practices and trends are presented in Table 3-18. Graphic comparisons between the program and nonprogram area distributors are shown in Figure 3-10 and Figure 3-11. Program area distributors are only slightly more likely to stock other efficient lighting products; however, whatever gap may have existed is being closed quickly as evidenced by the fact that nonprogram area distributors report greater increases in sales trends for these products over the past two years. This is consistent with several of our findings, presented in Section 6 of this report, that show a gap in efficiency stocking and sales between the program and nonprogram areas from the early 1990s, shrinking over time until the present. As presented in Table 3-18, almost all distributors in both the program and nonprogram areas stock occupancy sensors and LED or electroluminescent exit signs. Somewhat surprisingly, almost 60 percent stated that they stocked T-5 lamps.

Table 3-18
Other Efficient Products Distributors Have in Stock

	In Stock?		Sales Change Over Past Two Years		
Program	**Yes**	**No**	**Increased**	**Decreased**	**Stay the same**
Occupancy sensors	85%	15%	62%	11%	26%
Lumen maintenance (dimming) controls	70%	30%	46%	12%	42%
Indirect fluorescent fixtures	55%	45%	46%	19%	35%
LED or electroluminescent exit signs	85%	15%	64%	10%	26%
Parabolic reflectors for fixtures	77%	23%	52%	7%	41%
Dimmable fluorescent ballasts	64%	36%	49%	14%	37%
T-5 Lamps	58%	42%	34%	11%	55%
Nonprogram					
Occupancy sensors	93%	7%	54%	4%	42%
Lumen maintenance (dimming) controls	56%	44%	69%	15%	15%
Indirect fluorescent fixtures	46%	54%	46%	8%	46%
LED or electroluminescent exit signs	79%	21%	77%	0%	23%
Parabolic reflectors for fixtures	77%	23%	64%	9%	27%
Dimmable fluorescent ballasts	60%	40%	56%	6%	38%
T-5 Lamps	60%	40%	35%	12%	53%

Figure 3-10
Percent of Distributors Stocking Other Efficient Lighting, Program Area Versus Nonprogram Area

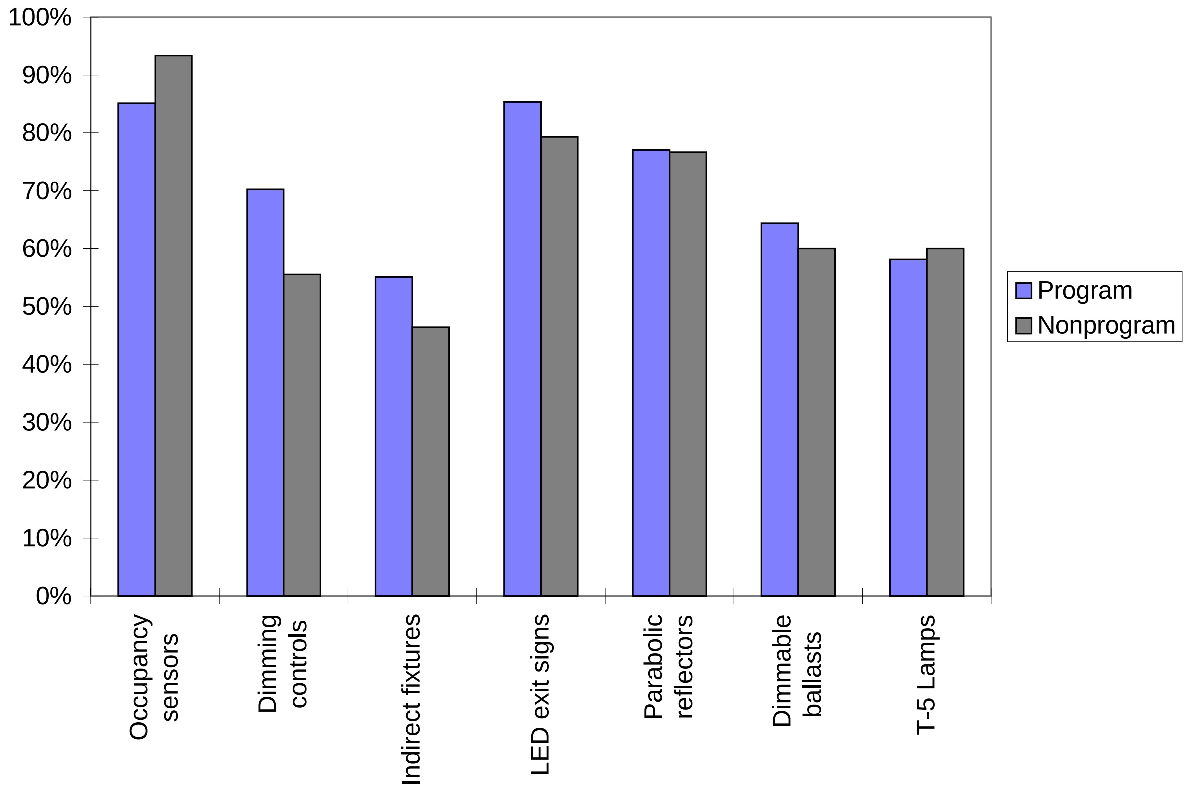
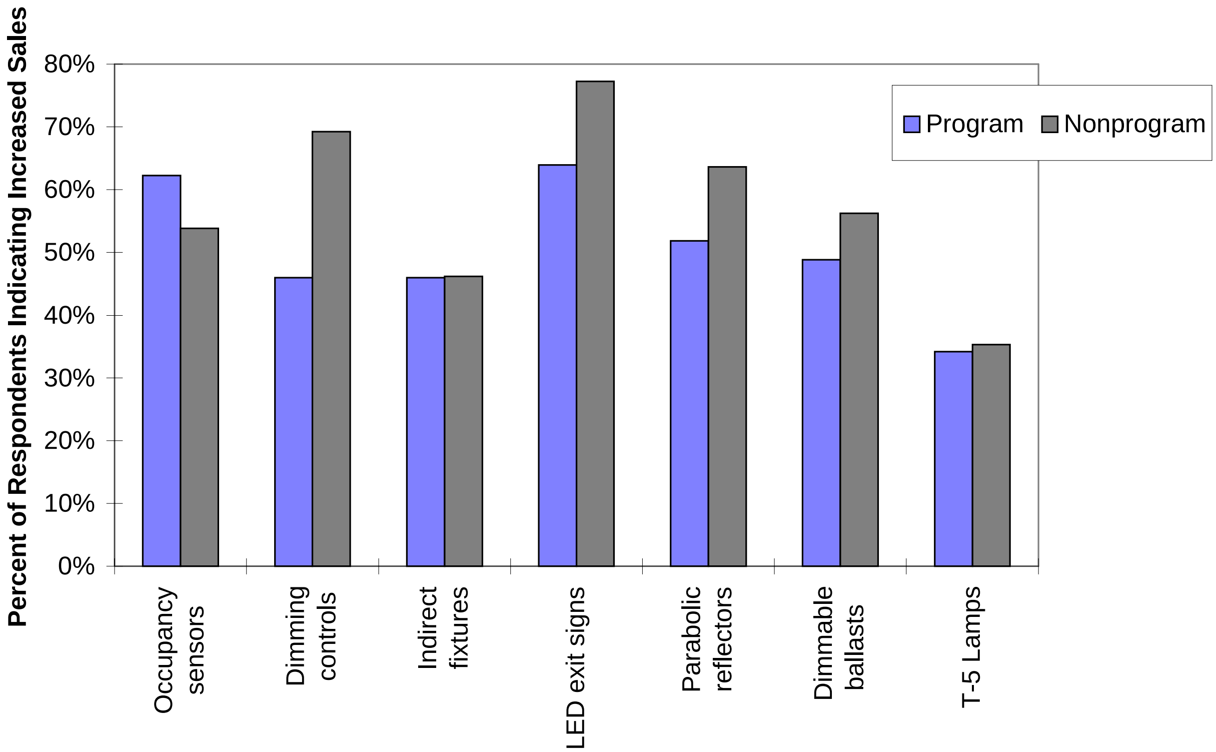


Figure 3-11
Increase in Distributors Sales for Other Efficient Lighting Equipment, Program Area Versus Nonprogram Area



Some manufacturers characterize the distributors' efficiency disposition differently, asserting that distributors are often resistant to stocking the more expensive energy-efficient technologies. One stated, "it is difficult to get distributors and contractors interested, since they are looking for the best price and energy efficient lighting is expensive. But end users and designers want the energy-efficient lighting to save on energy and long-term cost savings." Another simply stated "they resist the increased cost."

Influence on Design and Equipment Specification

Distributors, to the degree that they are not directly involved in the specification process, play a relatively small part in the overall influence of design and equipment selection decisions. Distributors influence the design and selection of equipment primarily through their stocking and promotion practices. As sellers of lighting equipment, they, in a sense, create the market for commercial lighting. However, although distributors determine what equipment takes up their shelf space, they generally respond to product demand and manufacturer influence when making stocking decisions. As one manufacturer put it, "they take whatever we sell them." Distributors, as illustrated in the above subsection, are most concerned with customer service and will stock according to consumer demand.

As a method of selling their products, distributors often provide layout and specification services to their clients (contractors and end users), usually without charge.[4] We spoke with a few distributors who were frustrated because they spent resources working on specifications in the hopes of making a sale, and the customer used the template without purchasing the equipment.

3.5 Designers & Specifiers

Sample Characterization

Interviews were conducted with 82 designers (57 serving the sponsors' service territories, and 25 in nonprogram areas) at six different types of firms. Table 3-19 below shows the breakdown of interviews given in each of the six types of firms that do design work, by program area and nonprogram area. A breakdown of the nonprogram area sample is provided in Table 3-20.

Table 3-19
Sample Size by Designer Type

Designer Type	Total	Program Area	Nonprogram Area
Architectural firm	13	11	2
Engineering firm	17	13	4
Distributor	7	4	3
Lighting designer	25	17	8
ESCOs	5	4	1
Contractor	15	8	7
Total	**82**	**57**	**25**

[4] In some cases distributors are passing along templates and schematics that were created by manufacturer's reps as their own sales tool.

Table 3-20
Breakdown of Nonprogram Designer Sample by State

State	Percent of Sample	Number of Observations
Pennsylvania	44%	11
Texas	28%	7
Arizona	8%	2
Louisiana	4%	1
Missouri	4%	1
Mississippi	4%	1
New Mexico	4%	1
South Carolina	4%	1
Total	**100%**	**25**

In Table 3-21, we present the average size (in terms of revenue and full-time employees) of design firms, the average ages of the different design firms, and the percentage of work that is lighting-related for each of the different design firms for program and nonprogram territories. As expected, the percentage of lighting-related business is largest for Distributors, Lighting Designers, and ESCOs, and smallest for Architectural, Engineering, and Contractor firms.

Table 3-21
Characteristics of Designers/Program and Nonprogram*

	Average Age of Company	Average Number of FT Employees	Average 1996 Revenue ($ Million)	Average Percentage of Revenue Related to Lighting Work
Architectural firm	27.5 (23.5)	22.5 (116)	8.6 (18)	24.3% (35.5%)
Engineering firm	20 (56)	17 (19)	1.6 (4)	40% (33%)
Distributor	8 (17)	11 (12)	4 (6)	100% (100%)
Lighting designer	12 (13)	7 (5)	1 (44)	84% (100%)
ESCOs**	21.8 (-)	22 (-)	10 (-)	90% (-)
Contractor	12.6 (41)	28 (68)	2 (5)	53% (41%)
Overall	**17 (30)**	**18 (44)**	**4 (7)**	**59% (65%)**
Sample Sizes	**57 (24)**	**56 (25)**	**34 (19)**	**56 (25)**

*Note that only lighting distributors and manufacturing reps for lighting companies in the Distributor category were surveyed with regard to lighting design practices.

** Note that nonprogram ESCO figures are based on one sample point.

Market Overview

The market structure for individuals and corporations that design and specify lighting equipment is complex. The entities that design and layout commercial lighting include lighting designers, architects, engineers, electrical and design/build contractors, distributors, manufacturers' reps, and energy service companies (ESCOs). These groups can be single-person operations with a limited set of specialties or large corporations designing or building entire structures. Each of these designer types is used in differing capacities depending on the type of work (i.e., new construction, renovation, retrofit, etc.), the scope of the work (building size and type), and the needs of the client/owner (lighting levels, aesthetic needs, etc.).

Particular lighting needs result in different choices of designers used to specify lighting equipment. These different types of designers often have different goals in mind when specifying lighting equipment, resulting in heterogeneous patterns of equipment specification and design practices. Although we did not ask designers to explain and enumerate their different types of revenue sources, the differences in how they identify their primary business provides some information on differences in their business models with respect to revenues. The key differences between designers with respect to revenues is whether a designer is a service, labor, or equipment-based provider. Lighting design, architectural, and engineering firms are generally service companies for whom most revenues are obtained from design-related fees. Distributors, by definition, make most of their money from their sales of products. Contractors generally make most of their revenues on installation labor and equipment sales (see the following Section 3.6 on Installers). Finally, ESCOs revenues are generally obtained from a combination of services, including audits, design, installation, labor, and financing, all of which are sometimes paid for through shared savings contracts.

For each of the subsegments, we have drawn out some of the attributes that characterize the activities and motivations of these different groups.

Architects

- Generally larger firms specialize in the design of whole buildings and structures, where lighting design is simply a portion of the work, not the major emphasis.
- Often have an electrical engineer on staff or sub out to an electrical engineer or lighting designer for commercial lighting specification.
- Rarely consider rebates for lighting, they are often unaware of utility programs and generally specify efficient equipment because they consider it a better product for their client.
- Often employed to design high-end renovations and remodeling projects that can require more complicated lighting design.
- Emphasize good communication and customer satisfaction, and good, innovative, high quality designs.

- The average size of a design project for an architectural firm (program area) is 150,000 sq. feet, with small projects around 3,000 sq. ft.
- Most lighting projects (47 percent) are in the new construction market.

Engineers

- Often work with architects and/or general contractors providing electrical design services, with lighting design and layout representing a significant share of their typical workload.
- Often perform equipment specification and electrical design work.
- Engineer specification is sometimes heavily influenced or aided by manufacturers' reps and distributors - they tend to use "canned" schematics or templates.
- When asked what were the most important factors in running a profitable design practice in today's market, engineers most frequently cited thorough knowledge of lighting technology and prices, good communication with customers, and quality work.
- Most of engineers' lighting projects (44 percent) are in the new construction market.

Distributors and Manufacturer Reps

- Distributors and manufacturers' reps often assist contractors or electrical engineers to improve the odds that their equipment is chosen. These types of designers (i.e., contractors and engineers) sometimes then reward the rep with specification of their equipment, often making specifications "tight" in an effort to prevent the contractor from selecting alternative equipment.
- Several distributors stated that they rely on efficient lighting rebate programs for business survival, often basing their specification of lighting on that program that will garner a rebate.
- Most of distributors' lighting projects (29 percent) are in the replacement market, with significant shares of work in the retrofit market (26 percent) and new construction market (23 percent).
- Reps generally sell to distributors, and rarely sell to end users or contractors.

Lighting Designers

- Specialize in lighting design and layout, often employed for their expertise in high-end or special circumstance lighting situations.
- Lighting design firms are generally small firms, often only employing one or two people; the largest generally employ up to 30 or 40 people.
- These firms are frequently hired by architects or engineering firms for their expertise in particular lighting situations, but are usually not hired to perform basic or standard design.

- Lighting designers typically consider their clients to be high-end, where the quality of the light and the integrity of the entire lighting system are more important factors than cost.
- Most of lighting designers' lighting projects (41 percent) are in the new construction market, with a significant share (31 percent) in the renovation market.

Contractors

- Contractors (or engineers on-staff at a contracting firm) often lay out lighting for smaller jobs, where the hiring of a design firm may not be necessary. These jobs are often design-build projects, where established rules of thumb are often employed in the design process.
- Generally, contractors that perform lighting design tend to be larger firms. One- or two-person electrical contracting firms generally do not provide design services.
- Lighting designers within contracting firms may alter the original equipment specification to achieve a lower cost for the owner.
- Most of contractors' lighting projects are in the new construction (32 percent) and renovation (31 percent) markets, with a significant share (20 percent) in the retrofit market.

Energy Service Companies

- ESCOs are often design-build contracting companies performing the design, specification, project management, materials procurement, finance, or actual building for a job.
- When not employing a design-build approach, ESCOs hire electrical contractors to perform installation, but they retain project management, supervision, and design responsibilities.
- ESCOs indicated the highest level of importance for energy-efficient lighting technologies, with 100 percent of both program and nonprogram area ESCOs saying they were *very important* to their business.
- These companies also reported the highest levels of rebate utilization for their projects.

As indicated in the above characterizations, the services provided by designers and specifiers can vary significantly from firm to firm. Engineers are probably most often used to specify lighting but this capacity is often only a portion of the work that is done by engineering or architectural/engineering firms. Building and design of space are often the main focus of these firms, with lighting design playing a secondary role. Distributors that perform lighting design and layout are first and foremost lighting or electrical equipment distributors. Lighting design and specification are services generally provided by these companies as an incentive for the end user to purchase their lighting equipment. Contractors and ESCOs may perform many services, including procurement of materials, project auditing, measurement and verification, development and design for lighting, mechanical and control system installation, and project financing.

In the tables that follow in this subsection, we provide a number of results from our surveys that help to explain the key market characteristics of the lighting design business. In Table 3-22, we provide a breakdown of designers' business by market event types (i.e., new construction, renovation, retrofit, etc.). A few observations on the characteristics of the markets served by the designers surveyed are warranted:

- In both program and nonprogram areas, most lighting design work is done in the new construction and renovation markets
- The portion of design activities reported for the retrofit market was much larger in program territories (17 percent for all designers) than in the nonprogram territories (6 percent).
- Replacement is very similar for both program and nonprogram territories, perhaps demonstrating a consistent lighting failure rate.
- Owner/occupants have relatively little influence in the selection decisions of lighting equipment, while architect/engineer/designers have the most influence by a large margin.

Table 3-22
Breakdown of Project Shares by Market Event

	Arch. Firm	Engineering Firm	Distributor	Lighting Designer	ESCO	Contractor	Total Program	Total Non-program
New Construction	47%	44%	23%	41%	0%	32%	38%	52%
Renovation	28%	16%	16%	31%	24%	31%	26%	20%
Remodel	23%	15%	6%	15%	6%	12%	15%	18%
Retrofit	2%	23%	26%	12%	46%	20%	17%	6%
Replacement	0%	2%	29%	1%	24%	6%	5%	4%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

The size and scope of lighting design projects have considerable impact on the type of firm used for design and layout of the lighting system at a facility. The larger architectural and engineering firms tend to take on the larger-sized projects, with lighting designers, distributors, contractors and ESCOs typically picking up the smaller projects. Table 3-23 below shows the average-sized design projects in program and nonprogram territories for each of the six designer types. Overall, the average project size is similar between designers in program and nonprogram areas. Not surprisingly, on average architectural firms, lighting designers, and ESCOs work on larger projects more often than do distributors, engineering firms, and contractors.

Table 3-23
Lighting Design Project Size by Designer Type

	Average Sized Design Project/ Program Area (1,000 sq. ft.)	Average Sized Design Project/ Nonprogram Area (1,000 sq. ft.)
Architectural firm	156	188
Engineering firm*	1,053 (75)	38
Distributor	29	83
Lighting designer	116	201
ESCO	360	
Contractor	49	80
Average	**131**	**118**

* Note that median size (75,000 sq. ft.) was used for engineering answers to the average sized project question because of a particularly large outlier.

A breakdown of the types of customer segments with which the samples of designers do business is provided in Table 3-24. This breakdown is very similar between the program and nonprogram samples. Note that industrial sites make up only roughly 5 percent of this business.

Table 3-24
Breakdown of Customer Segments With Which Designers Work Most Often

	Retail	Leased Buildings	Owner Occupied Buildings	Industrial Sites	Total
Architectural firm	10%	20%	60%	10%	100%
Engineering firm	7%	14%	71%	7%	100%
Distributor	40%	40%	20%	0%	100%
Lighting designer	29%	24%	41%	6%	100%
ESCOs	25%	75%	0%	0%	100%
Contractors	13%	25%	63%	0%	100%
Program Segment %	**19%**	**26%**	**50%**	**5%**	**100%**
Nonprogram Segment %	**17%**	**22%**	**56%**	**6%**	**100%**

Importance of Energy Efficiency

Before asking where energy efficiency fits into their business strategy, we first asked designers and specifiers what were the most important considerations behind lighting selection decisions. The breakdown of the designers' perceptions of the most important reasons for selecting lighting equipment and designs is shown in Table 3-25. Although there are some differences in the program and nonprogram sample results, the overall patterns are very similar. Lighting quality is stated as the most important consideration, followed by electric costs of operation.

Table 3-25*
Designers' Most Important Reasons for Selecting Lighting Equipment and Designs

Reason	Architects	Engineers	Distributors	Lighting Designer	ESCOs	Contractors	Program Total (%)	Non-program Total (%)
Initial cost of the equipment	29%	14%	14%	29%	0%	14%	**11%**	**0%**
Electric costs of operation	6%	25%	0%	25%	19%	25%	**25%**	**35%**
Lighting level	33%	0%	33%	33%	0%	0%	**9%**	**8%**
Lighting quality	27%	14%	9%	41%	0%	9%	**35%**	**38%**
Ease of lamp replace/maint.	40%	0%	20%	0%	0%	40%	**8%**	**4%**
All of the above★	0%	50%	0%	25%	25%	0%	**6%**	**8%**
Satisfying clients★	0%	100%	0%	0%	0%	0%	**2%**	**0%**
Varies by client and application	0%	50%	0%	50%	0%	0%	**4%**	**0%**
Best total solution★	-	-	-	-	-	-	**0%**	**4%**
Performance of lighting system	-	-	-	-	-	-	**0%**	**4%**
Total							**100%**	**100%**

*Note that seven respondents chose more than one answer, and responses with a ★ correspond to "Other" responses

With the purpose of determining the efficiency disposition of designers and specifiers, we asked respondents what the importance of efficient lighting was to their competitive position. Not surprisingly, the responses varied from one subsegment to another, as indicated by the results in Table 3-26. In general, energy efficiency is reported to be an important part of the majority of designer's competitive positions, both in and out of the program areas:

- Fifty-eight percent of designers considered energy-efficient technologies *very important* to their firm's competitive position (62 percent for nonprogram territories)
- ESCOs and contractors were the designer categories that placed the most importance on energy-efficient lighting technologies, with architectural firms.
- A much larger percentage of nonprogram area designers (23 percent versus 9 percent) report that efficiency is *Not Very Important* to their business.

Table 3-26
Importance of Energy Efficient Technologies to the Competitive Position of Design Firms/ Program Area and Nonprogram Area

	Very Important	Somewhat Important	Not Very Important	Not at All Important
Architectural firm	27%	55%	18%	0%
Engineering firm	64%	18%	9%	9%
Distributor	33%	66%	0%	0%
Lighting designer	50%	31%	13%	6%
ESCO	100%	0%	0%	0%
Contractor	75%	13%	13%	0%
Total Percentage	**58% (62%)**	**31% (15%)**	**9% (23%)**	**3% (0%)**

To provide more explanation of the above responses, we have included, in Table 3-27 below, a categorization of the respondents' own explanation of their responses contained in Table 3-26 above.

Table 3-27
***Why* are Energy Efficient Technologies Important to the Competitive Position of Design Firms? (Program Area Only)**

Why are energy-efficient technologies very important, somewhat important, not very important, or not at all important to your competitive position?		
Importance	**Post-Coded Responses**	**Percent (n=34, 1 respondent = 3%, does not include *No Answer*)**
Very or Somewhat	EE is an important element of the design process.	38%
	We believe in it.	15%
	Our job is to provide expertise, EE is part of this.	15%
	Savings drive the process.	9%
	Customers now expect EE.	6%
Not Very or Not at All	EE is still too expensive.	6%
	EE is secondary to other design considerations.	6%
	We are still concerned about the technologies.	3%
	Customers are not interested.	3%

As indicated earlier, the subsegment of lighting designers is particularly sensitive to lighting quality. This outlook can be at odds with energy-efficient design and specification. For example, several lighting designers and architects indicated that fluorescent lights are often overspecified (specified when inappropriate or unnecessary). These situations often arise in special circumstances where fluorescent lighting is inappropriate, such as illuminating art or wood-panel walls. This also happens when someone is convinced to replace a T-12 MB system before the end of the useful life of that fixture. These designers felt that “blindly” retrofitting to efficient technology is not always the best solution and indicated a distaste for companies who push these retrofit jobs on clients regardless of appropriateness.

In a related question, designers were asked how often their *clients requested* T-8s and electronic ballasts. This question sought to gauge preemptive requests by the client with no need to be educated by the designer about lighting system attributes. Table 3-28 shows the incidence of client requests for T-8s and electronic ballasts and the trends in these percentages over the past five years. It is interesting to note that 48 percent of program area designers indicated an increase in client requests for T-8s and electronic ballasts, with only 3 percent saying that the percentage had actually declined. Nonprogram area designers reported a somewhat higher incidence of T-8 and EB requests by clients than did program area designers (42 percent for nonprogram vs. 32 percent for program).

Table 3-28
Percentage of Clients Requesting T-8s and Electronic Ballasts

	Requesting T-8s and Electronic Ballasts		Change in Requests for T-8s and Electronic Ballasts Over Past Five Years/Program Area			
	Program Area	Nonprogram Area	Increased	Decreased	Stayed Same	DK/NA
Architectural firm	30%	38%	56%	0%	22%	22%
Engineering firm	39%	60%	64%	0%	18%	18%
Distributor	65%	68%	75%	0%	0%	25%
Lighting designer	18%	21%	8%	8%	69%	16%
ESCO	20%	-	100%	0%	0%	0%
Contractor	32%	100%	67%	0%	17%	17%
Sample	**46**	**16**	**44**			
Total	**32%**	**42%**	**48%**	**3%**	**32%**	**18%**

Influence on Design and Equipment Specification

This subsection presents the relevant research on the tendency for designers and specifiers to select energy-efficient technologies. The research draws on both supply-side interviews conducted with designers and specifiers, as well as the end-user survey data.

It is often difficult to determine exactly where a design or equipment specification originates. Design and specification work is commonly subcontracted out by the lead design firm (e.g., architect or general contractor). This occurs frequently in situations where the design work requires a high degree of technical knowledge for very specific applications, or when there is a clear economic advantage to allowing another designer to lay out the lighting. Specification may also be heavily influenced by fixture manufacturers' reps, who may offer access to lighting analysis software and templates of layouts as an enticement to the designer to choose a rep's equipment. It should be noted that what comes through as engineer-specified equipment may indeed be equipment that was specified with the aid of a manufacturer's rep. It may be transparent to the contractor or owner who actually designs the lighting that although the work appears to have been performed by the engineer/architect, in fact some credit may be given to the rep.

A breakdown of the locus of decision-making for lighting design and equipment selection (for those projects on which designers work) is shown in Table 3-29. Most importantly:

- Owner/occupants have relatively little influence in the selection decisions of lighting equipment, while architect/engineer/designers have the most influence by a large margin.
- Although owners generally have the final say in what they purchase, designers often indicated that they were hired by the owner as the expert to make the most appropriate decisions for the owner's needs and, hence, their selections were generally heeded.

Table 3-29
Breakdown of Entity Reported to Have the Most Influence on Lighting Design and Equipment Selection Decisions (Program and Nonprogram Areas)

	Owner/ Occupant	General Contractor	Arch./Engineer/ Designer	Total
Architectural firm	23%	8%	62%	
Engineering firm	7%	0%	93%	
Distributor	25%	0%	75%	
Lighting designer	12%	8%	80%	
ESCO	33%	33%	33%	
Contractor	50%	0%	50%	
Count	13	5	51	67
Count percentage	**18%**	**7%**	**75%**	**100.0%**

In the end-user survey we asked respondents whether they had undertaken various kinds of construction projects involving installation or replacement of fluorescent lighting systems over the past five years. These questions were asked in blocks addressing different types of lighting purchase events – new construction/remodeling, renovation, and retrofit – separately and in sequence. Those customers who answered affirmatively were asked whether the supply-side actors shown below had participated in lighting selection for the most recent such purchase. Respondents could mention multiple specifiers for a given purchase. Table 3-30 displays the results of this portion of the survey. Major observations resulting from the data are as follows:

- Generally, the percentages of establishments that report the use of certain kinds of companies or professionals for lighting specification are close to the percentages of floorspace they represent. This suggests that larger organizations do not necessarily use architects and designers more often than smaller ones.
- According to customers' perceptions, electrical engineers and general contractors are the professionals most often involved in lighting specification. This may reflect the customers' point of view: that they deal directly with the general contractor or architect.
- With respect to new construction and remodeling, the relatively high percentage of customers who report that no designer was used may reflect the customers' point of view. That is, customers generally do not get involved with lighting specification in new construction. In terms of floorspace represented, electrical engineers were mentioned most frequently as having input into lighting selections in new construction and remodeling (42.4 percent). The next most frequently mentioned supply-side actors were general contractors (37.4 percent) A surprisingly high percentage of respondents (24 percent) reported that no specifiers were involved in the decision.
- The most frequently involved actors in renovation projects were electrical contractors (55 percent) and general contractors (50 percent)
- The most frequent participants in retrofit decisions were electrical engineers (54 percent) and electrical contractors (32 percent).

Table 3-30
Percentage of "Most Recent Projects" in Which Supply-Side Actors Participated in Lighting Projects

	Build-Out/Remodeling		Renovation		Retrofit	
	% of floorspace	% of Estab's	% of floorspace	% of Estab's	% of floorspace	% of Estab's
Architect	35.5%	17.5%	34.0%	25.1%	5.3%	5.8%
Lighting Designer	25.6%	8.8%	17.8%	7.2%	32.2%	18.9%
Electrical Engineer	42.4%	21.7%	34.7%	22.9%	54.0%	33.8%
General Contractor	37.4%	29.6%	50.0%	43.0%	30.8%	22.4%
Electrical Contractor	31.1%	12.9%	54.9%	49.3%	32.7%	36.3%
Distributor	9.2%	6.7%	28.6%	33.1%	30.4%	27.9%
No Designer	45.1%	37.0%	13.7%	14.6%	17.8%	37.3%

Table 3-31 and Table 3-32 show the percentage of customers who report using electronic ballasts and T-8 lamps in construction projects involving lighting by purchase event type and reported use of various kinds of specifiers. Only lighting designers and distributors show a consistently high level of association with installation of efficient equipment across all lighting events. The general pattern of response is similar for the T-8s and electronic ballasts.

Table 3-31
Percent of Customers Who Use Electronic Ballasts by Specifier Type on Most Recent Project and Event

Type of Specifier	New Construction/ Remodeling	Renovation	Retrofit
Architect	36%	31%	39%
Lighting Designer	98%	82%	99%
Electrical Engineer	38%	40%	77%
General Contractor	28%	43%	71%
Electrical Contractor	38%	59%	73%
Distributor	64%	77%	55%
No Specifier	16%	65%	49%
Sample Average	**35%**	**55%**	**58%**

Table 3-32
Percent of Customers Who Use T-8 Lamps by Specifier Type on Most Recent Project and Event

Type of Specifier	New Construction/ Remodeling	Renovation	Retrofit
Architect	27%	6%	13%
Lighting Designer	80%	9%	44%
Electrical Engineer	21%	12%	46%
General Contractor	14%	13%	27%
Electrical Contractor	35%	35%	47%
Distributor	60%	38%	20%
No Specifier	15%	30%	27%
Sample Average	**22%**	**29%**	**36%**

3.6 INSTALLERS

Sample Characterization

A total of 38 installers were interviewed for the study, 30 of which were in the program area and the remaining eight were in nonprogram areas. The interviews covered a broad range of installer types. As the segmentation section below describes, there were a variety of installer types. Each company may not fit exactly into the category described in the segmentation section listed in the table below, as there are numerous business models within this segment of the industry.

Moreover, given the diversified business models in this market sector, some companies may overlap the proposed categories. Additional characteristics of the installer sample are provided below:

- Out of 20 respondents, three, or 15 percent, were affiliated with an electric utility.
- Out of 21 respondents, 14, or 67 percent, had other offices in California.
- Ten out of 17 installer interviews, or 59 percent, were located at the company headquarters.
- The average project size of program respondents was approximately 82,000 sq. feet; the average project size for nonprogram respondents was 92,000 sq. feet

Table 3-33
Breakdown of Installer Sample

Type	Program	Nonprogram
Electrical Contractor	16	7
Energy Service Company	7	1
Lighting Management Companies	3	0
Integrated Lighting Companies	4	0
Total	**30**	**8**

Table 3-34
Installer Sample Characterization

Installer Type	Average Age of Company	Average Number of FT Employees	Average 1996 Revenue ($ Million)	Average Percentage of Revenue Related to Lighting Work
Electrical Contractor	27 (n=13)	26 (n=13)	3.6 (n=13)	41% (n=13)
Energy Service Company	21 (n=4)	25 (n=5)	6.9 (n=4)	85% (n=5)
Lighting Management Company	20 (n=3)	10 (n=3)	4 (n=1)	65% (n=3)
Integrated Company	10 (n=2)	14 (n=2)	0.25 (n=1)	85% (n=2)
Program Total*	**23 (n=22)**	**23 (n=23)**	**3.9 (n=19)**	**58 (n=23)**
Nonprogram Total	**33 (n=8)**	**74 (n=8)**	**4.9 (n=6)**	**36% (n=8)**

Market Overview

Once the lighting layout and specification has been completed and the equipment has been procured, the final step is the installation of lighting equipment; we refer to the class of market actors that perform this task as Installers. As will be further discussed, this sector is characterized by a wide variety of business models and a large number of firms. The segmentation of installers is defined below.

Given the large number of firms participating in the market, there is relatively little market concentration. The installation market is highly competitive; for the typical project, bidding and price are the most important factors in awarding a contract.

There are six subclasses of actors involved in the installation of fluorescent luminaires, lamps and ballasts. They are:

1. Electrical contractors. Electrical contractors perform most of the installations for new construction, tenant improvements, and retrofit projects. Generally, electrical contractors specialize in electrical installation, maintenance and repair. Most of their projects are limited to these tasks; however, a small share of firms offer other services, such as financing, design, and energy services. Out of 13 respondents, nine stated that at least 80 percent of their business was attributable to installation.
2. Energy Service Companies. ESCOs often initiate and manage retrofit projects, but tend to subcontract the actual installation to electrical contractors. These companies almost always offer design and layout services as well as energy management services.
3. Lighting Management Companies. Lighting management companies often install, maintain, and repair fluorescent lighting for end users. These companies are usually involved in retrofit and replacement activities. Often these companies offer lighting maintenance services, for end users who wish to outsource lighting maintenance, repair. and operation (MRO).
4. Integrated Lighting Companies. These companies install, maintain, and repair fluorescent lighting in addition to offering other lighting services. These firms can be fully integrated, starting with the manufacture of lighting equipment. Often these firms manufacture “retrofit kits,” a luminaire upgrade containing a reflector, and T-8 EB system. They may also design and distribute their own lighting equipment, as well as distribute or resell other lighting equipment. Installation and lighting maintenance usually account for the largest share of these firms’ revenues.
5. End Users/Facilities Managers. End users and facilities managers, although not part of the supply side of the lighting market, have a significant impact on lighting selection decisions for replacement, since they are frequently the market actors who replace failed equipment.

Note that End Users/Facilities Managers are generally not considered actors in the supply side of the lighting market, but are included in this section to properly characterize the types of entities involved in installing equipment over the study period.

Also note that the lighting maintenance firm is a relatively new business model that has evolved over the past five years. Through several in-depth interviews with these firms and other energy service companies considering entry into this market, we learned that lighting maintenance companies often started out as retrofit contractors but in recent years have expanded their services. As the outsourcing of facilities management tasks increased and utility rebates decreased, these companies created a new market for lighting maintenance services. As further evidence of this trend, the following quote is from a June 1997 press release by Sylvania Lighting Services, the largest lighting maintenance company in the United States, "Due to changes in the marketplace brought about by utility deregulation, and the decline of demand-side management (DSM) and utility rebate programs, there has been a shift from the retrofit market to the maintenance service market."

In addition to lighting retrofits, these firms offer replacement, maintenance, cleaning, and repair services. Three of the largest lighting maintenance companies we spoke with indicated that distribution between lighting maintenance and retrofit projects was approximately half and half. We also interviewed several retrofit contractors and ESCOs that are contemplating entering the lighting maintenance market in response to, as one interviewee phrased it, the "dwindling [retrofit] market."

According to at least two firms we interviewed, maintenance services are most often provided to chains and property management companies. The retail sector was the most frequently cited end-user segment that employs lighting maintenance companies.

The development of lighting maintenance firms has had a positive impact on energy efficiency. Generally, lighting maintenance firms practice energy-efficient specification when it is "cost effective" for their clients; energy savings through improved technologies, group relamping and lumen maintenance are a significant selling point for lighting maintenance companies. One firm we spoke with indicated that their policy is to replace all failed ballasts with electronic models and use T-8 lamps. All of the lighting management companies we spoke with were knowledgeable of life-cycle cost analysis and use energy savings analysis as a marketing tool.

With regard to ESCOs, a number of respondents pointed out significant changes that this sector has undergone in recent years. Below are the major trends in the ESCO industry that survey respondents identified.

- According to several ESCOs we interviewed, in recent years the structure of the ESCO market, both nationally and in California, has undergone, and continues to experience, significant changes. Changes in ownership and in the types of transactions reflect the two primary areas identified by the ESCOs interviewed. Ownership has changed through utility acquisitions of ESCOs and through nonutility consolidation. The change in ownership is caused by decreasing profitability in the industry and the expansion of utility services brought on by the prospects of electric deregulation. One ESCO asserts that ESCOs are faced with two choices, "file for bankruptcy or else get acquired by a utility."

- The second trend identified through our research is the movement away from performance contracting and towards third-party financing for retrofit projects. Three of the ESCOs we interviewed, all of which operated in multiple states, including California, claimed that end users objected to the performance contracting approach because they think ESCOs “keep too much of the savings.” In the words of one respondent, “a lot of customers are afraid that they are leaving too much on the table.” In place of the performance contracting approach, ESCOs are increasing the amount of third-party financing as a way to mitigate the customer’s resistance to the initial cost of the project.
- The trend in utility acquisitions of ESCOs and contractors impact the market by “cutting out the middleman” and reducing the cost of lighting. According to one ESCO, utilities can buy direct from the manufacturer, given that they “already have excellent relationships.” He also stated that electrical and industrial distributors make very little money on lighting, implying that lighting will be supplied less and less through distributors.

Looking now at the types of projects these business types are involved in, Table 3-35 displays the breakdown of supplier activity by the type of event. As can be seen from the table, electrical contractors are most active in the new construction market, while, not surprisingly, ESCOs and lighting management companies are most active in the retrofit market.

Table 3-35
Percent of Projects by Event (Program and Nonprogram)

Installer Type	New Construction	Major Renovation	Remodeling	Retrofit	Replacement	Sample Size
Electrical Contractor	46%	25%	13%	16%	1%	14
Energy Service Company	4%	14%	5%	62%	15%	5
Lighting Management Co.	1%	2%	2%	70%	25%	4
Integrated Company	5%	45%	18%	15%	17%	2
Total	**27%**	**21%**	**10%**	**34%**	**9%**	**25**

Table 3-36 and Table 3-37 display the primary purchasing channels used by installers. Generally, most equipment procurement is done through wholesale distributors in both the program and nonprogram areas, while buying direct from manufacturers accounts for a much smaller share, approximately 16 percent in the program area. In Table 3-37, we show the percentage of supply-side purchases for traditional versus nontraditional contractors (nontraditional being defined as ESCOs, lighting management, and integrated lighting firms). The information in this table indicates that the nontraditional contractors seem to purchase significantly more product directly from manufacturers, thus cutting out the distributors in the middle of the market.

Table 3-36
Installer Purchases by Supplier Type, Program Versus Nonprogram Areas

Supplier	Program	Non-program
Wholesale	80%	88%
Manufacturers	20%	12%
Retail	0%	0%

Table 3-37
Installer Purchases by Supplier Type, Traditional Versus Nontraditional Contractor

Supplier	Traditional Electrical Contractor	Non-traditional Contractor*
Wholesale	93%	64%
Manufacturers	7%	36%
Retail	0%	0%
*Includes the ESCO, lighting management, integrated lighting firms.		

Table 3-38 and Table 3-39 provide additional information on the types of other services offered by installers and the most common type of facility that they work on.

Table 3-38
Percentage of Companies Interviewed that Offer Services by Type of Service

Area	Installation	Design	Manufacture	Sell Equipment
Program	100%	69%	7%	14%
Nonprogram	100%	88%	0%	0%

Table 3-39
Most Common Type of Facility Worked On (Number of Responses)

	Institutional	Office	Industrial	Retail	Other
Nonprogram	3	0	4	1	0
Program	4	11	3	5	3

Importance of Energy Efficiency

Installers vary widely with respect to their disposition on energy efficiency. Generally, the dispositions vary with the subsegments into which they are categorized in this study. Electrical contractors are generally less concerned with efficiency than are energy service companies and lighting management firms. However, we did interview some electrical contractors that viewed energy efficiency as very or somewhat important to their competitive position. All ESCOs and lighting management companies stated that energy efficiency was very important to their competitive position. In Table 3-40 we present the reported importance of energy-efficient products and services segmented by traditional and nontraditional installers. Although the sample sizes are small, it is important to note that all of the nontraditional installers reported that efficiency was *very important* to their position versus only 45 percent of traditional contractors.

Table 3-40
Importance of Energy-Efficient Technologies to the Competitive Position of Installers

In terms of maintaining your firm's competitive position, how important is offering energy-efficient lighting technologies in your installations? Is it ...		
Response	**Traditional Electrical Contractor (n=20)**	**Nontraditional Contractor* (n=8)**
Very Important	45%	100%
Somewhat Important	30%	0%
Not Very Important	15%	0%
Not at All Important	10%	0%
Total	**100%**	**100%**
*Includes the ESCO, lighting management, integrated lighting firms.		

Table 3-41 provides further explanation from respondents on their energy-efficiency disposition.

Table 3-41
Respondents' Explanations of the Importance of Energy Efficiency to Their Firms' Competitive Position (Program Area Only)

Assessment of importance of Energy Efficiency	Verbatim responses when probed to give their assessment of the importance of energy efficiency to their firms' competitive position.
Very Important	"Providing cost savings and energy savings for the customers is what keeps us competitive and gives the customers what they want."
Very Important	"The customers like the color index and lack of flickering with these technologies as well as the energy and costs savings."
Very Important	"Customers are not only looking for energy efficient products - they want other services as well...design, layout, maintenance, customer service, etc."
Very Important	"The energy and money savings related to these products is what drives their sales."
Very Important	"The customers want these products. To remain competitive we need to use these products and we need to bid on projects that provide savings to the customer both in energy and in their wallet."
Very Important	Energy efficiency is "all we do."
Not Important at All	"The work is already designed and specified, we just bid on it and do the installation."
Not Important at All	"We already have established customers - we'll be able to sell regardless of energy efficiency."
Not Very Important	"We need to know and understand energy-efficient technologies, but they're not that important."

According to 16 program respondents, customers object to the specification of T-8 electronic ballast systems an average of 5 percent of the time. According to all nonprogram respondents, in no cases do customers object to the specification of T-8 electronic systems. With respect to efficiency penetration, 13 out of 15 respondents stated that the share T-8 electronic ballast systems increased over the past five years; the remaining two respondents stated that they did not know.

Influence on Design and Equipment Specification

Most lighting installers offer design and specification services, although the degree to which they actually participate in the design and specification process varies widely from company to company. Of 23 respondents interviewed, 11 stated that they have design and specification influence less than 20 percent of the time, while nine of the 23 stated that they have influence in over 80 percent of the lighting projects they work on. According to those surveyed, the level of participation in this aspect of the lighting process has not changed much over the past five years. Only two out of 22 claimed the percentage of time that they participated in the design and specification process has increased over the past five years and only two out of 22 claimed they participated less.

We asked installers directly what market actor has the most significant influence over the selection of lighting equipment. The responses to the questions are displayed in the table below (each column is a response category). Installers report that specifiers (architect/engineer/ designer) have the most influence followed by owners/occupants, whereas general contractors and developers rarely have influence in the selection of lighting equipment.

Table 3-42
Breakdown of Entity Reported by Installers to Have the Most Influence on Lighting Design and Equipment Selection Decisions (Program Area Only)

	Owner/ Occupant	Developer	Architect/ Engineer/ Designer	General Contractor	Contractor/ ESCO
Contractors	3		9	1	4
ESCOs	2		3		2
Lighting Management Co.	1	1			1
Integrated Lighting Co.		1			
Total	**6**	**2**	**12**	**1**	**7**

4 MARKET INTERVENTIONS: UTILITY PROGRAMS AND GOVERNMENT STANDARDS

This section provides descriptions both of the programs offered by PG&E and SDG&E to promote energy-efficient lighting in their service territories and of the commercial lighting activities of government agencies, principally with respect to California's Title 24 energy code. The section is organized as follows:

- Brief overview of aggregate program activities over time.
- Description of PG&E's programs during the study period.
- Description of SDG&E's programs during the study period.
- Description of relevant government interventions.

4.1 OVERVIEW OF SPONSORS' PROGRAM ACTIVITY LEVELS

We provide in Figure 4-1 a general summary of the major program activities of the sponsors' nonresidential lighting-related programs. The program profiles that follow in this section include descriptions of the types of programs offered, program changes over time, program activity, and participation trends. The lighting programs of the sponsor utilities resulted in the installation of millions of efficient lighting components and systems. Most of these installations were the result of incentives paid to end users and/or other market actions. From a market effects perspective, however, the direct change-outs do not provide the complete picture. The utility programs also involved many other activities that may have directly or indirectly reduced market barriers. While impact evaluations are available (these summarize energy and demand impacts from the incentive programs), indirect activities (such as vendor education and customer financing) have not been well documented, even by the sponsor utilities. Some of these efforts, such as the Pacific Energy Center, are being separately assessed in their own market effects studies. In addition to the "hard data" on program effects, this section presents some preliminary discussion of indirect program efforts from in-person and telephone interviews conducted with program personnel during the summer and fall of 1997.

As Table 4-1 shows, the ballasts and lamps rebated through the sponsors' programs accounted for a large portion of the estimated total flow of purchases. The volume of equipment rebated through PG&E's new construction programs is an estimate based on reported savings and staff comments on the representation of lighting measures in the overall mix of equipment supported by the programs. Moreover, based on estimates of the penetration of efficient technologies discussed above, the sponsors accounted for 50 to 60 percent of the purchases of efficient equipment.

Figure 4-1
Time Line of PG&E and SDG&E Lighting Program Activities

Year	PG&E New Construction	PG&E Nonresidential CEE Spending ->	PG&E Retrofit	SDG&E New Construction	SDG&E Lighting Rebates ->	SDG&E Retrofit
1985						
1986	Start program to promote Title 24 to large commercial customers					
1987						
1988	Promote Title 24 LPD+20% through incentives and education -- attempt to address small customers			Promotion of Title 24+ to architectural and mechanical-electrical design firms		Custom lighting retrofit through a few contractors for large commercial
1989						
1990	Increase educational efforts tto designers & general market through PG&E Enegy Center			Focus on 4' lighting	$74,647	Quantity-based incentives
1991					$5,416,342	
1992	Address stocking of efficient products through vendor incentives -- targeting owners and property managers	$57,945,000	Retrofit Express started to push most efficient lighting components	Launch Savings through Design program based on Title 24 for all projects	$6,656,309	Broaden list of contractors, start audit program for small commercial, use of kWh based incentives
1993		$57,878,000			$9,090,772	
1994	Update incentive structure to increase share of whole building performance projects	$80,402,000	Special emphasis on working with PG&E divisions	Dropped whole building performance approach in favor of prescriptive/custom mix	$15,631,347	Merge programs into Power to Save -- emphasis on schools and military bases
1995		$52,385,000			$22,011,449	
1996		$44,625,000	First year of CustomNet and targeting of local chains	Adopted LPD approach for better than Title 24 (+ >14%)	$12,044,417	Prescriptive rebates started -- drop 4' T-8 lamps
1997						
1998	Push for 20% or better over Title-24		Transition away from rebates as well as dropping technologies with high saturation			

Table 4-1
Estimated Unit Volume of Sponsors' Program Activity
In Relation to Total Purchase Volumes*

Units Rebated: 1992-1996 by Program Type (in millions)					
Utility	**Retrofit**	**Custom**	**New**	**Total**	**% of Total Purchases: 1992-1997**
PG&E					
Electronic Ballasts	3.6	0.3	1.5	5.3	28%
T-8 Lamps	6.9	0.8	4.4	12.1	24%
SDG&E					
Electronic Ballasts	--			2.2	32%
T-8 Lamps	--			4.7	27%
Sponsor Total					
Electronic Ballasts				7.5	30%
T-8 Lamps				16.8	26%

*A number of assumptions are required to convert utility tracking system data to units because many measures are bundled. In some cases, for example, the PG&E New Construction programs, total savings at the end-use level was converted into estimates of the number of electronic ballast and T-8 lamps. The total number of units rebates should thus be considered approximate estimates.

4.2 PG&E PROGRAMS

This section presents summaries and analyses of PG&E's efforts during the study period (1992-1996) to achieve nonresidential lighting savings. Key sources for the information in this section include data received from PG&E's Marketing Decision Support System (MDSS) database; review of PG&E program collateral, M&E studies, annual DSM reports; and interviews with PG&E staff.

4.2.1 Program Descriptions

The relevant nonresidential programs include these five main program components:

- Commercial New Construction Programs.
- Incentive Programs.
- Energy Management Services.
- Information Programs.
- Other Commercial Energy Efficiency Programs.

These programs offered a variety of services to the commercial, industrial, and agricultural sectors, including:

- Commercial new construction efficiency promotions.
- Rebates.
- On-site energy surveys.
- Conservation and energy-efficiency information.

Commercial New Construction Programs

Commercial New Construction Programs were established to promote the design, construction, and operation of energy-efficient buildings. The programs paid incentives for demonstrated improvements over Title 24 standards. Energy-efficient lighting components were offered through the following subprograms:

Prescriptive Express offered incentives for projects 30,000 sq. feet or less. Incentives were offered on a per item basis for lighting systems that reduced the allowed lighting power density by 20 percent or more from Title 24 standards.

Prescriptive Plus offered incentives on projects of any size, using a prescriptive method of compliance for projects exceeding Title 24 energy-efficiency standards.

Performance by Design offered incentives for reducing estimated annual energy use by 10 to 40 percent below Title 24 standards. Typically this program was used for large projects. Incentives ranged from $0.05 to $0.40 per kilowatt hour for savings beyond the base case.

The New Construction programs have always emphasized Lighting Power Density (LPD) as the key measure of lighting “efficiency” for a space, rather than the efficiency of individual components or systems.

In the New Construction area, PG&E staff indicated that they have historically tried to leverage and improve the Title 24 standards through indirect activities. Cited examples included:

- Promotion of the use of Title 24 provisions among designers ahead of their initial adoption in 1987.
- Efforts to improve compliance with Title 24 through program incentives and helping to simplify and extend the code in the early 1990s.
- Persuasive lobbying for tighter standards in the revision to take effect in 1998 (including use of program accomplishments as evidence of the feasibility of lower LPD levels).

Incentive Programs

Over the study period, PG&E principally offered two types of financial incentive programs to commercial, industrial, and agricultural customers for retrofitting lighting equipment.

- Retrofit Express Program
- Customized Program

In the later years of the study, 1995 and 1996, the customized program evolved into new program vehicles (APO - Advanced Performance Options, and REO - Retrofit Efficiency Options) that generally excluded lighting measures otherwise available via the Express program.

The ***Retrofit Express Program*** was primarily marketed to small- and medium-sized commercial customers. The program offered a standard fixed rebate per item. Customers were required to provide proof of purchase along with an application to receive the rebate. The program was marketed by PG&E representatives and trade allies, including manufacturers, retailers, and distributors. A Retrofit Express Web site was started in 1996.

The ***Customized Program*** was offered to customers who undertook large complex projects. Incentives were offered on a first-year savings basis and were paid on a cents per kWh and dollar per kW-saved basis. As noted above, from 1992 to 1994, many of the same measures incented in the Retrofit Express program were also eligible for the customized program (since the latter paid on a per kWh or kW-saved basis). Components available in the Express program were no longer eligible for the Custom programs after 1994.

Energy Management Services

The Energy Management Services Programs were designed to help commercial customers understand how they are using energy. Services range from a “walk through” energy audit (including basic recommendations) to special consultant studies, informational seminars, and technical workshops. All program efforts are aimed at informing the customer about how they can best maintain existing technology and use new energy-efficient technologies to replace obsolete or inefficient equipment.

In the earliest period of program activity, PG&E’s Energy Management Services helped customers determine “low cost, no cost” energy savings measures (all technologies). From 1983 to 1985, the peak period of activity, PG&E fielded 250 full-time engineers to support this program. By comparison, there are currently approximately 50 EMS field engineers.

Other Programs

Powersaving Partners. As part of a collaborative agreement, PG&E has conducted a pilot DSM bidding program that allows ESCOs to provide cost-effective DSM measures to PG&E customers. This program commenced in earnest in 1995 and 1996 but is not in the scope of this project.

Commercial Sector Pilots. The goal of the commercial sector pilots was to increase the delivery effectiveness of energy-efficiency resources to various customer groups and local distribution areas. Much of the effort in the pilots focused on lighting technologies including T-8 lamps, electronic ballasts, optical reflectors, and hardwired compact fluorescents. The pilots would typically pay a high portion (up to 100 percent) of the labor and hardware costs of the installations. One example of this type of program was the small commercial component of the Model Energy Communities (MEC) Program, which operated over the period 1991 to 1993. This portion of the MEC program aggressively sought to offset rapid growth in a selected local area's electricity demand through implementation of direct installation lighting and HVAC programs.

4.2.2 Incentive Levels and Eligible Measures Over Time

The essential structure of the PG&E programs with regards to nonresidential lighting did not change substantially between 1992 and 1996, with a few exceptions as noted in the following subsections. The information in the tables in these subsections was developed from collateral material, generally the rebate forms themselves, for the 1992 to 1996 period.

Retrofit Programs

Customized Incentives

Changes in the customized program rebates are shown in Table 4-2. The Customized Incentive program was closed to new applications after 1994. New variants of the program emerged in the following years. These post-1994 programs generally precluded lighting measures that were otherwise available through the Retrofit Express program.

Table 4-2
PG&E Customized Incentives by Year (Lighting Component Years Only)

Year	Minimum Rebate	Maximum Rebate	$/kWh	$/kW
1992	$100	$300,000	$0.06	
1993	$250	$300,000	$0.05	$50
1994	$2,500	$500,000	$0.04	$200 plus $50/kW for early completion

In 1996, the Retrofit Express program offered a Tailored Energy Planning Assistance (TEPA) service that offered professional services in lieu of rebates as incentives. Customers could use the rebate dollar amounts to purchase services from PG&E or to hire third-party providers.

Retrofit Express

The following table documents the rebates offered for nonresidential lighting technologies from 1992 to 1996.

Table 4-3
PG&E Retrofit Express Rebates for Lighting Equipment

Equipment	1992 Rebate	1993 Rebate	1994 Rebate	1995 Rebate	1996 Rebate
Incandescent to Fluorescent Lamp with Electronic Ballast			$25	$15	$15
Electronic Ballast	$5				
2-lamp ballast		$10	$8	$6	$5.50
3-lamp ballast		$15	$12	$9	$8.50
4-lamp ballast		$20	$16	$12	$11
Replacement of Lamps (32-watt T-8 lamp)		$1/lamp			
Retrofit Fixtures with T-8s and Electronic Ballasts					
(1) 32-watt T-8 lamp	$10				
(2) 32-watt T-8 lamps	$25				
(3) 32-watt T-8 lamps	$30				
(4) 32-watt T-8 lamps	$30				
Replacement of Lamps and Ballasts (/lamp installed)					
2-foot, T-8 lamp & electronic ballast		$7	$3	$2.25	$2.25
3-foot, T-8 lamp & electronic ballast		$4	$4	$3	$3
4-foot, T-8 lamp & electronic ballast		$6	$6	$4.50	$4.25
8-foot, T-8 lamp & electronic ballast		$10	$12	$9	$8.50
New Fixtures with T-8s and Electronic Ballasts					
2-Foot Fixtures					
(1) 31-watt T-8 U-tube or (2) 17-watt T-8 lamps			$10	$8	
(2) 31-watt T-8 U-tubes or (4) 17-watt T-8 lamps			$25	$20	
(3) 31-watt T-8 U-tubes or (6) 17-watt T-8 lamps			$30	$24	
4-Foot Fixtures					
(1) 32-watt T-8 lamp	$10	$10	$10	$8	
(2) 32-watt T-8 lamps	$30	$25	$30	$22	
(3) 32-watt T-8 lamps	$35	$30	$35	$28	
(4) 32-watt T-8 lamps	$40	$35			
8-Foot Fixtures					
(2) 32-watt 4-foot, T-8 lamps or (1) 8-foot, T-8 lamp				$22	
(4) 32-watt 4-foot, T-8 lamps or (2) 8-foot, T-8 lamps			$40	$30	
High-Output Fluorescent Conversion					
(2)32-watt T-8 or (2)40-watt T-10 and electronic ballast			$12	$6	

Table 4-4
Retrofit Express Rebates for Lighting Equipment

Equipment	1992 Rebate	1993 Rebate	1994 Rebate	1995 Rebate	1996 Rebate
High-Intensity Discharge (HID) Fixture, 176W or greater					
Interior					
176-250 watt lamp		$100	$100	$70	$63
250-400 watt lamp			$120	$80	$72
Exterior >= 175 watt lamp		$60	$50	$30	$27
Controls					
Time clock		$25	$15	$10	$9
Occupancy sensor					
72-350 watts controlled		$15			
351-1,000 watts controlled		$31			
1,000+ watts controlled		$80			
Wall-mounted sensor			$15	$10	$8
Ceiling-mounted sensor			$30	$25	$22
Bypass/Delay Timer		$10			
Photocell		$10	$5	$4	$3.50

The tables above indicate that PG&E's rebate levels fell over the study period. Moreover, rebates for several kinds of measures were terminated during the study period. For example, rebates for bypass/delay timers for lighting controls were terminated in 1993. Note that rebates for new fixtures fitted with T-8 lamps and electronic ballasts were combined into the measure "replacement of lamps and ballasts" in 1996.

New Construction

Prescriptive Express

The following table documents the new construction rebates offered for 1992, 1994, and 1995. Generally, these rebate levels and the specification of eligible equipment remained virtually unchanged over the study period. Level 1 and Level 2 in the tables below correspond to specific Lighting Power Density (LPD) threshold levels by building and area types. Incentives on a per fixture basis ended in 1995, leaving the $/sq. foot incentives based on LPD described in the Prescriptive Plus subsection below.

Table 4-5
PG&E Prescriptive Express Rebates for Lighting Equipment

Equipment	1992 Level 1	Rebate Level 2	1994 Level 1	Rebate Level 2	1995 Level 1	Rebate Level 2
2-Foot Fixtures						
(1) 31-watt T-8 U-tube	$6	$10	$6	$10	$4	$10
(2) 31-watt T-8 U-tubes	$12	$18	$12	$18	$8	$18
4-Foot Fixtures						
(1) 32-watt T-8 lamp	$7	$10	$7	$10	$5	$10
(2) 32-watt T-8 lamps	$15	$25	$15	$25	$10	$25
(3) 32-watt T-8 lamps	$20	$30	$20	$30	$15	$30
8-Foot Fixtures						
(2) 32-watt 4-foot, T-8 lamps	$18	$25	$18	$25	$15	$25
(4) 32-watt 4-foot, T-8 lamps	$30	$40	$30	$40	$25	$40
HID Fixtures						
176-250 watt	$45	$45	$45	$45	$30	$45
251-400 watt	$60	$60	$60	$60	$40	$60

Prescriptive Plus

In the Prescriptive Plus method, incentives were provided on a dollars per sq. foot basis and were not tied to components, as they were in the Prescriptive Express. The Prescriptive Plus also utilized a Lighting Power Density (LPD) Incentive Matrix with incentive levels that varied significantly as a function of LPD by building type (for example, from $0.02/sq. foot to $0.53/sq. foot in 1996).

4.2.3 Summary of Program Activity and Trends

In this subsection, we present three types of program tracking information. First, we present a summary of total nonresidential savings and spending levels over the 1992 to 1996 period. We also present lighting activity levels by program type and year, to the extent available. Second, we provide measure level trends. Third, we provide information on repeat participation across the analysis period.

Aggregate/Program Level Activity

Table 4-6 summarizes trends in nonresidential customer energy-efficiency program spending and net savings over the study period. Spending and energy savings reached their peak in 1994. Since then, the level of program activity has decreased by roughly 45 percent.

Table 4-6
PG&E Total Nonresidential Program Results

Year	MW Savings	MWh Savings	Nonresidential CEE Spending (x1,000)
1992	94.9	475,351	$57,945
1993	73.8	478,277	$57,878
1994	112.8	603,535	$80,402
1995	72.2	419,370	$52,385
1996	60.3	337,052	$44,625

Table 4-7 presents data collected from PG&E evaluations that documented specific program results segmented by lighting end use. We reviewed all of the PG&E evaluations received and incorporated them to the extent that end-use information was available.

Table 4-7
PG&E Nonresidential Lighting Program Results from Evaluation Studies and Regulatory Filings

		Utility Database Savings		Evaluation Gross Savings Estimate		Net Savings (not including spillover)		T-8 & Electronic Ballasts	
Years	**Data Description**	**kW**	**kWh**	**kW**	**kWh**	**kW**	**kWh**	**kW**	**kWh**
	New Construction								
1992-93	Nonres. New Construction (SBW, 1995)	14,686	61,202	13,673	61,202	9,297	41,617		
1992	Commercial New Construction Rebate Program Lighting (PG&E, 1993a)			5,454	22,162				
1993	Commercial New Construction Rebate Program Lighting * (PG&E, 1997a)			8,936	37,811				
1994	Nonres. New Construction Rebate Program Lighting (RLW, 1997)			12,200	63,780				
	Retrofit Programs								
1991-92	CIA Lighting Express & Customized Programs (XENERGY, 1993)	102,360	508,772	80,156	453,342	61,720	349,073		
1994	Commercial Lighting Retrofit Express and Customized Incentives (indoor) (Quantum, 1996a and b)	52,416	280,014	62,389	277,688	56,181	250,058	22,700	87,775
1994	Commercial Lighting Retrofit Express and Customized Incentives (indoor + outdoor) (Quantum, 1996a and b)	52,540	300,752	63,172	295,746	57,044	267,059	na	na
1995	Commercial Indoor Lighting Retrofit Express and Customized Incentives (Quantum, 1997a and b)	26,654	148,842	32,267	138,006	31,492	133,999	14,552	57,723
	Energy Management Services								
1994	Commercial/Industrial Energy Management Services (Hagler Bailly, 1996)			0.65	3,560	0.47	2,581		

Measure Level Transaction Trends

The charts and tables that follow provide a variety of perspectives on program transaction trends for retrofit lighting measures and program types. Information on measure trends in the New Construction programs is not presented because this information is not currently available from the program database (which tracks end use but not measure level impacts).

The two principal retrofit program types, as discussed previously, are Express and Customized. In Figure 4-2 below, we present savings by major measure category and retrofit program type. As indicated by the figure, most of the T-8 and electronic ballast and HID activity has been in the Retrofit Express program.

Figure 4-3 through Figure 4-5 present additional detail on the composition of measures by program year in the Retrofit Express program. These figures present measure activity by savings, rebate, and quantity levels, respectively. Figure 4-6 provides a breakdown of the "Other" lighting category for the Retrofit Express program. As it turns out, this category consists primarily of delamping and CFL measures.

In Table 4-8, we present the major measure activity by year for the Custom program. Unfortunately, most of the activity is in the "Other" lighting category, which we break down in Figure 4-7. There again, however, we find that most of the custom lighting measures have been tracked in an unspecified lighting category.

Note that the major measure categories in the tables and figures represent an aggregation of individual measures that may be lamps, ballasts, or combinations thereof. In Section 9, we provide documentation for how we disaggregated measure bundles into their constituent components (as in Table 4-1 presented at the outset of this section). These component estimates required assumptions regarding savings per measure bundle, particularly for the Custom program because the number of measures implemented is not tracked in the PG&E database. The PG&E database for Custom lighting measures tracks number of applications by measure type—which are often lamp/ballast bundles—and total savings by measure and application type; thus, with assumed savings per measure type it was possible to estimate the number of items in the Customized Program as well.

Figure 4-2
PG&E Major Measure Category and Retrofit Program Type by Year

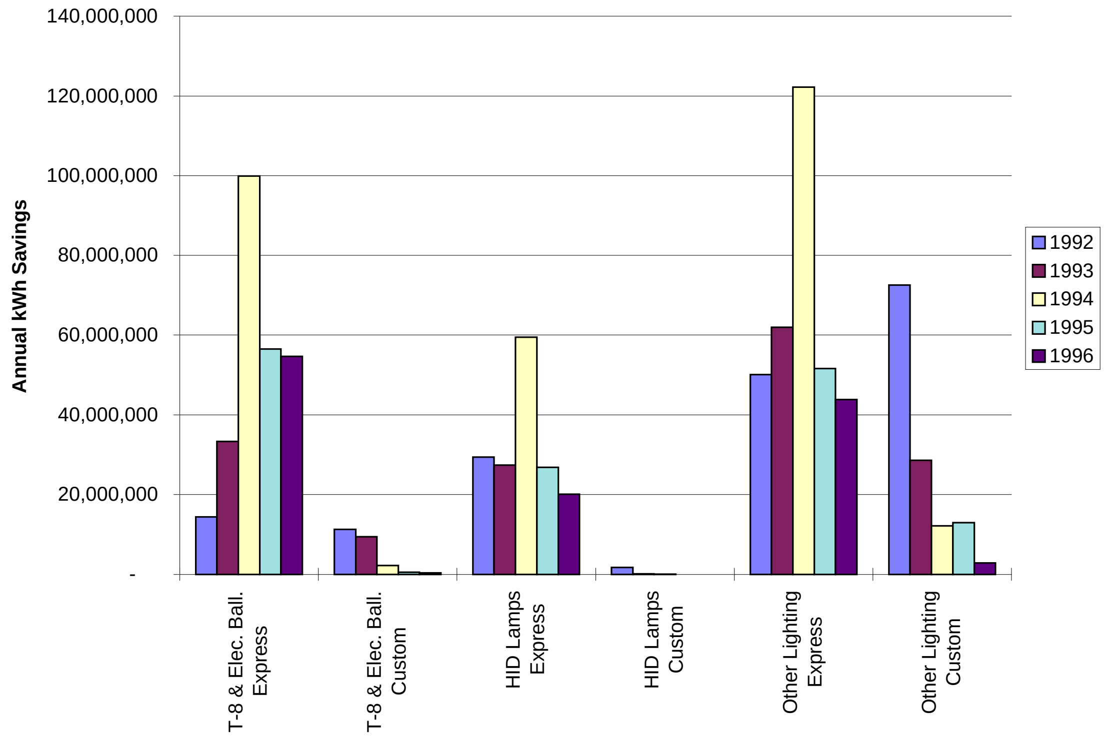


Figure 4-3
PG&E Retrofit Express: Lighting Energy Savings by Measure Type by Year

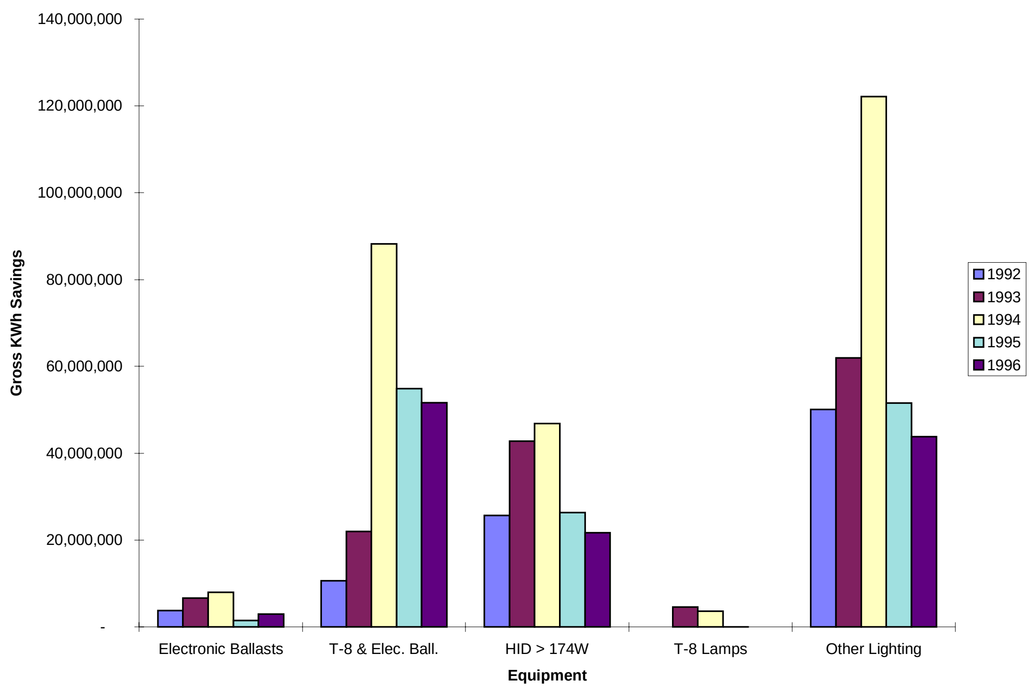


Figure 4-4
PG&E Retrofit Express: Lighting Rebate Amounts by Measure Type by Year

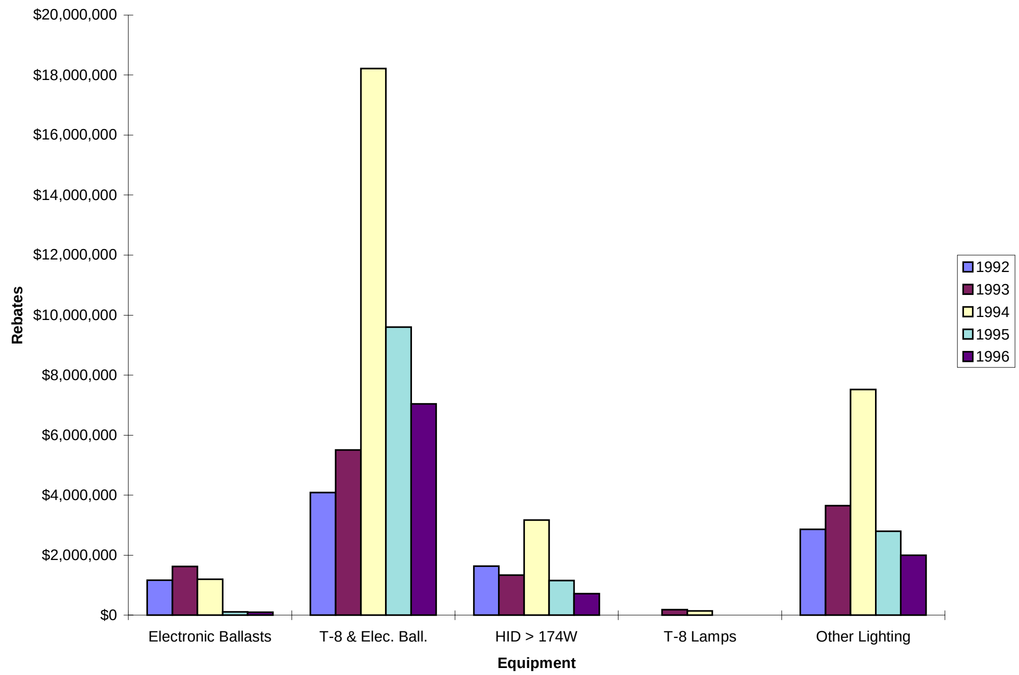


Figure 4-5
PG&E Retrofit Express: Lighting Quantities by Measure Type by Year

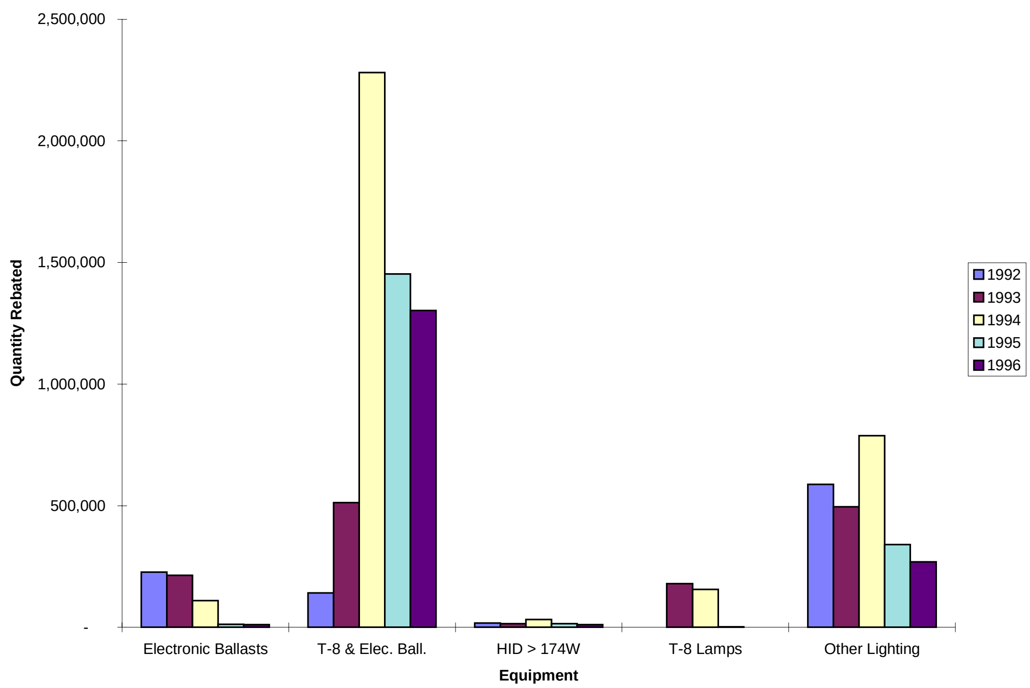


Figure 4-6
PG&E Retrofit Express: Breakdown of "Other Lighting" Category

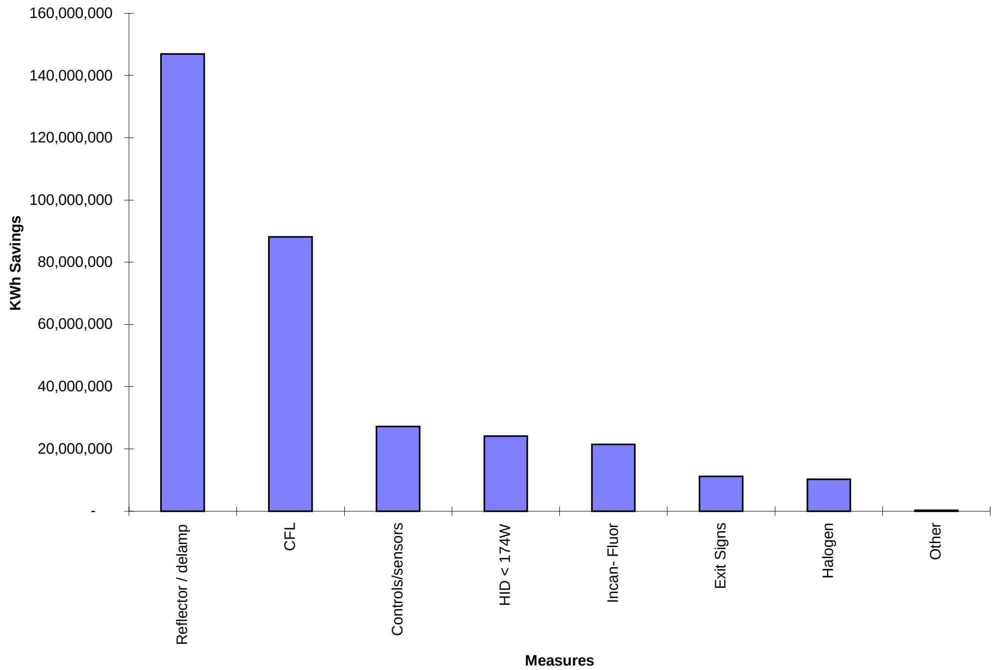
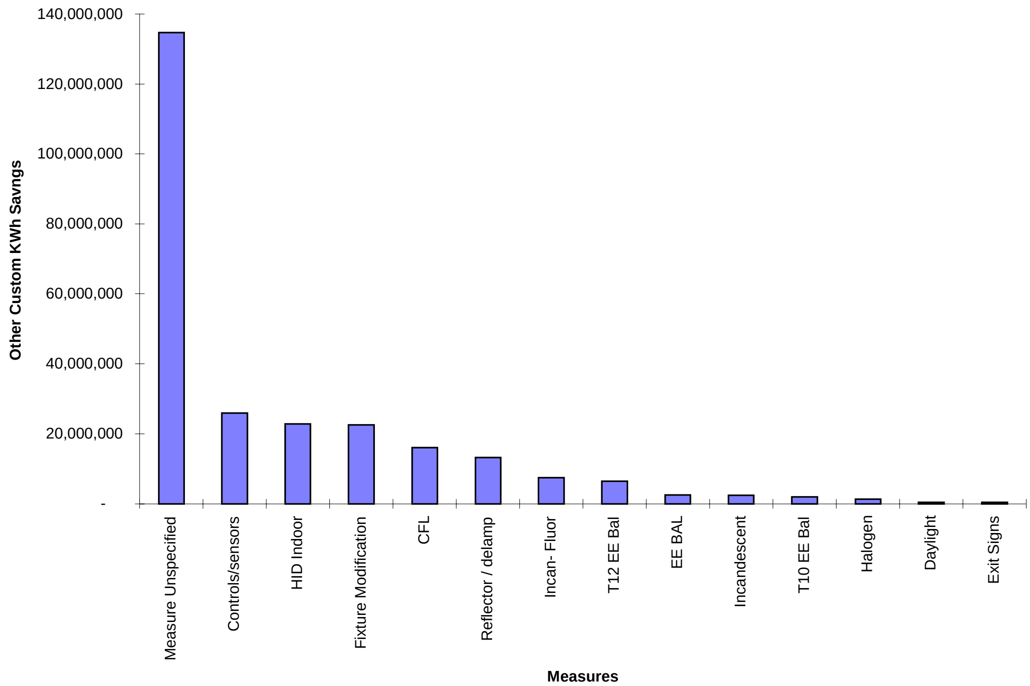


Table 4-8
PG&E Custom Retrofit: Activity by Measure Type by Year

Year	Measure	# of Applications	Quantity Rebated	Amount of Rebates	Gross KWH Savings	Gross KW Savings
1992	Electronic Ballasts	122	N/A	$285,313	3,854,662	655
	T-8 & Elec. Ball.	111	N/A	$340,256	4,407,583	880
	T-8 & Elec. Ball. & Refl.	4	N/A	$37,385	444,415	68
	T-8 & Energy Eff. Ball.	2	N/A	$6,084	119,946	17
	T-8 Lamps	54	N/A	$202,932	2,353,113	514
	T-12 & Elec. Ball. & Refl.	3	N/A	$9,875	115,210	24
	Outdoor HID Lamps	58	N/A	$105,592	1,721,570	82
	Other Lighting	2194	N/A	$4,872,206	72,497,238	11,820
1993	Electronic Ballasts	30	N/A	$91,874	991,325	206
	T-8 & Elec. Ball.	69	N/A	$369,669	4,663,998	1,510
	T-8 & Elec. Ball. & Refl.	2	N/A	$124,119	1,427,586	283
	T-8 Lamps	26	N/A	$190,780	2,393,301	469
	T-12 & Elec. Ball. & Refl.	1	N/A	$355	4,141	1
	Outdoor HID Lamps	11	N/A	$5,510	129,060	
	Other Lighting	526	N/A	$2,140,331	28,612,103	3,310
1994	Electronic Ballasts	4	N/A	$177,895	2,178,352	500
	T-8 & Elec. Ball.	18	N/A	$209,270	2,224,871	390
	T-8 Lamps	3	N/A	$24,926	310,429	83
	Outdoor HID Lamps	1	N/A	$4,004	73,584	
	Other Lighting	201	N/A	$972,984	12,146,082	1,900
1995	T-8 & Elec. Ball.	5	N/A	$59,306	505,247	117
	Other Lighting	75	N/A	$1,028,622	13,018,740	1,436
1996	T-8 & Elec. Ball.	2	N/A	$29,787	335,387	45
	Other Lighting	35	N/A	$314,636	2,837,291	304

Figure 4-7
PG&E Custom Rebate: Breakdown of "Other Lighting" Category



Building Type Transaction Trends

The following figures provide indications of measure activity by customer class and building/business type. Note that no information on participation by building type was made available to us for the New Construction programs; thus only data for retrofit programs is shown.

As shown in Figure 4-8, the vast majority of lighting savings occurred in the commercial sector. When we examine measure installation types by more refined building categories, we find that participation is dominated by several segments. Figure 4-9 through Figure 4-11 present total savings by building type for T-8 lamps and electronic ballasts, HID > 174 watts, and Other lighting measures, respectively. T-8 and electronic ballast participation is dominated by Offices and Retail. Food Stores, Industrial Assembly, and Schools also show significant participation levels. Not surprisingly, HID participation levels show distinctly opposite trends with Industrial Assembly, Industrial Non-Assembly, Commercial Unspecified[1], Commercial Other, and Warehouse dominating savings. Finally, a large percentage of the "Other" lighting category is also associated with an unspecified building type.

[1]Commercial Unspecified differs from Commercial Other as follows: Commercial "Other" was a direct specification within PG&E's database. Commercial Unspecified are those items for which the building type in the PG&E database was "All."

Figure 4-8
Lighting Savings by Class

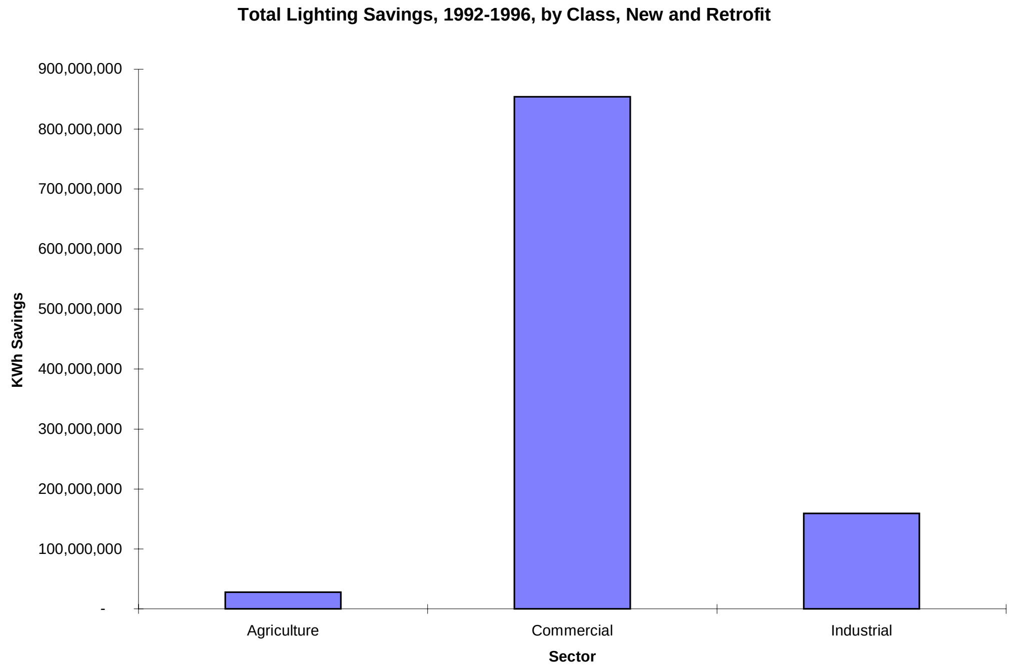


Figure 4-9
T-8 and Electronic Ballast Savings by C&I Building Type

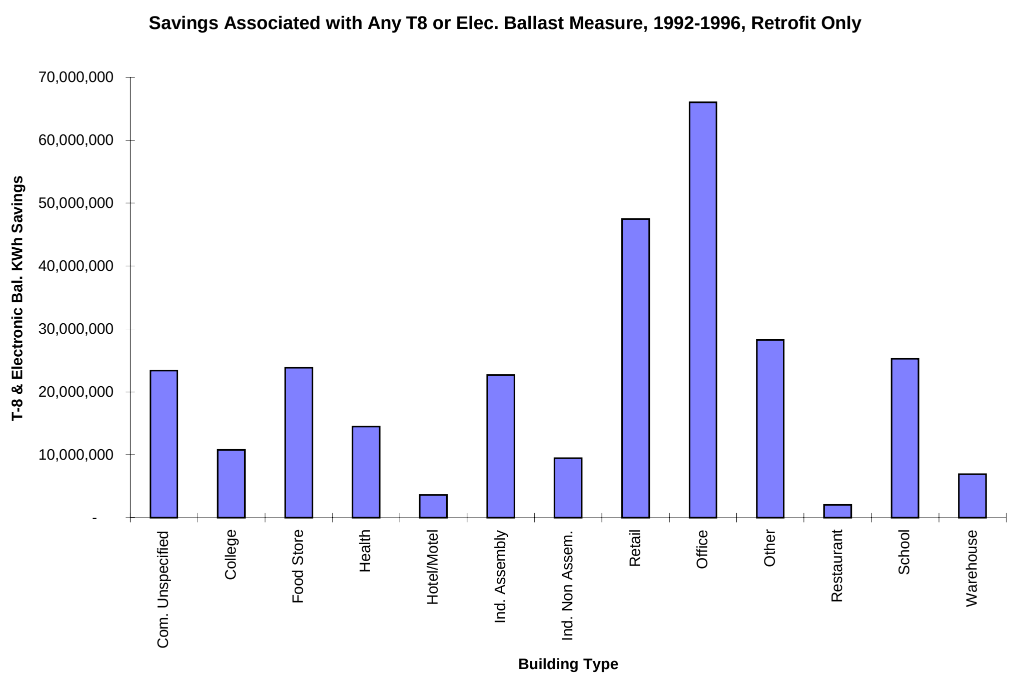


Figure 4-10
HID Savings by C&I Building Type

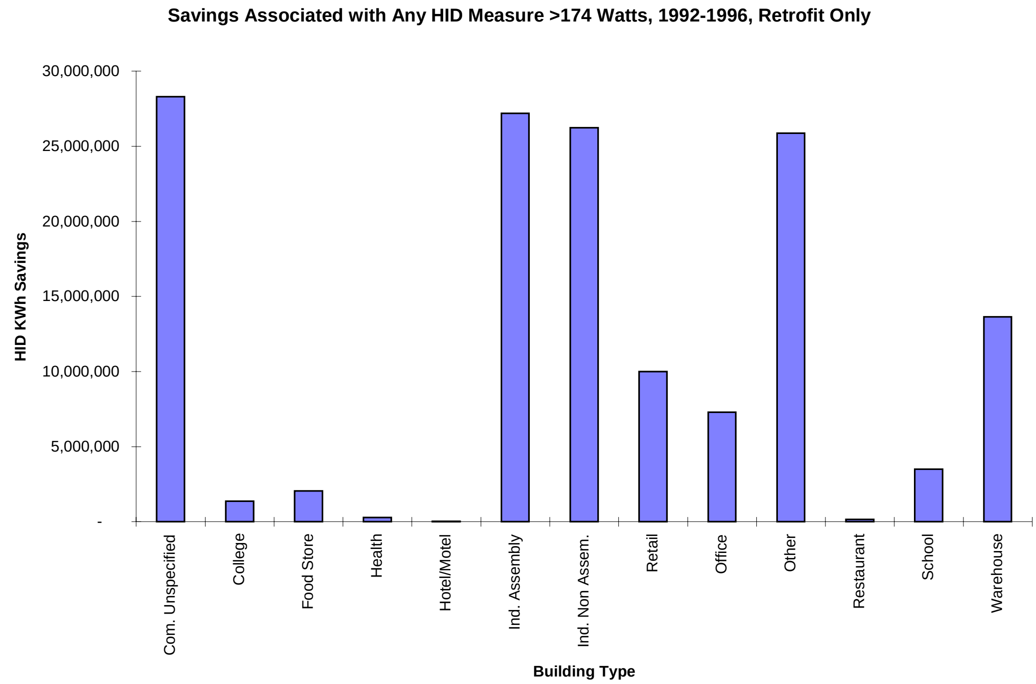
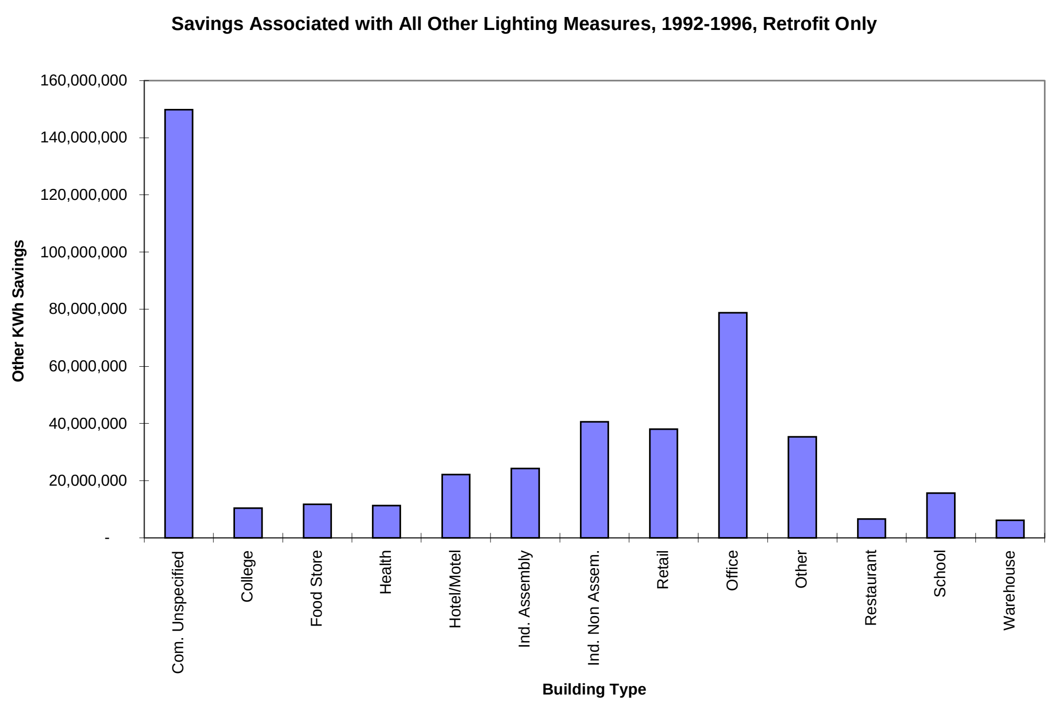


Figure 4-11
Other Lighting Savings by C&I Building Type



Repeat Participation

Some initial indications of repeat participation can be obtained by examining the number of times unique accounts appear for lighting measures across program years. This information is presented in Table 4-9. Roughly 85 percent of accounts have participated only once across the study period, 11 percent twice, and 3 percent more than twice.

Table 4-9
Unique Account Level Lighting Participation

Transaction Years	All Programs		New Construction Programs		Retrofit Programs	
	Participants	Percent	Participants	Percent	Participants	Percent
1	24,436	85.2%	1,278	88.8%	22,882	85.2%
2	3,220	11.2%	111	7.7%	3,033	11.3%
3	726	2.5%	33	2.3%	686	2.6%
4	215	0.8%	12	0.8%	201	0.7%
5	58	0.2%	5	0.3%	53	0.2%
6	11	0.0%	1	0.1%	10	0.0%
Total	28,666	100.0%	1,440	100.0%	26,865	100.0%

4.3 SDG&E PROGRAMS

4.3.1 Program Descriptions

Retrofit and Replacement Programs

SDG&E's programs to promote retrofit and replacement with efficient lighting among commercial customers began on a significant scale in 1989. Since that time, the programs have evolved substantially in terms of target markets, measures supported, customer incentive levels and formats, and delivery mechanisms. One constant throughout has been a high level of customer contact and logistical support for retrofit projects, including project planning, prescreening of contractors, and, for some customers, full turnkey project management. The following paragraphs briefly describe the evolution and current status of the lighting retrofit and replacement programs.

1989-1991. Prior to 1992, SDG&E promoted efficient commercial lighting through two programs, the Commercial/Industrial Incentives and the Commercial Lighting Retrofit program.

- ***Marketing and delivery.*** Both of these programs were marketed primarily to large "assigned" customers by SDG&E field representatives. The assigned customers are generally those with 300+ kW demand. There are roughly 750 of these customers and they account for 70 percent of SDG&E's commercial and industrial load.

- ***Measures supported.*** The programs supported a full range of commercial lighting technologies: electronic ballasts, T-8 lamps, HID fixtures, and controls.
- ***Measure identification.*** Measures were identified by the field representatives through facility audits.
- ***Incentive levels.*** Incentive levels were not published on a measure by measure basis. Rather, they were estimated by the field representative based on the projected earnings the company could claim for the project. In the early stages of the program, the incentive "payout" was set between 50 and 70 percent of projected earnings.
- ***Contractor participation.*** Initially, contractor participation was limited to a set of nine preapproved companies who bid against each other for jobs.
- ***Inspection.*** SDG&E staff inspect all jobs for compliance with specifications prior to release of incentives. SDG&E dealt directly with contractors to remedy any problems identified in the inspection (or by the customer).

1992-1993. During this period, the following major changes occurred:

- A Small Commercial Audit program was started to broaden the range of firms that were participating in the lighting rebate program.
- Participation was opened to broader range of contractors.
- Incentive levels were reduced to a maximum of 50 percent of projected earnings.

1994-1997. In 1994, the Small Commercial Audit and Lighting Retrofit programs were merged to form the "Power to Save" program. This program targeted smaller customers (100 or fewer fixtures). There are two rebate formats, a prescriptive "measure level" approach and a custom approach similar to that used previously. The payout level decreased to 22 to 40 percent in 1996 and now stands between 5 and 10 percent. The program dropped rebates for 4-foot T-8 lamps in 1997.

New Construction Programs

SDG&E has included lighting measures in its new construction programs from the beginning. The earliest program, Title 24+, ran until 1994. In order to qualify for incentives, new construction plans had to meet lighting power density allowances contained in the 1993 revision of Title 24. This was viewed as a vehicle to educate engineers regarding Title 24 requirements and as a way to improve compliance. Incentive levels were set at 20 to 30 percent of incremental cost. Marketing focused on large architectural and mechanical engineering firms.

In 1994, the Savings Through Design program was launched. At first, a "performance" based incentive system was tried. This, however, proved to be too unwieldy to administer and was largely abandoned. In its place, SDG&E has adopted an incentive system based on lighting power density levels. These levels have gone through several revisions. As of June 1, 1997, design lighting power densities must be at least 20 percent below current Title 24 requirements to qualify for program support.

4.3.2 Summary of Program Activity

To interpret the effects of the programs on customer behavior, and on spillover in particular, it is useful to understand:

- Trends in participation and efficient lighting sales over time and by type of program.
- Participation by unique customers versus program transactions and patterns of repeat participation.
- Trends in rebate levels and their relationship to retail prices.

Trends in Transactions and Lighting Sales

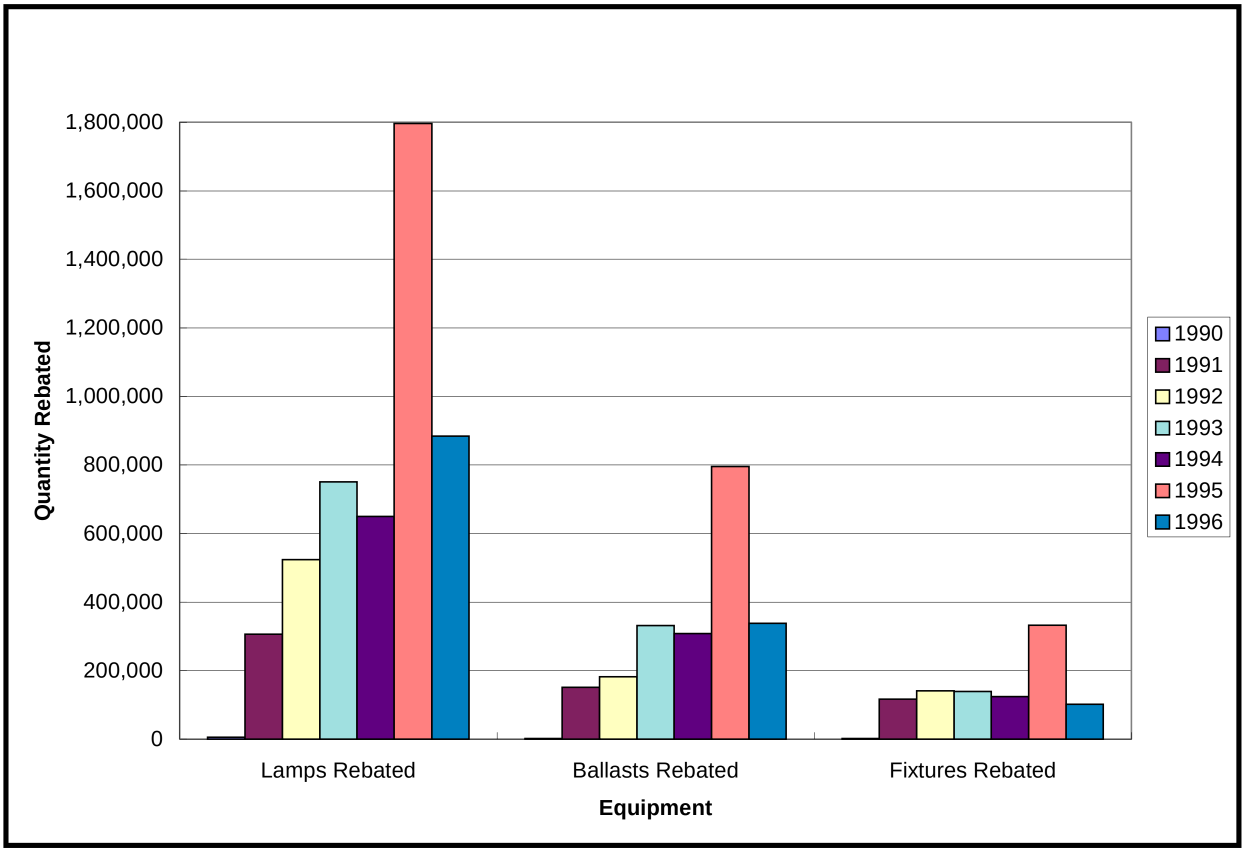
Since 1990, SDG&E's programs to promote energy-efficient lighting have served 43,288 sites and provided rebates for 8,123,561 lamps, ballasts, and lighting fixtures. Table 4-10 summarizes this activity by major equipment component: lamps, ballasts, and fixtures. The lamp category contains HID as well as fluorescent products. HIDs account for less than 0.5 percent of lamps rebated. The tables were developed from database reports that broke the equipment into much more detailed categories, such as "31-watt, 4-foot u-tube." For some of these categories, the number of units rebated were reported, but the amount of the rebates was not. The last column in the table indicates the percentage of rebated units for which the amount of the rebates was missing.

Table 4-10
Trends in Lighting Program Activity

Equipment/Year	Number of Sites	Quantity Rebated	Rebate Amount	% Missing
Lamp				
1990	7	5,112	$5,233	33.33%
1991	485	305,803	$305,091	60.00%
1992	811	523,747	$388,361	42.86%
1993	1,596	750,339	$517,908	63.64%
1994	2,071	650,046	$1,281,241	26.67%
1995	6,577	1,796,573	$1,934,377	47.50%
1996	9,102	884,587	$6,324,878	9.21%
Total	20,649	4,916,207	$10,757,089	30.10%
Ballast				
1990	7	2,043	$40,036	0.00%
1991	457	150,956	$3,303,538	25.00%
1992	539	182,374	$3,949,451	12.50%
1993	1,895	331,416	$6,755,208	26.67%
1994	2,351	307,797	$12,653,103	50.00%
1995	5,810	795,127	$16,401,309	50.00%
1996	2,453	337,680	$4,726,444	31.25%
Total	13,512	2,107,393	$47,829,089	35.35%
Fixture				
1990	7	1,503	$29,378	0.00%
1991	579	116,281	$1,807,713	0.00%
1992	703	140,622	$2,318,497	0.00%
1993	899	138,695	$1,817,656	9.09%
1994	1,088	124,102	$1,697,003	12.50%
1995	3,534	331,810	$3,675,763	5.88%
1996	1,207	101,874	$993,095	18.75%
Total	8,017	954,887	$954,887	10.53%
Total	42,178	7,978,487	$70,925,283	28.36%

Figure 4-12 shows the trends in rebates for the three major product categories over time. For SDG&E, program activity peaked sharply in 1995, with 1,800,000 lamps, 800,000 ballasts, and 330,000 fixtures rebated. In 1996, rebate volume dropped by more than half for each of the product categories.

Figure 4-12
SDG&E Trends in Lighting Product Rebate Activity over Time



4.3.3 Changes Over Time in Types of Equipment Rebated

Figure 4-13 shows the change in the types of ballasts that were rebated over time. In 1990, T-12 electronic ballasts accounted for only 29 percent of all ballasts rebated. By 1992, this ratio had increased to 95 percent. In 1993, the T-12 ballasts were largely supplanted by T-8 models. In 1996, virtually all ballasts rebated were T-8. Through the eight years documented, T-8s accounted for 83 percent of all ballasts rebated.

Figure 4-13
Trends in Types of Ballasts Rebated

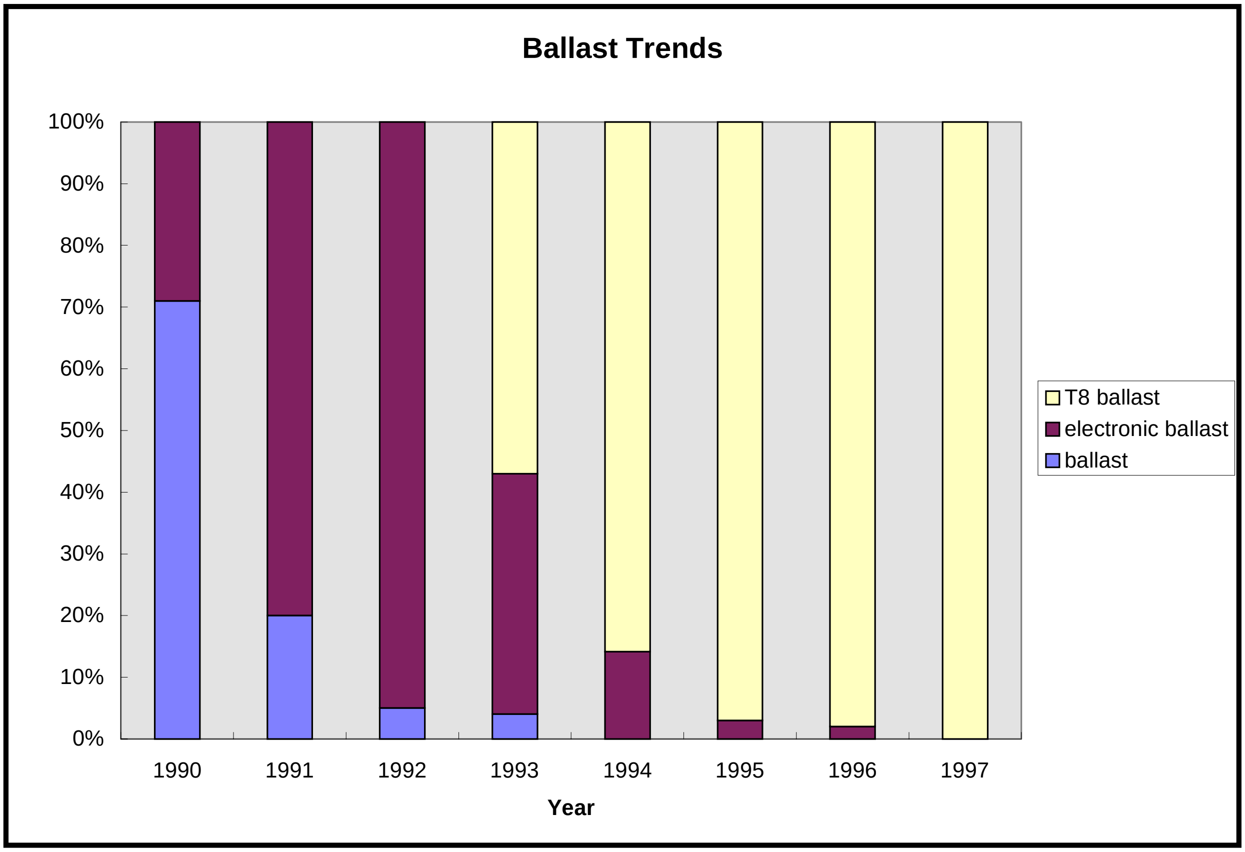
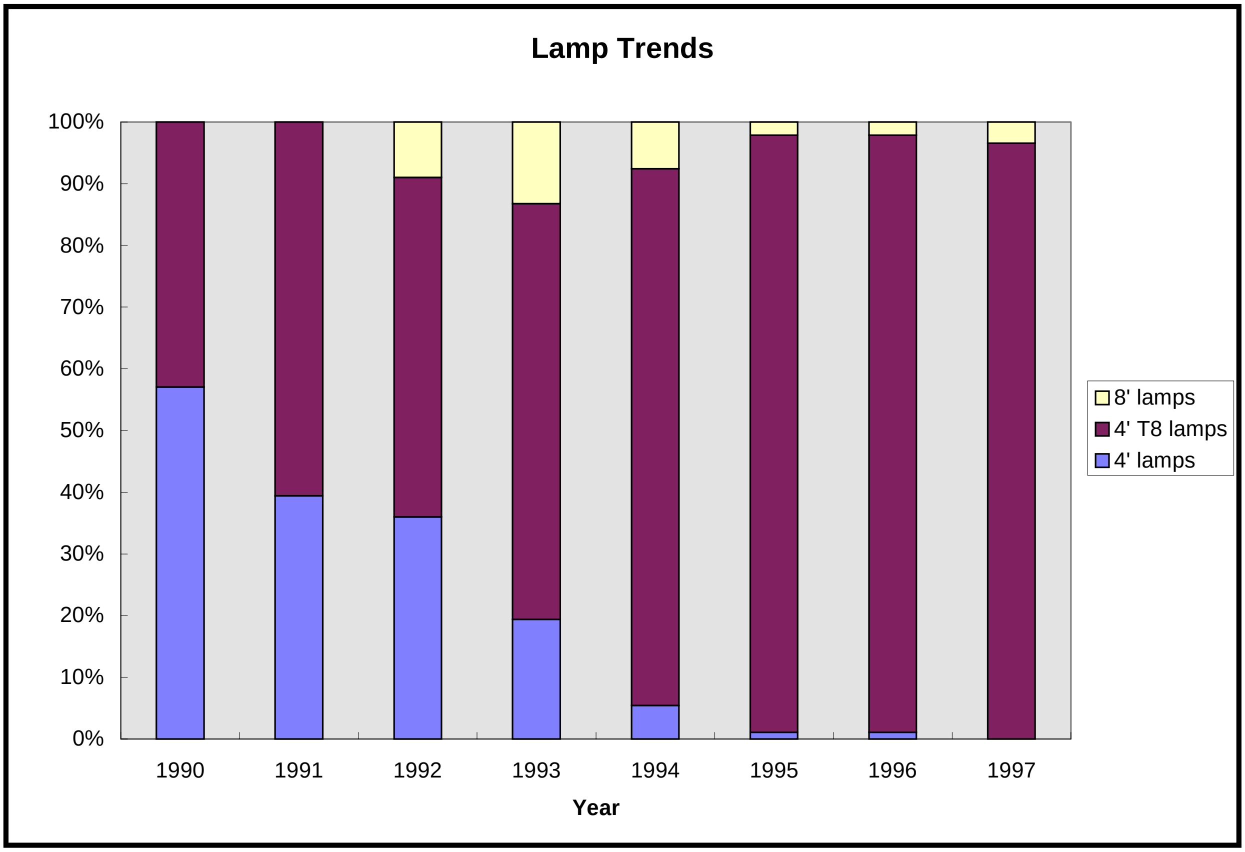


Figure 4-14 illustrates the trends in fluorescent lamp types supported by SDG&E's programs. In 1992, 4-foot T-8 lamps accounted for 55 percent of all lamps rebated. As of 1996, this percentage had risen to 89 percent. Over the eight years documented, 4-foot T-8s accounted for 79 percent of all fluorescent lamps rebated.

Figure 4-14
Trends in Lamp Types Rebated by SDG&E Programs



4.3.4 Participation by Building Type

Figure 4-15 displays the distribution of SDG&E lighting program participants by building types. Office, lodging, and retail constitute the largest market segments for the program. Industrial (assembly plants), meeting halls, restaurants, and warehouses constitute a second tier of segments, each with roughly 7 percent of program participants.

Figure 4-16 shows trends in participation by market segment over time. Retail and office customers dominated use of the program in the earliest years. Over time, lodging and institutional customers became more frequent participants, reflecting shifts in program marketing focus.

Figure 4-15
Distribution of SDG&E Lighting Program

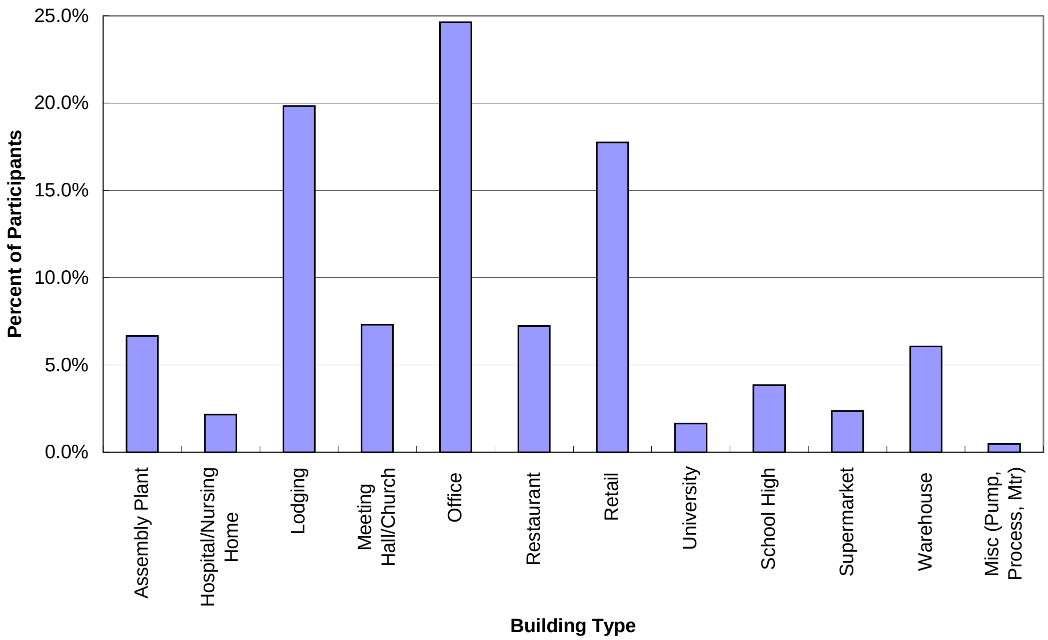
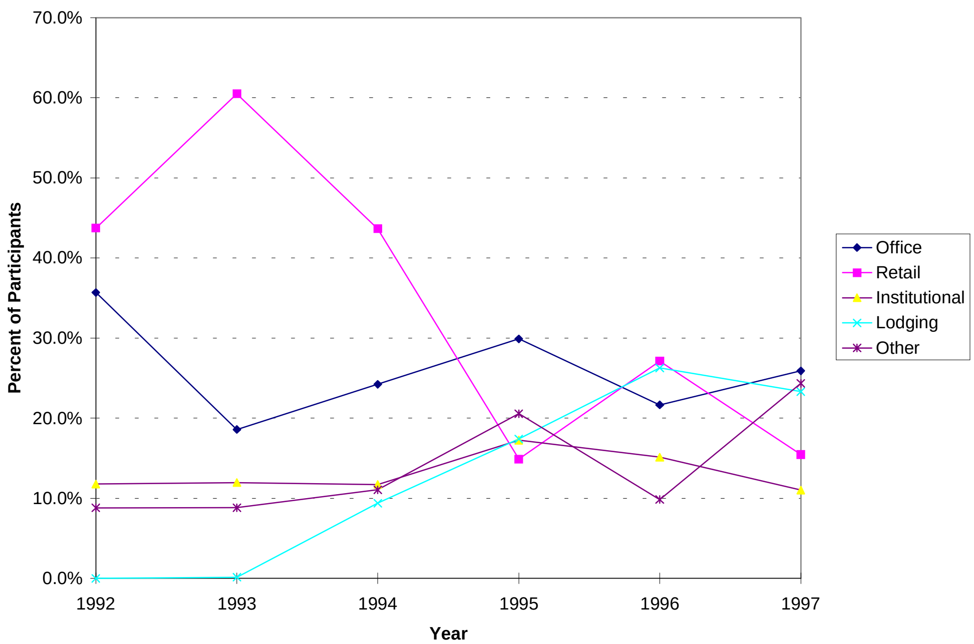


Figure 4-16
Lighting Program Participation Trends



4.3.5 Participation in Terms of Unique Customers

It is important to develop counts of unique customers who have participated in SDG&E's programs for a number of reasons. First, the ratio of the count of unique participants to the number of commercial customers represents the most valid measure of the extent to which the programs have reached their targeted markets. Evaluations of individual programs in other jurisdictions have indicated that a sizable portion of participants take part more than once or use multiple programs to obtain efficient lighting.

Table 4-11 shows the percentage of unique premises that participated in lighting programs once, twice, three times, and so on, over the study period. These data were summarized from "Repeat Participation" tables received from SDG&E, which indicated: Total Sites, Total Premises, and Repeated Premises. The data indicate that only 5.6 percent of customers in the C&I Incentive program participated more than once, versus 14 percent for the New Construction Program, 12.6 percent for the Lighting Rebate Program, and 14.4 percent for Power to Save. Given the longevity of these programs, this level of repeat participation seems fairly low.

Table 4-11
Patterns of Repeat Participation

Number of Transactions	C/I Incentive	C/I New Construction	Lighting Rebate	Power to Save
1	94.4%	86.0%	87.4%	85.6%
2	3.9%	8.5%	11.1%	10.5%
3	1.0%	3.3%	1.1%	2.2%
4	0.4%	0.6%	0.3%	0.7%
5+	0.3%	1.7%	0.1%	1.0%
Total	8,070	1,012	1,511	4,293

4.4 LIGHTING MARKET INTERVENTIONS - CODES, REGULATIONS & STANDARDS

This section provides an overview of the numerous codes, regulations, and standards promulgated by government agencies and other organizations that affect the selection of commercial lighting equipment. Although this section does not attempt to measure or assess the impact of each code, regulation, or standard upon lighting equipment decision-making in California, it identifies all of the significant influences through interviews and secondary research.

We present here a background summary for all codes, regulations, and standards (federal, state, and municipal) that affect California markets for commercial lighting equipment. California's Title 24 lighting codes are given special attention, including discussion of requirements, impacts on specification practices, implementation, compliance, and enforcement.

4.4.1 Categorization of Codes, Regulations & Standards

Federal, state, and municipal governments have all impacted the California lighting market with the intention of improving energy efficiency. We have categorized these interventions into four types:

- Lighting System Performance.
- Lighting Equipment Standards.
- Lighting Equipment Labels.
- Lighting Education.

The four types of interventions are highlighted below, and relevant codes, regulations, or standards are contained under their respective headings:

Lighting System Performance. These methods of improving energy efficiency seek to achieve energy savings by recommending or mandating performance standards for lighting systems. These standards include specification of lighting power densities (LPDs), and requirements for certain types of controls and switching. The codes, regulations, and standards that fall under this category include the following:

- Title 24.
- EPACT (mandates state adoption of building codes).
- CFR 435 (Federal buildings requirements).
- Municipal ordinances.
- ASHRAE/IESNA 90.1 and ASHRAE/IESNA 90.
- 1RIESNA manuals.

Lighting Equipment Standards. These types of regulations seek to improve energy efficiency by mandating the elimination of inefficient equipment, thus speeding up the transition to more efficient lighting equipment. Regulations that feature mandates to eliminate inefficient choices include the following:

- NAECA.
- EPACT.
- State laws.

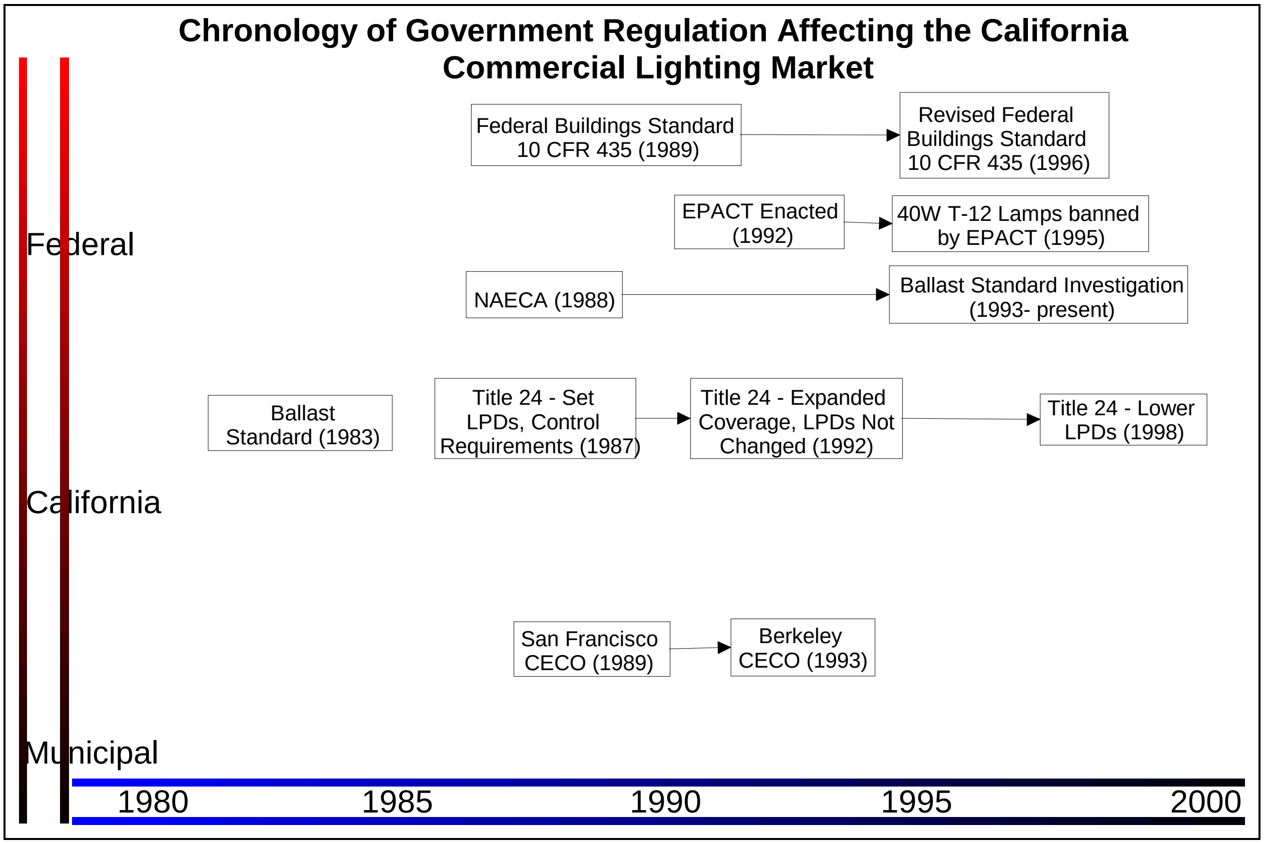
Lighting Equipment Labels. Labeling regulations attempt to increase the use of efficient lighting equipment by providing the user a label to look to for assurance that the product is indeed energy-efficient. FTC labeling under EPACT has been the only regulation to utilize this strategy to increase the use of energy-efficient lighting equipment.

Lighting Education. Education has also been seen as an effective method to increase the use of efficient lighting equipment. The following regulations have enacted measures to increase the level of education and awareness of involved parties when lighting equipment selection decisions need to be made:

- Warren Alquist Act (empowers CEC).
- EPACT lighting centers.
- EPACT training.
- EPACT testing.
- IESNA manuals.

The following flow chart provides a chronological history of codes, standards, and regulations that directly affect the California commercial lighting market. The origins of the regulations (federal, state or municipal) are also indicated on the chart.

Figure 4-17
Time Line of Commercial Lighting-Related Regulations



As this chart shows, the State of California adopted the first set of regulations to affect the lighting market within the State itself. This ban of standard magnetic ballasts in California in 1983 came more than seven years before the federal government enacted NAECA in 1988 (a ban of standard magnetic ballasts by 1991). In 1992, EPACT mandated at the federal level a ban of 40-watt fluorescent bulbs (to be enacted by 1995). The first LPD requirements to affect the California lighting market came in 1987, when California developed and implemented the nonresidential lighting standards as part of Title 24. Title 24 has been expanded and updated, but the original LPDs have remained the same since 1987. The only municipal codes within California were enacted in 1989 for San Francisco and 1993 for Berkeley.

4.4.2 Title 24 - Background

The California Energy Commission (CEC) establishes energy standards for both residential and nonresidential buildings. The purpose of these standards is to encourage energy-efficient lighting throughout California. The standards are developed at the CEC with input from designers, utilities, various organizations, and the general public. Before becoming official regulation, the proposed codes and code revisions must pass a broad review.

Every three years (during its Triennial Cycle), the California Building Standards Commission (CBSC) reviews the newest model codes promulgated by various independent agencies, including the California Energy Commission (CEC). The CEC and the public then draft proposed changes to the model energy code. These are reviewed in public by committee. At the conclusion of this process, these changes, and the base model codes, come before the CBSC for review and possible approval.

Summary of Title 24 Code Revisions

1978

The first standards adopted in 1978 were based on ASHRAE recommendations.

1987-1988

The first major revision was adopted in 1987 and took effect in 1988. The scope of these standards was broader, introducing control requirements. At the time the values for these standards were being debated, there was concern about the availability of T-8 lamps and electronic ballasts (as well as concerns about ballast costs and reliability). Consequently, the standards did not fully embrace these technologies. This first introduction of power adjustment controls included credit for bilevel switching and occupancy sensors. LPDs were set at 1.5 watts/sq. foot (sf) for office spaces and 2.0 watts/sf for retail spaces. Unique LPDs values were developed for 35 different occupancy space types.

1992

The Title 24 lighting code was again updated in 1992. The LPDs did not change this time, but the scope of building types covered by the code expanded. Also, the revisions introduced a set of LPD allowances specific to the space type within the broader building categories. This refinement was in recognition of more space-specific levels to allow variation that would then average out. This was in preparation for the tailored method, a new compliance technique introduced in 1992 to provide a mechanism for higher LPDs based on "exceptional" needs.

1994-1995

Lighting power densities did not change in the 1994-1995 review process.

1997-1998

In October 1997, the Commission's Code Advisory Committees accepted public comments on the 1997 Triennial Code change proposals, evaluated the technical merit of the code change proposals, and recommended action to the California Building Standards Commission. After the Code Advisory Committee meetings, the California Building Standards Commission will make the proposed code changes and the Code Advisory Committees' recommendations available for challenges from mid-November through mid-

January. The California Building Standards Commission is expected to take action on the code change proposals on May 5, 1998. Proposed reductions in LPD levels are 10 to 25 percent of existing levels; the proposed office, health, and restaurant reductions are 20 percent, while that for retail is 15 percent. The new code revisions are expected to take effect in January 1999. These new levels are expected to virtually require use of T-8 lamps and electronic ballasts in new fluorescent fixtures.

4.4.3 Title 24 - Description and Requirements

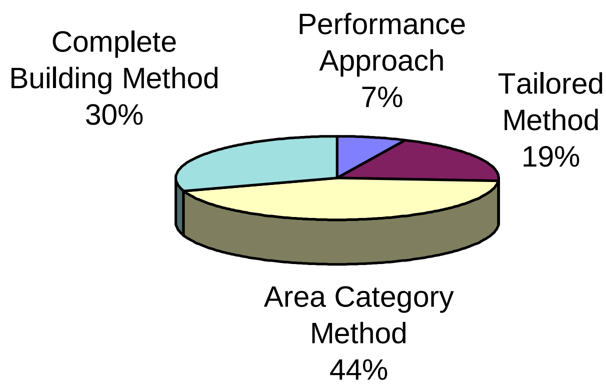
Title 24 lighting code requires that certain buildings comply with standards regarding LPDs, switches, and controls. The standards attempt to encourage the use of energy-efficient lighting by:

- Limiting the maximum power allocated for lighting.
- Requiring automatic lighting control devices.
- Requiring manual switching or controls to allow turning off or dimming lights.
- Requiring certified lighting products.
- Providing for the use of daylighting.

Requirements for Compliance

A building type that falls under the Title 24 code must meet the stipulated LPDs for that particular type of building. The Actual Lighting Power of the building must not exceed the prescribed Allowed Lighting Power (Standard Lighting Power Density for the performance approach). There are two methods that can be used to calculate the Allowed Lighting Power for LPD compliance, the ***prescriptive*** approach and the ***performance*** approach. Three methods are available to determine the Allowed Lighting Power under the prescriptive approach: the ***Complete Building Method***, the ***Area Category Method***, and the ***Tailored Method***. The performance approach requires the use of a Commission-certified computer program to calculate the Standard Lighting Power Density for the building. The builder uses a Proposed Lighting Power Density to determine the building's compliance. If compliance is met, this Proposed Lighting Power Density is translated into the Allowed Lighting Power. Figure 4-18 below is a breakdown of methods used to calculate Title 24 LPD compliance, based on results from the designer surveys conducted for this study.

Figure 4-18
Breakdown of Designers' Reported Utilization of Title 24 Compliance Methods



Other requirements of Title 24 include design provisions for switching of lighting systems that permit efficient operation of the system. Independent lighting controls are required for areas enclosed by ceiling-height partitions. These controls may include:

- A switch located so that the person using the device can see the lights or area controlled by that switch.
- A switch with an indication of whether the lights are "on" or "off," when viewing that area from the switch is not possible.
- An occupant-sensing device.
- Other exceptions that may apply in special circumstances.

Other lighting control features may also include:

- Bilevel switching.
- Daylighted area switching.
- Automatic shut-off controls.
- Automatic controls on exterior lights.
- Tandem wiring for certain lamp configurations.

4.4.4 Comparison of Existing and Proposed Title 24 LPDs

In the tables below, we provide a comparison of the existing and proposed Title 24 LPDs for both the Building and Area methods. We also include, for comparative purposes, the ASHRAE 90.1R and 90.1 LPD levels. Note that the building and area categories for Title 24 and those for

ASHRAE are significantly different; the number of ASHRAE categories is significantly larger than those in found Title 24. Therefore the ASHRAE LPDs have been mapped, where applicable, to correspond to the Title 24 categories.

Table 4-12
Existing and Pending Revised Title 24 LPDs and Corresponding ASHRAE Values Under the Complete Building Method

	Lighting Power Density (W/ft^2)			
Building Type	**Revised Title 24**	**Existing Title 24**	**ASHRAE 90.1 R**	**ASHRAE 90.1**
High Bay Work Buildings	1.2	--	1.0	--
Low Bay Work Buildings	1.0	1.2	1.0	--
Grocery Store	1.5	1.8	--	--
C&I Storage Buildings	0.7	0.8	1.0	--
Medical Buildings and Clinics	1.2	1.5	1.7	--
Office Building	1.2	1.5	1.3	1.5-1.9
Religious, Auditorium, Convention	1.8	2.0	1.3/2.0[1]	--
Restaurants	1.2	1.5	1.5	1.3-2.2
Retail and Wholesale Store	1.7	2.0	2.3	2.1-3.3
Schools	1.4	1.8	1.4	1.5-2.4
Theaters	1.3	1.5	1.5	1.5
All Others	0.6	0.8	--	--

[1]The equivalent ASHRAE building types are broken out into 'Religious Building' - with an LPD of 1.3 - and 'Convention Center' - with an LPD of 2.0.

Sources for the table above*: Energy Efficiency Standards for Residential and Nonresidential Buildings, 1995, CEC, Table1-M; ASHRAE/IESNA 90.1-1989R Table 9.3.1.1.2; ASHRAE/IESNA 90.1-1989 Table 6-5*

Table 4-13
Existing and Pending Revised Title 24 LPDs Under the Area Category LPDs

Area Type	Existing Title 24	Revised Title 24	ASHRAE 90.1 R	ASHRAE 90.1
Auditorium	--	2.0	--	--
Auto Repair	--	1.2	1.0	--
Bank/Financial Institution	1.8	1.4	--	2.8
Classrooms, Lecture, Training, Vocational Room	2.0	1.6	--	--
Commercial and Industrial Storage	--	0.6	1.0-1.8	--
Convention, Conference, and Meeting Centers	1.6	1.6	--	--
Corridors, Restrooms, Stairs and Support Areas	0.8	0.6	0.7-1.0	--
Dining	1.2	1.1	1.5	--
Electrical, Mechanical Rooms	--	0.7	0.8	--
Exercise Center, Gymnasium	--	1.0	1.3	--
Exhibit, Museum	2.3	2.0	--	1.9-3.9
General Commercial and Industrial Work	1.3	--	0.7-1.5	--
High Bay	--	1.2	--	--
Low Bay	--	1.0	--	--
Grocery Store	2.0	1.6	--	--
Hotel Function Area	2.3	2.2	--	--
Industrial and Commercial Storage	0.6	--	1.0	--
Food Preparation	2.2	1.7	2.5	--
Laundry		0.9	--	0.9-1.3
Library	--	--	1.4	--
Reading Areas	--	1.2	--	--
Stacks	--	1.5	--	--
Hotel	2.3	2.2		
Main Entry Lobby	1.6	1.5	1.7-1.8	1.9
Reception/Waiting	--	1.1	--	2.4
Locker/Dressing Room	--	0.9	--	1.2
Lounge/Recreation	--	1.1	1.3	--
Malls, Arcades, and Atria	--	1.2	1.4	--
Medical and Clinical Care	1.8	1.4	1.7	--
Office	1.6	1.3	1.3	--
Precision Commercial or Industrial Work	2.0	1.5	--	--
Religious Worship	2.2	2.1	2.0	2.5-2.7
Retail Sales, Wholesale Showrooms	2.2	2.0	2.3	--
Theaters				
Motion Picture	1.0	0.9	1.0	1.0
Performance	1.5	1.4	1.5	1.5
All Other	--	0.6	--	--

Sources for the table above: *Energy Efficiency Standards for Residential and Nonresidential Buildings, 1995, CEC, Table1-N; ASHRAE/IESNA 90.1-1989R Table 9.3.1.1.2; ASHRAE/IESNA 90.1-1989 Table 6-6b.*

As mentioned above, most experts expect that the pending revisions to Title 24 LPDs will virtually require T-8 lamps and electronic ballasts in most cases. Even in the critical retail and grocery store segments, for which allowed levels will be higher than most other building types, it is expected that T-8 lamps and electronic ballasts will be used in fluorescent fixtures in order to provide more room for owners and designers to continue to use highly valued decorative lighting.

4.4.5 Title 24 Impacts on Specification Practices

The presence on Title 24 standards in California has an impact on the choices available to specifiers when choosing lighting equipment. Title 24 consultant and designer interviews conducted for this study provided insight into their perceptions about the role the Title 24 energy code has played in the market for energy-efficient equipment.

Four Title 24 consultants were interviewed with respect to Title 24 over the past five years. There was no consensus about the effects of Title 24 on the market for efficient equipment, nor was there any consensus about whether or not California utilities have been more or less influential than the energy code in changing the market for T-8 lamps and electronic ballasts. The following comments were made by Title 24 consultants regarding Title 24 energy code influence over the market.

Title 24 Influence

- "[Title 24 had a] pretty significant role - more than half of T-8 penetration is probably due to standards."
- "[Title 24 was] instrumental - need these technologies if standard equipment doesn't pass code - some are just using T-8s."
- "Not sure about effects, probably small though, codes are too low to begin with."
- "[Title 24 was] not that instrumental, T-12 lamps and magnetic ballasts typically meet LPD requirements."

More Influential in Creating Market for T-8s and Electronic Ballasts - Utilities or Title 24 Code?

- "Yes, they [utilities] have been more influential."
- "Utilities [have been] less influential than standards."
- "Combination has been good."

Note that the above comments are based on a very small in-depth sample. By contrast, the results from our larger designer survey indicate that the most designers believe utility programs had a significant effect on developing the market for T-8 lamps and electronic ballasts (see Supply-Side Market Effects Results section for designer results).

Designers frequently mentioned the practice of achieving below-allowance power levels in non-lighting areas of the building such as HVAC systems to allow greater-than-allowance lighting levels. This was a more common practice in the retail segment where higher lighting levels are preferred by owners. It should also be noted that four designers mentioned without a prompt that they felt Title 24 codes had significant influence in changing the market for efficient fluorescent lighting. The following comments were made by these four designers:

- "Title 24 has more effect on selection than programs."
- "...Title 24 created the market."
- "...barrier is eliminated; cost of EB reduced; Title 24 reduced barrier; EPACT reduced barrier."
- "Title 24 helped."

A study conducted by Heschong Mahone Group using commercial building stock circa 1992-1994 concluded that a "modest" reduction of 0.06 watts/sf could be achieved in commercial space overall by uniformly lowering Title 24 standards. They also found anecdotal evidence that Title 24 was influential in prompting manufacturers to design and sell products specifically geared towards the California market to meet Title 24 code.

It is important to note that the above responses provide a weaker case for current Title 24 standards as drivers of increased penetration of T-8 lamps and electronic ballasts than do the results presented in the Supply-Side results section of this report, which demonstrate more convincingly that sponsors' programs played a significant role in reducing barriers to these technologies. In addition, the fact that these code levels have been in place since 1987, but little improvement occurred in T-8 lamp and electronic ballast penetration between then and 1990, indicates that these codes were not the key drivers. The 1987 code levels were met for years by 3-lamp fixtures with efficient magnetic ballast and 34-watt, T-12 lamps. It is more likely that as the barriers to electronic ballasts were reduced in the mid-1990s, designers began switching over to these technologies to produce more room for decorative and task lighting under the LPD limits.

4.4.6 Title 24 Code Enforcement/Compliance

Process to Comply

Five building inspectors were interviewed for this study. Building inspectors spend a significant fraction of their allotted time on lighting, at least 25 percent according to one inspector, while another claimed 15 percent. The time and resources of building inspectors are stretched thin, and they admit to not being able to check everything. The method for ensuring code compliance for buildings was fairly similar from jurisdiction to jurisdiction. For most projects, the process for compliance has four events:

1. Check plans.
2. Issue building permit.

3. Send inspector during construction (sometimes more than once).
4. If inspection fails, issue a notice of corrections.

Actual Ability to Comply

Building inspectors rarely encounter lighting code violations. Occasionally they instruct builders to make changes after inspecting plans. Most problems come from small, do-it-yourself companies. The retail sector was cited most frequently by Title 24 consultants and building inspectors as having difficulty achieving code compliance. Small tenant improvement projects, classrooms, manufacturing facilities, and warehouses were also mentioned as occasionally having problems being compliant. Often, retail space meets code at the time of construction, but track lighting is added later. Energy-efficient (T-8/EB) systems are often used in retail and medical applications to free up allowed power density for other applications.

Several Title 24 consultants indicated that building inspectors were, more often than not, overburdened with so much backlog that they were unable to pay much attention to lighting layouts. They often do not ask for Title 24 documentation or do not get around to inspecting the building at all. They also indicated a wide range of attention paid to lighting inspections, depending on the city or county for which the inspector was working. One reason given for this was that lighting is not a life-safety issue, and inspection departments are forced to allocate resources according to greatest need.

Title 24 Consultant Utilization

Most Title 24 consultants are employed by architects, engineers, or developers. Generally, Title 24 consultants and/or electrical engineers ensure code compliance for building owners/tenants. Municipal building inspectors are the Title 24 enforcement officials. A growing trend among Title 24 consultants is the offering of design services, especially to ensure compliance.

4.4.7 Overview of Other Codes and Regulations

The following additional codes and regulations are anticipated to have had a significant impact on the California lighting market. Quantifying the impacts of these regulations is beyond the scope of this study; however, a general description and listing of basic requirements is presented to provide a broad view of the influences on the California market for energy-efficient lighting equipment.

Energy Policy Act of 1992 (EPACT) Public Law 102-486

One of the most significant actions taken by the federal government to intervene in the commercial lighting market was the adoption of the Energy Policy Act of 1992 (EPACT). EPACT contains a wide variety of measures affecting commercial lighting use, including the ban on certain fluorescent lamp technologies, the establishment of regional educational centers, and a mandate for some states to adopt stricter energy codes.

The principal lobbyists in the development of lighting requirements in EPACT were the American Council for an Energy Efficient Economy (ACEEE) and the National Electrical Manufacturer's Association (NEMA). Electric utilities did not participate in developing the lighting component of the EPACT. During an interview, one major lamp manufacturer stated that the company advocated EPACT, that it had not gone far enough, and that it had lobbied for a ban of energy-saver lamps. Another major lamp manufacturer also expressed support for the EPACT lighting provisions.

Requirements of EPACT include:

- A ban of certain 4-foot fluorescent lamps, most significantly the 40-watt T-12, halophosphor type, based on LPW and CRI. (October 1995).
- State adoption of ASHRAE/IES 90.1 building energy standard (October 1994). (Not all states have complied with EPACT, which has generated criticism from environmental and efficiency advocates. The federal government has not been particularly active in enforcing compliance by the remaining 20 or so states).
- States revise their codes to keep up with or exceed the nationally accepted standard.
- Energy standards for federal buildings (October 1995).
- Establishing ten regional lighting centers to educate specifiers, designers, and end users (not one of the ten centers has been established to date).
- Labeling program must be developed for most fixtures.
- FTC-administered lamp labeling (April 1995).
- establishment of a luminaire testing and information program.

With respect to the last element above, the National Lighting Collaborative (NLC) has taken the lead in developing the program. The Collaborative, established in 1992, "represents a broad spectrum of opinion on lighting issues drawn from industry, government, designer, and energy conservation member organizations." Currently, the program covers 10 categories of fluorescent luminaires used in the commercial and industrial sectors. The National Electrical Manufacturers' Association (NEMA) and the American Lighting Association (ALA) claim that the recently developed Luminaire Efficacy Ratio (LER) is a tool to provide guidance on comparative energy-efficiency and costs-of-fluorescent-luminaire options. Manufacturers have stated that using the new system will add competitive advantage to their products and expect the testing and rating procedures to spread rapidly through the industry. LER and cost ratings are being added to product literature and used as marketing tools. The program received provisional approval from DOE on March 15, 1996. DOE's role is to provide financial and technical assistance, and to evaluate whether the program meets EPACT's objectives.

National Appliance Energy Conservation Amendments of 1988 [NAECA]

The National Appliance Energy Conservation Amendments are regulations that were negotiated between DOE, manufacturers, and environmental organizations. The original amendments were enacted in 1988, establishing a minimum ballast efficiency factor (BEF), and prohibiting manufacturers from selling standard magnetic ballasts. In 1993, DOE analyzed three alternative ballast standards (mandates corresponding to hybrid, electronic rapid start, and electronic instant start), and proposed a revised standard in 1994 (conducted by LBNL). This proposal was strongly opposed by manufacturers.

NEMA has been a very vocal opponent to ballast regulations, and has worked closely with LBNL to refine the impact study. A revised study was published in 1996, in which manufacturers criticized the study and provided comments and data for another revision. A one-year moratorium on efficiency standards was set during 1996 while a revised study was being developed. The revised study was published in July 1997 (comments from the public are being solicited). Upon acceptance of the LBNL impact analysis, DOE will conduct a manufacturer-impact analysis, and may subsequently issue a new ballast rulemaking.

Requirements of NAECA include:

- Setting minimum allowable ballast efficacy factors (BEF), effective 1991.
- Prohibiting the manufacture of standard magnetic ballasts (ballast manufacturers were ordered to stop selling standard magnetic ballasts by April 1990, and luminaire companies (OEMs) prohibited from selling standard magnetic ballasts by April 1991.

DOE Building Standard for New Federal Buildings

In 1989 the Building Standards for New Federal Buildings were enacted as an "interim rule," mandating LPDs for Federal buildings based on ASHRAE 90.1 standards (these LPDs are generally more stringent than Title 24 standards). The LPDs were revised again in 1996, with the new standards scheduled to become active in 1998. These federal efficiency standards generally require a three-year payback by law.

Municipal Codes

San Francisco

In 1989, San Francisco adopted a Commercial Energy Conservation Code, which was based on the 1981 Residential Energy Conservation Code. Due to limits on commercial development in San Francisco, CECO fills the gap left by Title 24 on addressing energy inefficiency in *existing* office buildings (which accounts for 47 percent of commercial electricity use in San Francisco).

Events that can trigger CECO review and enforcement include the transfer of a building's title, an addition to a building that increases the heated space by more than 10 percent, and renovation and improvements valued at more than $50,000. Upon CECO review, a private inspector identifies areas of the building that do not comply with the ordinance. The building owner must then implement prescribed energy-efficiency measures up to an established cost limit, unless they are not deemed cost-effective. Only those measures with a simple payback of four years or less must be implemented (Source: Bureau of Energy Conservation, City and County of San Francisco).

Berkeley

In 1993, Berkeley adopted the Commercial Energy Conservation Code, based on San Francisco's ordinance. The basis for CECO in Berkeley is to bring the most inefficient buildings up to an acceptable energy-efficiency standard. Expenditures are limited to a reasonable level by way of a cost ceiling, which is 1 percent of the building's sale price or 5 percent of the renovation costs.

Commercial buildings must undergo energy conservation retrofits upon sale or renovation. Due to inherent differences between San Francisco and Berkeley commercial buildings, an alternative compliance method was defined for meeting the lighting requirement. Incandescent and halogen lamps must be replaced with CFLs or lamps with an efficacy higher than 40 lumens/W.

CECO illustrates the difficulty of mandating standards for lighting retrofits. New construction requirements aren't always efficiently transferred to retrofit applications. As a consequence, retrofit ordinances are often designed to meet the lowest common denominator. Thus, an important aspect of CECO is the initial building audit, that creates a mechanism for customizing retrofit opportunities (Source: Berkeley Energy Commission).

NEMA Standardization Efforts

Working through the American National Standard Institute's process, NEMA developed a standard for high-efficiency electrical ballasts (C82.11), which allowed the Certified Ballast Manufacturers Association to list electronic ballasts, essentially recognizing their efficiency.

State Ballast Regulations

California adopted an energy-efficiency standard for fluorescent lamp ballasts in 1982, which became effective in 1983. The standard affected approximately 90 percent of ballasts manufactured at that time and banned the manufacture and sale of standard magnetic ballasts within the state of California. Over the next five years, four more states adopted efficiency standards that banned the manufacture and sale of standard magnetic ballasts. Standards for New York, Massachusetts, Connecticut, and Florida became effective in 1986, 1988, 1988, and 1989, respectively.

The following table, Table 4.13, shows the level of stringency for lighting codes across the country. It can be seen that only two states have lighting codes that are stricter than California's Title 24 code and four more have codes stricter that ASHRAE/IES 90.1. Ten states have no lighting codes at all.

Table 4-14
State Building Codes by Stringency*

Status of State Building Codes	Number of States
Exceeds Title 24	2
Exceeds ASHRAE/IES	4
ASHRAE/IES 90.1	19
Less than ASHRAE/IES 90.1	10
Voluntary	4
None	10
Total	49*

*Excludes California

5 OVERVIEW OF MARKET EFFECTS ANALYSES

5.1 INTRODUCTION

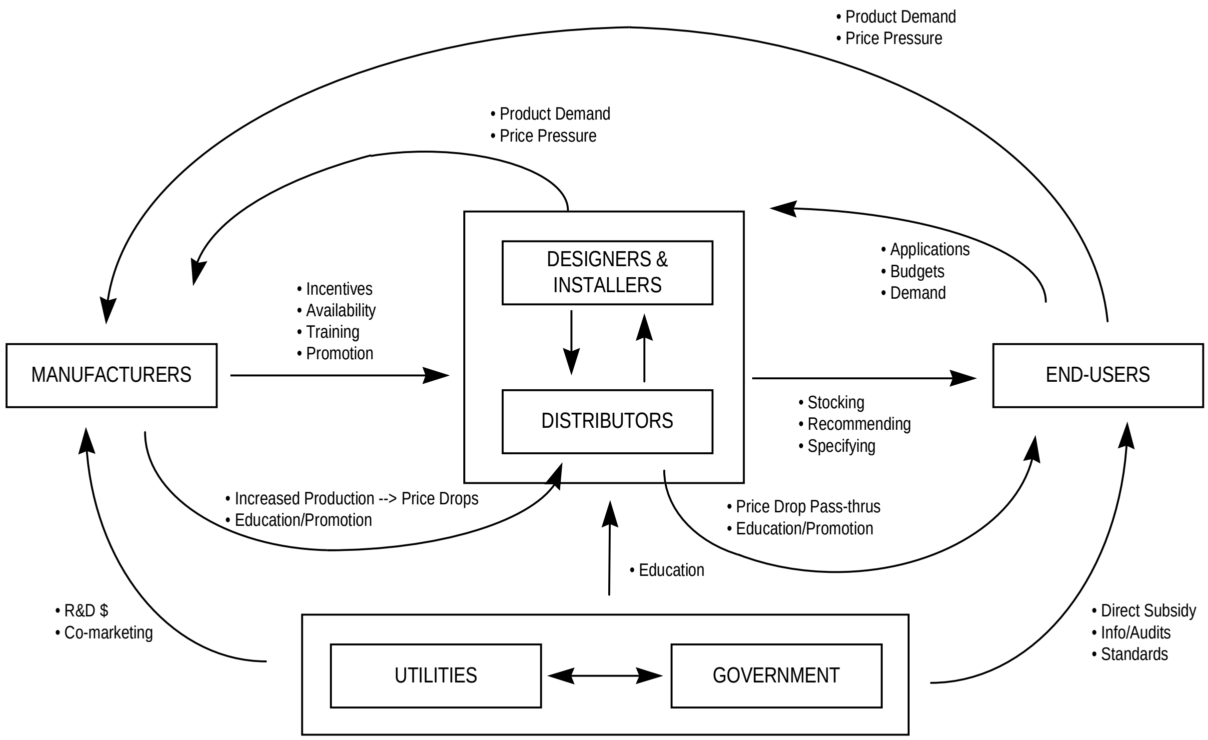
This section presents a concise summary of our findings concerning the market effects of the sponsors' efficient commercial fluorescent lighting programs. We offer it as a framework and point of reference for presentations of detailed findings concerning market effects on end users (Section 6) and supply-side actors (Section 7). As discussed in previous sections, these markets are dominated in terms of product design, availability, and price by manufacturers who operate on a national and international scale. We begin with a discussion of the causal relationships in the commercial lighting market. We then continue by summarizing the impact of utility programs in general, and the sponsors' programs in particular, on the national markets. These changes in the national market provide the framework within which local market changes and program market effects can be assessed. We then move on to summarize the market effects of the sponsors' programs in their own territories and present our assessment of the durability of those effects.

5.2 CAUSAL RELATIONSHIPS IN COMMERCIAL LIGHTING MARKET

In order for an energy-efficient product to be self-sustaining in the marketplace, both supply-side and demand-side interests must become aligned with respect to the value of the efficient product. On the supply side, it is critical that the product is available, that vendors are aware and knowledgeable about the measure, and that they stock, promote, and specify it in their business interactions with end users. On the demand side, it is equally critical that end users are aware and knowledgeable about the measure. In addition, most end users must be able to justify their purchases based on some level of economic analysis or judgment that demonstrates that the incremental costs, if any, are justified based on the monetary value of the energy savings or other value obtained. If the large majority of end users' investment criteria are not met (which could be because the measure is genuinely uneconomic or because the end users' investment criteria are inappropriate or nonexistent), or if end users have significant concerns about the product's features, quality, reliability, and the like, then it is unlikely that enough demand for the product will occur to create a significant self-sustaining market for the measure.

All of the factors mentioned above are dynamic and interactive in real markets. To illustrate these dynamics, we present in Figure 5-1 below a conceptual representation of the relationships between the different market actors and their activities with respect to commercial lighting supply and purchases. In addition, we include in the diagram the ways in which utility and government agents may intervene to stimulate these markets. Whether intentional or not, certain types of interventions have the potential to create naturally reinforcing feedback mechanisms in the marketplace. In fact, most of the relationships presented in the figure are positive feedback loops.

Figure 5-1
Selected Positive Feedback Loops and Typical Interventions in Commercial Lighting Markets*



Adapted from Easton, 1997

For example, interventions such as rebates that reduce the costs of an efficient product to the point at which large numbers of end users' investment criteria are met can induce increases in end-user demand for such products which, in turn, may result in manufacturers having to increase production. Increased manufacturer production may then lead to economies of scale and production rationalizations that result in decreases in the product's production cost. These production cost decreases may then be passed along to end users by distributors and installers. These reduced prices to end users may then stimulate even more demand for the product and set about another cycle of the feedback loop.

In addition to the production cost/end-user demand feedback loop, there is another positive feedback loop that occurs between supply-side actors' promotion and specification practices and end-user demand. As demand for the product increases, distributors, designers, and installers are likely to begin promoting and specifying the product in order to expand or maintain their competitive position. This change in specification and sales practices may then increase end-user demand further, initiating another positive feedback mechanism. Once these positive feedback cycles are established, the new product is more likely to become self-sustaining in the marketplace. This model has been at the heart of numerous efforts by governments, utilities, and private industry efforts to initiate “take-offs” of new products for decades.

Of course, there are some potential negative feedback loops, not shown in our Figure, that can be important to this process. For example, if production increases more quickly than it can be well managed, or if new lower quality entrants come into the market to supply the product, the quality and reliability may decrease. This decrease in product quality may then reduce end-user demand and cause downstream vendors to abandon or soften their support for the product. Another negative feedback mechanism that may occur is that manufacturers and vendors of the incumbent product that is being displaced by the high-efficiency alternative may fight their decreasing market share by reducing prices of their less-efficient products, thereby halting or reversing decreases in incremental prices to end users.

Although the elements and causal relationships discussed above are fairly well understood in theory, they are sufficiently complex with respect to ascertaining the specific effects of utility and government interventions as to make attribution of any observed market changes difficult in practice. In addition, because of the dynamic and interactive nature of these relationships, direct attribution may only be possible (or necessary) to ascribe to an initial set of primary forces--for example, increases in demand that spur price reduction, because the secondary effects were derived from the feedback mechanisms initiated (e.g., changes in vendors’ specification and promotion practices). These kinds of relationships are, in fact, those that we have observed through our research in this study and which we present in the remainder of this section.

5.3 CHANGES IN THE NATIONAL MARKETS AND MANUFACTURER IMPACTS

5.3.1 The Scale of Utility Intervention in the Commercial Lighting Market

From 1988 to 1996, U.S. utilities and, to a lesser extent, government agencies, conducted a massive, multi-faceted, and sustained intervention in the markets for fluorescent lighting system components. During this period, utilities nationwide paid out nearly $2 billion in rebates for efficient fluorescent lighting components. Table 5-1 summarizes these expenditures. These rebates subsidized the purchase of roughly half of all electronic ballasts shipped domestically during this period. This is 16 percent of *all* ballasts shipped during the study period. Other important utility efforts included large-scale customer education programs, negotiations with manufacturers concerning performance features of fluorescent lighting components, and participation in the development of stricter building codes. Utility efforts were complemented by government education programs such as the U.S. EPA’s *Green Lights,* as well as state and regional initiatives to increase required lighting efficiencies in commercial building codes.

Table 5-1
Spending on Rebates for Efficient Fluorescent Lighting Components (in Millions)

	Total DSM Spending		**Rebates for Efficient Fluorescent Lighting Components**		**Sponsor % of Total Ltg. Rebates**
	Nationwide	**Sponsors**	**Nationwide**	**Sponsors**	
1988	*$1,006*	$68	*$96*	$6	6.8%
1989	*$1,223*	$90	*$116*	$9	7.3%
1990	*$1,572*	$112	*$149*	$11	7.1%
1991	$1,804	$177	*$171*	$17	9.8%
1992	$2,348	$208	*$223*	$20	8.8%
1993	$2,744	$179	*$329*	$23	6.9%
1994	$2,716	$197	*$326*	$67	20.5%
1995	$2,421	$177	*$291*	$62	21.2%
1996	$2,243	$140	*$269*	$49	18.2%
Total: 1988-96	$18,076	$1,349	*$1,970*	$262	13.3%
Total: 1992-96	$12,472	$901	*$1,438*	$220	15.3%

Italicized figures estimated..

Sources: EIA (1996), LBL (1994), LBL (1995), sponsor records.

The sponsors' programs constituted a major presence in both their local markets and the national market. The sponsors paid rebates on roughly 50 to 60 percent of all electronic ballasts and T-8 lamps sold in their service territories during the study period. Units rebated through their programs accounted for an estimated 6 percent of all electronic ballasts sold in the U.S. during the study period. In addition to the sheer magnitude of the sponsors' lighting rebates, it is important to note the timing of the expenditures as well. Specifically, the sponsors' spending on commercial lighting rebates peaked in 1994 and 1995. During these years, the sponsors' programs accounted for roughly 15% of rebated electronic ballasts nationally, almost four times their 4 percent share of national commercial floorspace (see Table 2-1). Elsewhere around the country, utility program expenditures peaked in 1991 and 1992, and declined fairly rapidly after 1993. The later peak in the sponsors' spending probably helped sustain high levels of national activity and spared manufacturers from the effects of simultaneous declines in product support nationwide for an additional two years.

Table 5-2
U.S. Utilities and Sponsor Electronic Ballasts Rebated
1992 - 1996

	U.S. Ballast Shipments (mm)		Sponsor Ballasts Rebated			US Utilities Ballasts Rebated		
	Electronic	Total	Units (mm)	% US Electronic	% All US Shipments	Units (mm)	% US Electronic	% All US Shipments
1992	13.3	68.7	0.9	7%	1.3%	9.4	71%	14%
1993	24.5	79.3	1.2	5%	1.5%	13.2	54%	17%
1994	24.6	80.6	2.0	8%	2.5%	12.2	50%	15%
1995	32.9	80.6	1.9	6%	2.4%	11.1	34%	14%
1996	30.3	73.2	1.3	4%	1.8%	10.5	35%	14%
Total	**125.6**	**382.4**	**7.3**	**6%**	**1.9%**	**56.4**	**45%**	**15%**

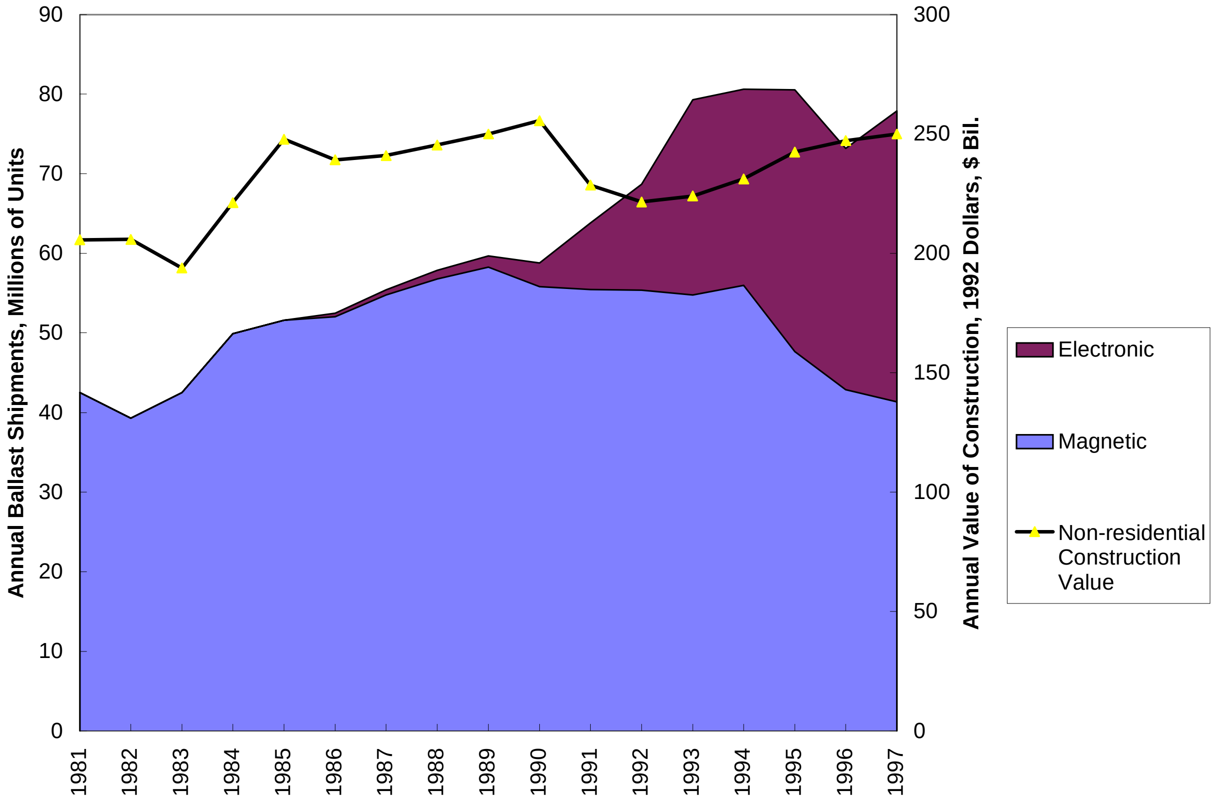
5.3.2 The Impact of Utility Programs on National Equipment Shipments

At the national level, the concerted efforts of utilities and government agencies led to a rapid increase in the demand for electronic ballasts and T-8 lamps. This growth consisted of two trends: (1) an expansion in demand for ballasts and lamps far beyond levels required to keep pace with current levels of commercial construction; and (2) a rapid increase in the market share of efficient equipment. Based on manufacturers' shipment data, the market share of 4-foot electronic ballasts increased from 13 percent in 1991 to 47 percent in 1997.

Figure 5-2 illustrates the dramatic impact of utility programs on the national markets for efficient fluorescent components. The solid areas show power factor-corrected fluorescent ballast shipments from 1981 through 1997; the darker area represents electronic ballast shipments. The black line shows the value of new construction put in place in constant (1992) dollars.[1] Prior to 1990, changes in ballast sales tended to parallel changes in construction expenditures with a lag of about a year. In 1991 and 1992, levels of construction spending dropped sharply, reflecting national recession conditions. Between 1992 and 1997, construction spending gradually returned to pre-recession levels. Ballast shipments, on the other hand, increased over 36 percent between 1990 and 1994, and most of this increase was accounted for by the steep rise in electronic shipments. Between 1992 and 1994 roughly 60 percent of electronics was rebated nationally. These trends reflect our findings that the sponsors' customers undertook a far higher level of lighting-related construction projects than did their counterparts in areas with no utility programs. The rapid increase in the market share of efficient ballasts is also apparent from Figure 5-2.

[1] Sources: U.S. Bureau of the Census, *Current Construction Reports*, Series C30. Represents value of construction put in place during the year. Includes renovations and additions and installed cost of normal building services. For ballast shipments: U.S. Bureau of the Census, *Current Industrial Reports.*

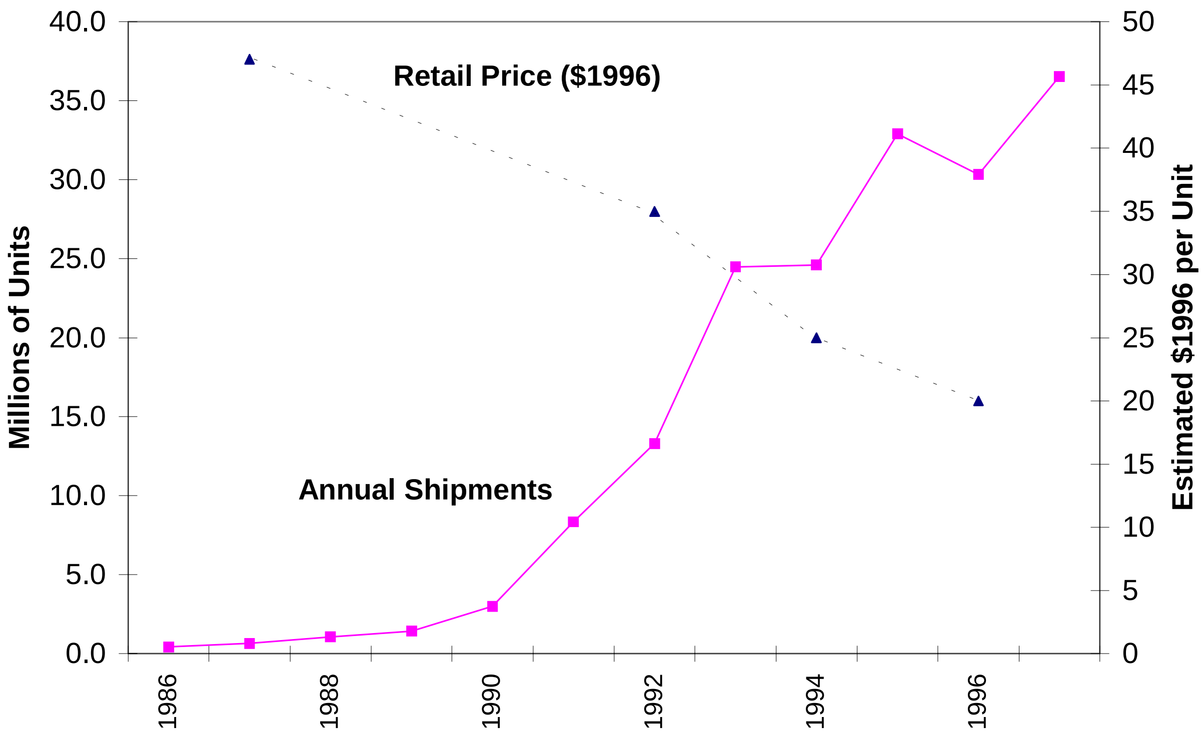
Figure 5-2
Trends in Electronic Ballast Shipments and Nonresidential Construction Expenditures: 1981-1996



5.3.3 The Impact of Increased Demand on Component Prices and Features

The rapid expansion of demand for electronic ballasts and T-8 lamps contributed to increased competition among manufacturers for market share. This competition led to improvements in product reliability and features, increased levels of promotion, and significant decreases in price. For example, the difference in price between a 2-lamp electronic ballast and a magnetic ballast decreased from $10 in 1992 to $5 in 1996. For some fixture configurations, electronic ballasts currently cost less than magnetic ballasts. The difference in price between 34-watt T-12 and T-8 lamps decreased from $1.40 in 1992 to $0.65 in 1996. Figure 5-3 illustrates the rapid decrease in electronic ballast prices along with the rapid increase in shipment volumes.

Figure 5-3
Changes in Electronic Ballast Shipment and Price Levels Over Time



As discussed in Section 7, we believe that evidence linking utility programs to decreases in the incremental costs of electronic ballasts and T-8 lamps is strong. While only two of the six manufacturers credited utility programs with direct influence on their production and pricing decisions, four of the six interviewed attributed a broad range of production, promotion, and pricing decisions to the increased volume of efficient component sales during the early and mid-1990s. The analysis presented above clearly links utility programs to that increase in demand. Moreover, most ballast and lamp manufacturers stated that they would not have made the same production-related decisions in the absence of the California programs and the increase in demand to which they were linked. These decisions covered:

- Timing and size of production runs.
- Allocation of shipments to California versus other regions.
- Changes in technical product specifications to meet sponsor requirements.

The combination of increased demand, declining prices, product improvements, and enhanced promotion appears to have created a feedback loop that has supported the "take-off" of efficient fluorescent lighting systems and their components. Penetration of electronic ballasts, the core of efficient fluorescent lighting systems, has reached 47 percent, with shares as high as 80 and 90 percent in some regions and market segments.

5.4 SUMMARY OF MARKET EFFECTS IN THE SPONSORS' SERVICE TERRITORIES: END USERS

5.4.1 Effects on Adoption of Efficient Fluorescent System Components

The national trends in the ballast and lamp markets were even more pronounced in the sponsors' service territories. The programs had a large net impact on the number of electronic ballasts and T-8 lamps purchased by their commercial customers during the study period. The penetration of electronic ballasts increased from 17 percent in 1991 to 55 percent in 1997; the market share for T-8 lamps in the sponsors' territories grew from 11 percent to 51 percent over the same period. By contrast, as Table 5-3 shows, electronic ballasts have only achieved 29 percent penetration in programs where no utility programs have been offered. The market share of T-8 lamps is estimated at 27 percent in nonprogram areas.

Depending on the method used to estimate net program impacts (see Section 6), the sponsors' programs were directly responsible for the purchase of 5 to 6 million electronic ballasts during the study period and 10 to 12 million T-8 lamps. This is roughly one-fourth of all fluorescent lighting equipment currently in use in the sponsors' commercial markets.

Table 5-3
Market Share of Efficient Equipment
Reported by Sample Distributors

Technology	Area	% Annual Market Share by Year		
		1997	1994	1991
T-8 Lamps	Program	51%	27%	11%
	Nonprogram	29%	12%	3%
Electronic Ballasts	Program	55%	29%	17%
	Nonprogram	27%	13%	3%

The impact of the programs in terms of net purchases of efficient fluorescent components appears to be concentrated in the institutional and office sectors – and particularly in owner-occupied office buildings. The program had little effect on the penetration of efficient equipment in the retail, wholesale, and miscellaneous other sectors. In these market segments, the penetration of efficient equipment in the program and nonprogram areas was basically the same.

5.4.2 Program Effects on Demand-side Market Barriers

The sponsors' programs reduced a number of important barriers to customer adoption of efficient fluorescent technologies. Most importantly, they:

- Increased customer awareness of efficient fluorescent technologies.
- Increased customer awareness of the full range of benefits associated with efficient fluorescent technologies.
- Helped customers reduce perceived costs of replacing inventories of standard equipment.

In addition, we can infer from comparisons of customer behavior between the program areas and nonprogram areas that the programs induced customers to develop resources and procedures to overcome barriers to measure adoption. These include designating staff to act as energy managers and establishing policies regarding the purchase of efficient lighting equipment. Table 5-4 provides additional detail of findings regarding reductions of market barriers.

5.5 SUMMARY OF MARKET EFFECTS IN THE SPONSORS' SERVICE TERRITORIES: OTHER SUPPLY-SIDE ACTORS

The sponsors' programs contributed to reducing a number of important barriers to the promotion of efficient fluorescent technologies by supply-side actors in the sponsors' service territories (see Section 7 for detailed analyses). Most importantly, they:

- Encouraged designers and installers to use the provision of efficient equipment as a strategy to gain and retain market share.
- Encouraged distributors to increase stocking of efficient equipment in order to gain and retain market share.
- Set the stage to make revisions in California's Title 24 building code which practically requires the use of efficient components politically acceptable to most supply-side actors.

Table 5-5 provides additional detail on the programs' supply-side market effects.

Table 5-4
Program Effects on Demand-Side Market Barriers

Hypothesized Effect	Evidence for Change	Utility Program Attribution	Relative Importance of Effect
Increase in awareness and knowledge of the product.	**Strong.** Lack of awareness of efficient technologies mentioned most often as a barrier to adoption early in program period.	**Strong.** Nearly 80 percent of program participants report being unaware of efficient fluorescent technologies prior to participation. Customer survey results corroborated by manufacturers, distributors, designers, and contractors.	**High**
Increased awareness of full range of program benefits.	**Strong**. High percentages of program participants are aware of a broad range of product advantages including longer useful life, reduced lumen degradation, reduced maintenance costs.	**Strong.** Program area nonparticipants and nonprogram area customers generally cannot cite any benefits. Few even recognize reduced electric costs. Corroborated by observations of supply-side actors.	**Moderate**
Reduced perception of costs associated with switching from standard to efficient lighting.	**Strong.** Over half of program participants mention reluctance to take on expense associated with use of two kinds of fluorescent technologies during transition.	**Moderate.** Some indirect corroboration from supply-side observers who identify cost as a barrier.	**Moderate**
Increase in use of internal energy managers.	**Moderate.** Survey finds significantly higher percentage of establishments with energy managers in program area than in nonprogram area. Strong association between having an energy manager and penetration of efficient components.	**Moderate.** Cross-sectional evidence shows strong association between energy manager on site and program participation. However, this may simply reflect self-selection.	**Moderate (could be important for durability)**
Increase in adoption of policies to purchase only efficient fluorescent components.	**Moderate.** Survey finds significantly higher percentage of establishments with purchase policies in program area than in nonprogram area. Strong association between having such a policy and penetration of efficient components.	**Moderate.** Cross-sectional evidence shows strong association between purchase policy and program participation. However, this may simply reflect self-selection.	**Moderate (could be important for durability)**

Table 5-5
Program Effects on Supply-Side Market Barriers

Hypothesized Effect	Evidence for Change	Utility Program Attribution	Relative Importance of Effect
DISTRIBUTORS, DESIGNERS, & INSTALLERS			
Programs lead designers and installers to use specification of efficient lighting equipment as a competitive strategy.	**Strong.** Great deal of self-reported change in specification practices during the study period.	**Moderate.** A portion of the effect is first order (among vendors that proactively promote). The remaining portion appears to be second order (among vendors whose practices are a reaction to end-user demand).	**High**
Changes in distributor stocking.	**Strong.** Great deal of self-reported change in stocking practices during the study period. Also, large cross-sectional difference in stocking patterns between program area and nonprogram area distributors.	**Moderate** from direct interventions to distributors. Strong from demand stimulus.	**Low**. Distributor inventories can change quickly.
GOVERNMENT			
Changes in government codes and standards	**Strong.** High likelihood of revision to Title 24 that will virtually require T-8 lamps and electronic ballasts.	**High.** CEC and State have been hesitant to revise standards in the past. Demand increases and accompanying end user, designer, and other vendor acceptance of T-8s and EBs provided more politically acceptable environment for revision. PG&E staff report high level of involvement with code revision process. Corroborated by other participants.	**High**. Standards will lock in market transformation for new buildings.

The Durability of Market Changes

Our assessment of the durability of changes in the commercial market for fluorescent lighting equipment in the sponsors' service territories addresses two questions.

1. How likely is it that the current levels of market share for electronic ballasts and T-8 lamps in the sponsors' service territories would persist in the absence of continued market intervention by local utilities?
2. How likely is it that growth in market share for electronic ballasts and T-8 lamps will persist in the absence of continued market intervention by local utilities?

We believe that evidence gathered through this study generally supports the conclusion that current levels of market share for efficient components would persist in the absence of further local utility market interventions. Evidence supporting a forecast of continued 5-6 percent annual growth in market share is less strong. Table 5-6 summarizes this evidence.

Table 5-7 provides summary information on the development of the national and local markets for efficient commercial fluorescent lighting system components in the form of a time line. It is provided for reference.

Table 5-6
Findings Regarding Durability of Market Changes

Conditions Supporting Durable Change	Conditions Mitigating Durable Change
Persistence of Current Levels of Market Penetration	
Continued increase in market share. From 1994 to 1997, national market share of electronic ballasts increased from 31% to 47% despite a decrease in utility support from $326 million to less than $250 million. **Widespread awareness.** Facilities encompassing 70% of total commercial floorspace report having purchased electronic ballasts and/or T-8 lamps in the past 5 years. **Low incremental costs.** Keen competition and consolidation in the electrical equipment market suggests that manufacturers will continue to compete on price. Current incremental costs for electronic ballasts are well within reported investment criteria. **Purchase practices and policies.** 32% of program area customers report having policies to purchase only efficient fluorescent components. **Energy Managers.** Facilities representing at least 67% of all commercial space have a designated energy manager. The presence of energy managers is associated with high penetration of efficient equipment.	**High saturation.** Paradoxically, high levels of saturation may mitigate continued high levels of market penetration. If program efforts are reduced, the proportion of retrofit and renovation-related lighting equipment purchases will fall and the volume of replacement purchases will rise. The market share of efficient equipment purchased for replacement is around 30%, versus roughly 50% for other purchase events. **Continued price resistance.** Among customers who have *not* used electronic ballasts and T-8 lamps, perceptions of high price continue to be identified as a barrier to adoption.
Continued Growth in Market Penetration	
Promulgation of Title 24 Revisions. The Title 24 Revisions to take effect in 1998 will virtually require the use of electronic ballasts and T-8 lamps in most market segments for any projects requiring building permits.	**Lack of interest among retail and "other" segments.** Despite massive programs including product rebates, customer education, contracting assistance, and – for some segments – direct installation, most customers in the retail sector and smaller customers in the office segments have not chosen to participate, nor have they adopted efficient equipment on their own. It is not clear what more utilities can do to reach these customers beyond support for code enforcement. These sectors account for 54% of total establishments and 28% of total floorspace in the program area. **Manufacturer resistance to magnetic ballast phase-out.** Generally, manufacturers have lobbied against federal product standards that would phase out magnetic ballasts for fear of lost international market share and margins. At least one U.S. ballast manufacturer has recently built a magnetic ballast factory.

Table 5-7
Time line of Efficient Fluorescent Lighting Components Market Development

	1988-1990	1991	1992	1993	1994	1995	1996	1997
UTILITY PROGRAM SPENDING (REBATES IN MILLIONS))								
U.S.	$361	$171	$223	$329	$326	$290	$361	n/a
Sponsor	$26	$17	$19	$23	$67	$62	$49	n/a
New England	$19	$75	$36	$32	$36	$36	$22	n/a
BALLASTS REBATED								
Sponsor Area		13%	18%	38%	75%	64%	45%	n/a
U.S.		8%	14%	17%	17%	15%	35%	n/a
CODES AND STANDARDS	1983: California bans standard magnetic ballasts - 1988: Title 24 revisions. Controls credit. Office LPD = 1.5	Federal Building Standards take effect – Require ASHRAE 90.1.	Title 24 Revision: Expanded coverage. No change in LPDs. EPACT passed.			Lighting provisions of EPACT take effect. Ban certain 40W fl. lamps. Require states to adopt ASHRAE 90.1.	Federal building standards revised: LPDs lowered.	Title 24 Revision (effective 1998): LPDs lowered 10 - 25%. Will require use of elec. Ballasts and T-8s.
MARKET SHARE FOR ELECTRONIC BALLASTS								
Sponsors		17%			29%			55%
Nonprogram		3%			13%			27%
US Shipmts (mil)		8.3	13.3	24.5	24.6	32.9	30.3	36.5
COSTS								
Elec. Ballasts			$35				$20	Note: A single 3- and 4- lamp electronic ballast costs less than 2 magnetic ballasts
EE Mag. Ballsts			$25				$15	
T-8 Lamps			$4.75				$3.50	
34W T-12 Lamp			$2.50				$2.25	

6 DEMAND-SIDE MARKET EFFECTS

6.1 OVERVIEW

In this section, we identify and, to the extent possible, quantify the market effects of the sponsors' programs on the end-user segments of their commercial fluorescent lighting markets. This introduction provides an overview of our general approach to assessing the programs' market effects on end users, our research and analytical methods, and our results. The subsequent subsections provide detailed findings regarding the effects of the programs on measure adoption and the reduction of market barriers. To the extent possible, we have included estimates of the 90 percent confidence interval around survey results. These are presented in the detailed findings contained in Section 6.2.

6.1.1 Approach

The *Scoping Study*, which we have used as a theoretical reference for this evaluation, defines a **market effect** as "a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of energy efficiency products, services, or practices and is causally related to market interventions." The *Scoping Study* then goes on to characterize most such changes as "reductions in market barriers" and provides a number of descriptive categories for these barriers.

In developing our characterization of the market effects of the sponsors' programs, we have attempted to answer the following basic research questions.

1. ***To what extent did the sponsors' programs affect commercial customers' adoption of efficient fluorescent lighting technologies?*** To answer this question we undertook detailed cross-sectional comparisons of the extent and timing of efficient measure adoption among participant, nonparticipant, and nonprogram area groups, as well as among market segments within those groups. We supplemented this cross-sectional analysis with interviews of key market actors, including representatives of REIMs and chain retailers.
2. ***In what specific ways did the sponsors' programs help customers overcome market barriers that may have inhibited or reduced their use of efficient fluorescent lighting technologies?*** XENERGY undertook the following steps to address this question.
   - *Develop hypotheses regarding the market effects of the sponsors' programs.* Based on our research on the sponsors' program offerings, we developed hypotheses regarding potential effects of the program on barriers to efficient fluorescent product adoption. For example, SDG&E offered a turnkey type approach to its retrofit programs, whereby installation contractors were pre-screened and their installations

inspected by San Diego staff. One could hypothesize that these services reduced a number of market barriers, including search costs for finding a contractor, hassle costs involved in remediating potential problems in installation, and perceptions of risk in working with unfamiliar tradespeople and technologies.

- *Gather information to test the hypotheses.* We drew information to test the various hypotheses primarily from the customer surveys, supplemented by the results of in-depth interviews.
- *Analyze information to test the hypotheses.* We focused our analysis of hypotheses on the programs' effects on factors that inhibited customers from using efficient fluorescent lighting technologies. First, to what extent did these factors change over the course of the study period? Second, to what extent were these changes attributable to the sponsors' programs? Given the limitations of large-scale telephone surveys, it was not always possible to build individual narratives on each potential market barrier which could then be aggregated and analyzed. In these cases, we tended to rely on cross-sectional comparisons.

3. ***How likely is it that market effects that occurred during the study period will persist after the reduction or elimination of sponsor programs to promote efficient commercial fluorescent lighting?*** By its very nature, this question can only be addressed through inference. To identify potential indicators of durability of changes, we hypothesized that customers' practice of selecting efficient lighting equipment would persist under one or more of the following conditions.
   - *Use of efficient lighting products is directly related to key modes of competition or management.* For example, representatives of REIMs told us that they compete on their ability to provide profits to real estate investors by containing operating costs and maintaining high levels of occupancy. Most were able to articulate the connection between the use of efficient equipment and cost containment, which allowed them to compete for tenants on the basis of lower operating cost allocations.
   - *Adoption of stated purchase policies.* Adoption of a stated policy to purchase efficient lighting products signals the investment of management time in lighting selection decisions. In the absence of major changes in the cost effectiveness of efficient equipment, adoption of a purchase policy should be a reliable indicator of the stability of an organization's selection decision.
   - *Extent of knowledge of product benefits.* As discussed in Section 5, price increases (or effective price increases due to rollbacks of rebates) may weaken customer commitment to efficient equipment. To the degree customers are aware of the full range of product benefits, they will be less likely to revert to purchasing standard equipment in the face of price increases.

   Information for the assessment of the durability of market effects on the demand side was drawn from a variety of sources, including the customer surveys, in-depth interviews with supply-side actors, and various evaluation and market research reports.

6.1.2 Program Effects on Customer Adoption of Efficient Fluorescent Lighting

Our analysis of the customer survey data and information from other sources yield the following major findings in regard to the effects of the sponsors' programs on customer adoption of efficient fluorescent lighting.

- The sponsors' programs had a huge net effect on number of efficient commercial fluorescent lighting system components purchased during the 1992-1997 period. This effect had two components:
  - The sponsors' programs contributed to an increased in the market share of efficient components above what it would have been in the absence of the program.
  - The sponsors' programs contributed to an increase in the number of ballast purchases above the volumes that would have been purchased in the absence of the program, and these incremental purchases were all electronic models. In other words, the bulge in national ballast shipments observed during the 1990s was concentrated to some extent in California and in the sponsors' areas.

- High penetration of efficient fluorescent system components was concentrated in the office and institutional sectors.

Increase in the Volume of Efficient Fluorescent Components Purchased

Effect on Market Share. We estimate that the sponsors' programs directly subsidized the purchase of approximately 8 million electronic ballasts and 17 million T-8 lamps during the study period. These volumes constitute roughly 50 to 60 percent of the electronic ballasts and T-8 lamps sold in that time frame.

Estimates of the portion of program-supported sales that can be counted as net program effects vary substantially based on the methods used. Table 6-1 displays the key results of major studies, including this one, which were designed to estimate net program effects. The sponsors' evaluation studies relied on a combination of billing data analysis and survey responses from a sample of participants and nonparticipants to estimate net program energy savings.[1] These studies arrived at Net-to-Gross Ratios in the 90 percent range for program participants. These findings reflect relatively low estimates of free ridership and small amounts of participant spillover. PG&E's studies also identified significant levels of nonparticipant spillover, which, if added to the Net-to-Gross ratio, would raise it over 1.0. Based on these estimates, the sponsors' programs would be responsible for the purchase of about 70 percent of all electronic ballasts purchased by their customers during the study period.

[1] See, for PG&E, Quantum Consulting, *1994 Commercial Retrofit Program Evaluation of Lighting Technologies: Final Impact Evaluation Report,* February 1996 and Quantum Consulting, *Evaluation of Pacific Gas & electric company's 1995 Nonresidential Energy Efficiency Incentives Program for Commercial Sector Lighting Technologies.* For SDG&E, see *1994 Commercial Energy Efficiency Incentives Program: First Year Load Impact Evaluation and Retention Studies* and *1995 Commercial Energy Efficiency Incentives Program: First Year Load Impact Evaluation and Retention Studies.*

The difference in *self-reported* market penetration of efficient equipment between the program area and a comparison (nonprogram) area during a given period can be used as a measure of net program effects.[2] Using this approach, the results of the customer survey conducted for this study (see Table 6-2 for a summary) suggest that the net impact of sponsors' programs on electronic ballast sales was 40 percent [(1-(.28/.47)] of all electronic ballasts sold. The corresponding figure for T-8 lamps was 82 percent.

Table 6-1 also displays net-to-gross ratios developed from the results of the survey of distributors in the program and nonprogram areas that was conducted for this study. These results suggest that the net impacts of the sponsors' programs declined over time as the market share of efficient components increased nationwide. Over the entire period, the ratios averaged around 65 percent.

Each of the methods used to estimate net program effects has its advantages and disadvantages. Stated briefly, the self-reported and logistic models used in the sponsors' studies may overestimate net effects due to their reliance on customers' interpretations of their own purchasing decisions. Cross-sectional comparisons of market penetration may underestimate program effects if the sponsors' program efforts contribute to the development of the market for efficient components in nonprogram areas. As discussed above, we believe an argument can be made that increased demand for electronic ballasts and T-8 lamps caused by utility programs led to product improvements and price decreases that stimulated demand in nonprogram areas.

Even if we accept the lower estimates of net effects from the distributor-based surveys (which we believe are somewhat more reliable penetration indicators than the customer self-reports), we can conclude that the sponsors' programs were responsible for purchases during the study period of over 5 million ballasts and 11 million lamps, which the sponsors' customers would not have made in the absence of the programs.

Effect on Volume of Lighting-Related Construction Projects. The customer survey found that the volume of reported construction involving the installation of new or replacement fluorescent lighting systems was nearly twice as high in the program areas as it was in the nonprogram areas and that the largest differences between areas appeared in the renovation and retrofit categories. Specifically, we estimated that retrofit, renovation, and remodeling projects involving the installation of fluorescent lighting encompassed 60 percent of total floorspace in the sponsors' service territories versus 30 percent in the nonprogram areas. This finding suggests that the sponsors' programs influenced not only the customers' selection of equipment, but their decisions regarding the timing and scope of construction projects.

The relatively high level of lighting-related construction projects in the program areas identified by the survey stands in stark contrast to trends in construction activity in California during the program period. As Figure 6-1 shows, the volume of permitted nonresidential construction

[2] See Weisbrod, Glen, Train, Kenneth, Hub, Andrew, and Benenson, Peter, *DSM Program Spillover Effects: Review of Empirical Studies and Recommendations for Measurement Methods,* Cambridge Systematics, Inc., January 1994.

declined much more steeply in California than in the rest of the nation during the study period and only began to recover in 1996. These findings suggest that the sponsors' programs did indeed play a large role in elevating the volume of lighting equipment sales and, specifically, the volume of efficient lighting component sales.

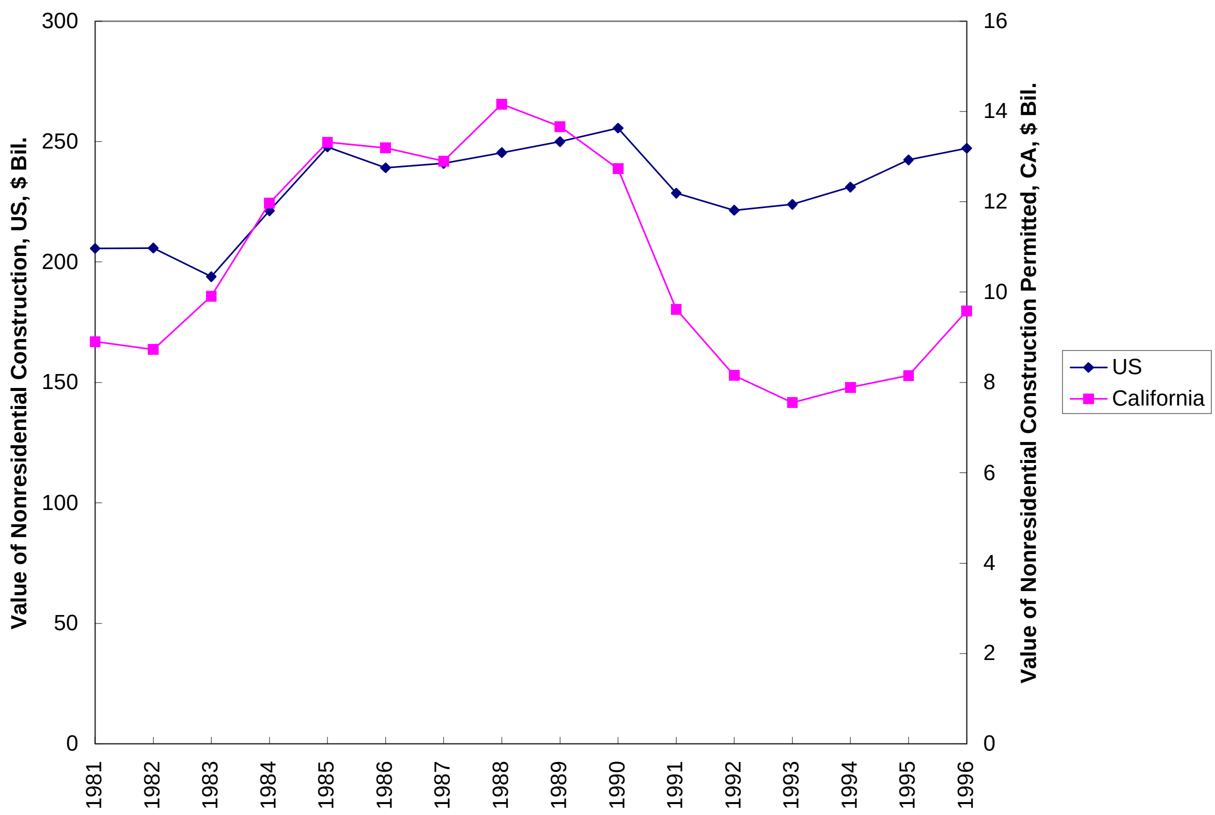
Table 6-1
Summary Results of Studies to Estimate Net Effects of the Sponsor's Commercial Lighting Programs

Sponsor/ Area Covered	Period Covered and Source	Summary of Methods	Net-to-Gross Ratio & Related Indicators
PG&E	1994 (Quantum, 1996a)	- Free ridership and net program *energy savings* (without nonparticipant spillover) estimated using logistic model with participant and nonparticipant billing data and surveys of customers on purchase plans, motives, and facility characteristics. - Spillover estimated on basis of self-reports only.	N-t-G (Part.): .90 Free Riders: .13 Part. Spillover: .03 Nonpart. Spil.: .18
PG&E	1995 (Quantum, 1997a)	- Similar methods to 1994 study.	N-t-G: .90 Free Riders(T-8): .10 Free Riders(EB): .10 Spillover: .14
SDG&E	1994 (SDG&E, 1996)	- Methods similar to PG&E.	N-t-G: .89
SDG&E	1995 (SDG&E, 1996)	- Methods similar to PG&E.	N-t-G: .89
PG&E & SDG&E	1992 - 1997 (This study)	- Estimate of *net units of efficient components* purchased based on comparison of efficient component penetration between program areas and nonprogram areas. - Penetration estimates <u>use self-reports of customers</u> surveyed re: purchases of lighting equipment. - Net purchases reflect free ridership, participants spillover, and nonparticipant spillover. These adjustments cannot be estimated separately with this method.	N-t-G (EB): .40 N-t-G (T-8): .82
PG&E & SDG&E	1992 - 1997 (This study)	- Estimate of *net units of efficient components* purchased based on comparison of efficient component penetration between program areas and nonprogram areas. - Penetration estimates <u>use reports of a statistical sample of distributors</u> re: market share of efficient components.	1991 N-t-G (EB): .82 1994 N-t-G (EB): .65 1997 N-t-G (EB): .51 1991 N-t-G (T-8): .73 1994 N-t-G (T-8): .66 1997 N-t-G (T-8): .47

Market Share of Efficient Components by Market Segment. Table 6-2 shows the penetration of electronic ballasts and T-8 lamps during the study period by area, program participation status, and market segment. For electronic ballasts, significant differences in market share between the program and nonprogram areas occur only in the office and institutional sectors. These segments were targeted by program marketing (institutional and large office in the case of San Diego, large office in the case of PG&E), and they are the segments which participated most heavily in the programs. They are also, as discussed in Section 2, the segments with the strongest motivations to reduce energy and related operating costs.

The differences between the program and nonprogram areas in the penetration of T-8 lamps is more consistent across sectors and generally larger than that reported for electronic ballasts. These findings may reflect customers' lack of familiarity with the "T-8" designation in the nonprogram areas.

Figure 6-1
Volume of Nonresidential Construction: U.S. and California



Sources: U.S. Bureau of the Census, *Current Construction Reports*. California Department of Finance, *California Statistical Abstract,* Table I-4.

Table 6-2
Cross-sectional Comparison of Efficient Lighting Component Market Share: 1992 - 1997

	Electronic Ballasts				T-8 Lamps			
	Program Area			*Nonprog-ram Area*	*Program Area*			*Nonprog-ram Area*
Segment	Partic.	Nonpartic.	All		Partic.	Nonpartic.	All	
1 Office/Own	88%	41%	71%	32%	88%	16%	37%	12%
2 Office/Lease	48%	9%	48%	38%	84%	4%	59%	15%
3 Retail/Sole	38%	16%	25%	32%	25%	6%	16%	8%
4 Retail/Chain	60%	10%	30%	40%	58%	8%	37%	5%
5 Institutional	55%	18%	53%	22%	55%	10%	53%	8%
6 Other	29%	3%	12%	30%	30%	1%	15%	12%
All Segments	**51%**	**15%**	**47%**	**28%**	**49%**	**7%**	**49%**	**9%**

6.1.3 Program Effects on Market Barriers

Identification of Market Barriers: Hypotheses and Findings

In Figure 6-2 we display the correspondence between hypothesized market barriers and program features. We also indicate in Figure 6-2 the market barriers that customers and supply-side actors identified through the interviews and surveys. The starred items were identified by large percentages of customers or supply-side actors as being important barriers to adoption of efficient lighting components. In some cases we make this identification by inference, relying on customers' reports of the effects of the programs on their lighting selection decisions. The items indicated by "**X**" were mentioned by smaller percentages of customers (10 - 20 percent). The potential barriers indicated by **"?"** were assessed through the analysis of the customer survey results and found not to be decisive in terms of adoption of efficient fluorescent components.

Figure 6-2
Relationships between Hypothesized Market Barriers, Program Offerings, and Barriers Identified by Study Subjects

Adoption State	Hypothesized Market Barrier	Program Response	Identified as Important by: Customers	Identified as Important by: Supply Side
Unaware				
	• Information or search costs.	• Sponsor programs provide product information, audits. • Sponsor programs reward customers for becoming informed with cash incentives (rebates).	✪	X
Aware				
	• Concerns about reliability and performance of products.	• Sponsors negotiate product performance standards with manufacturers.		✪
	• Lack of knowledge of full range and amount of product benefits.	• Sponsor programs provide product information to customers, designers, distributors, contractors.	✪	
	• Split incentives.	• PG&E targets program marketing to property managers.		
Interest				
	• Lack of means, staff to evaluate financial benefits of the product.	• Sponsors provide product information. • SDG&E performs payback calculations for some.	?	
	• High first cost.	• Sponsors provide product information. • Rebates to offset perceptions of high costs.	X	✪
	• Organizational practices/hidden costs: geared up to stock and service older technology.	• Rebates to offset hidden costs.	✪	X
Intent				
	• Concerns regarding reliability of contractors.	• SDG&E provides contractor pre-screening. • Both sponsors provide inspection.		
	• Cost and hassle of contracting.	• SDG&E provides turnkey installation. • Both sponsors provide targeted turnkey installation for small commercial customers.		
Purchase				
	• Lack of resources to track performance and to communicate benefits to rest of organization.		?	
Repeat Purchase				

We have borrowed the framework of adoption process models of market penetration to order the presentation of hypotheses and information in Figure 6-2. Adoption process models posit that there is a sequence of steps or "states" in an organization's decision to use new products, and that this sequence is fairly uniform among organizations. For end-use customers, market barriers can be understood as conditions or circumstances that impede their movement from one state to the next. We have borrowed the sequence of states to provide a framework for the rather long list of potential market barriers addressed by the programs.[3]

Attribution of Market Effects: Evidence and Analysis

As Figure 6-2 shows, customers and supply side actors (mostly distributors, designers, and contractors) identified certain market barriers as important factors in their lighting equipment selection decisions. In this section, we summarize the evidence from the customer and supply-side research regarding the relative importance of these barriers and the effects of the sponsors' programs in reducing them.

Lack of awareness of efficient fluorescent lighting components. According to customers, lack of awareness of efficient fluorescent lighting components was the most important barrier to their adoption of such products. It also appears that the most profound effect of the sponsors' programs on end-use customers was to make them aware of the efficient technologies and of their benefits. Evidence to this effect includes the following.

- Seventy-four percent of program participants interviewed for the study reported that the main reason they had not used electronic ballasts or T-8 lamps prior to program participation was that they were not aware of these products. The next most frequently mentioned barrier – high first cost – was mentioned by only 19 percent of program participants.
- Eighty percent of participants in PG&E programs and 87 percent of participants in SDG&E programs reported that their first purchases of electronic ballasts or T-8 lamps were made through the programs.
- Among nonparticipants, 57 percent of customers who had not used electronic ballasts or T-8s reported that they were not aware of the technology. (Note: Customers representing only 28 percent of nonparticipants' floorspace reported that they had never used electronic ballasts or T-8 lamps.)

Many supply-side actors interviewed for this project indicated that customers' lack of awareness was a major barrier to widespread adoption of efficient fluorescent technology and that the sponsors' programs had done much to educate customers. For example:

[3] Please note that this study was not designed to estimate a process adoption model. Rather, we are simply making use of the conceptual structure of such models to help organize our findings. For a description of adoption process models and examples of their use in the energy field, see EPRI, 1991. *Market Penetration of New Technologies, Programs, and Services*, prepared by Research Triangle Institute for the Electric Power Research Institute, 1991.

- Eleven percent of distributors interviewed identified lack of customer knowledge as a major barrier to acceptance of electronic ballasts and T-8 lamps early in the program period.
- Forty percent of distributors identified customer education provided by the programs as the most important reason why high levels of efficient product penetration would likely persist in the face of declining rebate availability. Customer education was the most frequently mentioned factor in distributors' assessments of the durability of market changes.
- Interviews with contractors and designers yielded similar patterns of responses.

Customer concerns regarding the reliability and performance of efficient fluorescent lighting components. Hardly any customers surveyed for this project mentioned concerns about the reliability of electronic ballasts or T-8 lamps as a barrier to their purchase. By contrast, 48 percent of distributors and 41 percent of designers identified concerns about reliability of these components as a barrier to their acceptance during the early part of the study period. These perceptions were echoed by four of six ballast manufacturers interviewed. As discussed later in this section, we believe utility programs in general contributed to the reduction of this barrier by increasing the size of the market for electronic ballasts and T-8 lamps and, thereby, manufacturers' interest in securing shares of that market through product improvement.

Lack of knowledge of the full range of benefits of efficient fluorescent components. Results of the customer surveys strongly suggest that the sponsors' programs helped educate participants about the full range of benefits associated with efficient fluorescent system components. Evidence to this effect includes the following.

- Fifty-two percent of program participants (correctly) mentioned longer useful life in an unprompted question concerning the benefits of efficient fluorescent components. By contrast, only 3 percent of nonparticipants and 1 percent of nonprogram area customers mentioned this benefit.
- Fourteen percent of program participants mentioned a variety of other legitimate product benefits, including lower maintenance costs and reduced lumen degradation. Hardly any program area nonparticipants or nonprogram area customers were able to report such benefits.
- Virtually all program participants were able to name at least one legitimate benefit of efficient fluorescent components. By contrast, 62 percent of program area nonparticipants and 39 percent of nonprogram area customer were *unable* to name *any* legitimate product benefits.

Perceptions of high first cost. The *Scoping Study* does not list perceptions of high first cost as a market barrier. Rather, the authors posit that perceptions of high first cost are related to customers' reluctance or inability to apply the appropriate kinds of decision frameworks to the purchase of lighting equipment. Specifically, they maintain that perceptions of high first costs are related to customers' lack of knowledge of the benefits associated with efficient lighting equipment and with their inability to apply life-cycle costing or investment frameworks to the purchase decision. Nonetheless, our sample manufacturers, distributors, designers, and contractors all identified high first cost as the most important barrier to the widespread adoption of efficient products at the beginning of the study period (1991). Thirty-two percent of distributors and 46 percent of designers identified high first cost as an important current barrier.

Customers viewed the incremental cost of efficient lighting equipment as a somewhat less important barrier to purchase. For example, only 19 percent of program participants mentioned high first cost as a reason for *not* using electronic ballasts or T-8 lamps prior to participation in the sponsors' programs. Only 7 percent of nonparticipants who had never used electronic ballasts or T-8 lamps identified high first cost as the most important barrier. By way of contrast, 58 percent of these customers reported they were not familiar with efficient fluorescent components.

There are several possible explanations for the discrepancies in perceptions between supply-side actors and customers regarding the importance of first costs as a barrier to purchasing efficient lighting equipment. These include the following.

- Distributors and designers deal not only with end-use customers but with contractors, general contractors, and developers, who are generally under pressure to reduce costs to compete on price and minimize financing costs.
- Many customers simply are not aware of the difference in cost between the competing technologies.
- Customers underreported their sensitivity to price to meet perceived expectations of the interviewer.

We were not able to investigate these hypotheses based on the responses to our survey.

Lack of staff or procedures to analyze the costs and benefits of efficient equipment. Some analysts believe that the availability of staff and procedures to conduct cost-benefit analyses of lighting purchases will mitigate resistance to higher first cost and facilitate adoption of efficient equipment. To test this hypothesis, we asked customers in the survey whether they had an energy manager on staff and whether they applied investment criteria to lighting purchases. We then compared the penetration of efficient lighting equipment among customers grouped according to the reported presence of an energy manager and the reported application of investment criteria to lighting purchases.

We found that penetration of electronic ballasts (the core of efficient fluorescent systems) was strongly associated with the presence of an energy manager and the use of investment criteria to guide lighting equipment purchases. In fact, program area customers with energy managers (excluding those in the leased office sector) had a 48 percent market share for electronic ballasts versus 24 percent for those without an energy manager. Similarly, those who reported applying investment criteria to lighting purchases registered a 75 percent market share for electronic ballasts versus 22 percent for those who did not apply investment criteria.

The association between the programs and the presence of energy managers or the application of investment criteria to lighting purchases, however, was not very strong. Customers representing 67 percent of floorspace reported having energy managers in the sponsors' service territories, versus 43 percent in the nonprogram areas. For the use of investment criteria, the difference was 34 percent versus 27 percent. Neither of these differences are statistically significant at the 90 percent confidence level. We did find, however, that the presence of an energy manager and the application of investment criteria among the sponsors' customers were very strongly associated with program participation.

6.1.4 Assessment of the Durability of Demand-Side Market Changes

Our assessment of the durability of changes in the commercial market for fluorescent lighting equipment in the sponsors' service territories addresses two questions.

1. How likely is it that the current levels of market share for electronic ballasts and T-8 lamps in the sponsors' service territories would persist in the absence of continued market intervention by local utilities?
2. How likely is it that growth in market share for electronic ballasts and T-8 lamps will persist in the absence of continued market intervention by local utilities?

Adoption of purchase policies. Perhaps the clearest indicator of durability of changes on the demand-side of the market are reports of the adoption of policies to purchase efficient components only. We found that customers representing 34 percent of program area floorspace had established policies to purchase electronic ballasts and T-8 lamps only, versus 18 percent in the nonprogram areas. This difference was not statistically significant at the 90 percent confidence interval. Still, the commitment of customers representing one-third of the market to such policies suggests that current levels of efficient component market share are likely to persist.

Other factors contributing to the persistence of current levels of efficient component penetration include:

- Persistence in the growth of market share both nationally and in the program area in the face of declining utility support and incentive payments.
- Widespread awareness (facilities encompassing 70 percent of total floorspace) among end users of the benefits of efficient fluorescent lighting equipment.

We also identified evidence which suggests that the recent pace of growth in efficient product market share is unlikely to be sustained. This evidence includes the following:

- Despite a decade of intense promotion and plentiful rebates, the retail and miscellaneous sectors have not adopted efficient fluorescent technology in great numbers. Moreover, adoption of efficient products by smaller customers in virtually all sectors is relatively low. It is unclear what more the sponsors can do to get the attention of these customers.

6.2 DETAILED FINDINGS

6.2.1 Efficient Product Adoption

Volume of Lighting-Related Projects

The program area and nonprogram area customer surveys both contained sequences of questions designed to support estimates of the volume of construction projects involving the installation or replacement of fluorescent lighting systems. Table 6-3 shows a comparison between the program and nonprogram areas in the volume of such projects during the study period, estimated as a percentage of existing floorspace.[4]

Table 6-3
Comparison of Program and Nonprogram Areas
Volume of Construction Activity Involving Fluorescent Lighting: 1992 - 1997

	Program Area		Nonprogram Area	
Event	**% of Establishments**	**% of Floorspace**	**% of Establishments**	**% of Floorspace**
Remodeling	7.7%	4.7%	10.2%	7.7%
Renovation	23.2%	25.9%	26.7%	16.3%
Retrofit	16.1%	28.9%	12.7%	6.1%
Total	**47.0%**	**59.5%**	**49.6%**	**30.2%**
(90% Conf. Intrvl)	*(8.1%)*	*(31.7%)*	*(6.4%)*	*(10.8)*

Market Shares of Efficient Equipment

Our findings from the analysis of survey results of program effects on the market share of efficient components yields conclusions similar to those gleaned from the analysis of program effects on overall lighting-related construction activity. Overall, the penetration of efficient

[4] It is not feasible to develop a similar estimate for new construction from the survey data because of the relatively low representation of respondents in new construction and most occupants' limited access to knowledge about the construction process.

components during the study period was significantly higher in the program area than in the nonprogram area when measured as a percentage of floorspace affected. (This is a proxy for percentage of units purchased.) However, we find that the percentage of establishments that purchased efficient components during the study period is roughly equal. Moreover, as discussed in Section 2, sharp increases in the saturation of efficient components and high levels of current market share were concentrated in the institutional and office sectors. This pattern suggests that program effects were concentrated in several sectors and, within those sectors, on a group of fairly motivated customers.

The following paragraphs add detail to this assessment.

Penetration of Efficient Components by Purchase Event. Table 6-4 displays the penetration of efficient equipment by purchase event for the program and nonprogram areas. The following conclusions can be drawn from this table.

- Overall, penetration of efficient components was significantly higher in the program areas than in the nonprogram areas. For example, the market share of electronic ballasts in the program areas was 41 percent versus 23 percent in the nonprogram areas. For T-8 lamps, the comparison was 40 percent versus 15 percent.
- In terms of purchase events, the differences between the program and nonprogram areas are most pronounced in renovation and replacement. The difference in the renovation category can be traced back to the design of the programs, which heavily targeted upgrades in existing buildings. The similarity in the market share of electronic ballasts in retrofit situations is not surprising, given that energy efficiency is a major motivation for retrofits. We should remember, however, that the volume of retrofits was nearly five times higher in the program areas than it was in the nonprogram areas.
- The substantial difference between the program and the nonprogram areas in market share for replacement (31 versus 19 percent) may constitute an indicator of market effects. As mentioned in Section 2, this figure was derived by analyzing customers' responses to a question concerning practices in replacing failed equipment. The results indicate that a significantly higher portion of customers in the program areas compared with those in the nonprogram areas have adopted the practice of replacing failed ballasts with electronic models.

Table 6-4
Comparison of Program and Nonprogram Areas
Penetration of Efficient Equipment by Event and Technology: 1992 - 1997

	Percent of Total Category Purchases in % of Floorspace	
***Event*/Technology**	**Program Area**	**Nonprogram Area**
New Construction/Remodeling		
Electronic Ballasts	37.8%	30.6%
T-8 Lamps	17.3%	10.7%
2-lamp Fixtures	47.9%	30.7%
Renovation		
Electronic Ballasts	53.7%	25.6%
T-8 Lamps	51.2%	18.0%
2-lamp Fixtures	54.5%	26.4%
Retrofit		
Electronic Ballasts	47.5%	47.0%
T-8 Lamps	46.7%	22.6%
2-lamp Fixtures	46.9%	34.4%
Replacement		
Electronic Ballasts/T-8s	31.2%	19.0%
All Events		
Electronic Ballasts	47.0%	28.1%
T-8 Lamps	49.0%	9.2%
2-lamp Fixtures	50.0%	16.0%

Penetration of Efficient Components by Market Segment

Market Share of Purchases. Table 6-5 shows the penetration of efficient components in the program and nonprogram areas by market segment. The significant overall difference between the program and nonprogram areas in efficient component penetration is by no means consistent when the samples are broken down by market segment. Moreover, the ranking of segments in terms of efficient component penetration is not consistent between the program and nonprogram areas. Specifically:

- In several segments, notably leased office space, single-location retail, and “other,” the market shares of electronic ballasts are similar. In some cases, the market share is higher in the nonprogram areas. The same pattern holds for T-8 lamps.

In the program areas, penetration of efficient components is very high in the institutional sector. It ranks second in terms of market share of electronic ballasts and T-8 lamps, just slightly below the market shares in the owner-occupied office sector. (We might add that the owner-occupied office sector is considerably smaller than the institutional sector in terms of floorspace.) In the nonprogram areas, however, the institutional sector ranks dead last in terms of penetration of electronic ballasts (15 percent versus 60 percent in the program areas) and T-8 lamps (9 percent versus 59 percent in the program areas). In this, as in many other variables, the impact of the sponsors' marketing emphasis on institutional customers is evident.

Table 6-5
Comparison of Program and Nonprogram Areas
Penetration of Efficient Equipment by Segment and Technology: 1992 - 1997

	Market Share for Efficient Components in Percentage of Floorspace					
	Electronic Ballasts		T-8 Lamps		2-Lamp Fixtures	
Market Segment	Program	Nonprog.	Program	Nonprog.	Program	Nonprog.
1 Office/Corp. Own	71%	32%	37%	12%	64%	10%
2 Office/Lease	48%	38%	59%	15%	53%	17%
3 Retail/Sole	25%	32%	16%	8%	28%	10%
4 Retail/Chain	30%	40%	37%	5%	40%	32%
5 Institutional	53%	22%	53%	8%	51%	17%
6 Other	12%	30%	15%	12%	10%	11%
Total	**47%**	**28%**	**49%**	**9%**	**50%**	**16%**
(90% Conf. Interval)	*(19%)*	*(12%)*	*(19%)*	*(6%)*	*(20%)*	*(13%)*

Table 6-6 shows the percentage of establishments that reported purchasing electronic ballasts and T-8 lamps during the study period by market segment. Overall, the percentage of establishments that purchased electronic ballasts in the program and nonprogram areas was greater in the program areas. However, the differences between areas are not large. This finding is consistent with others which suggest that high levels of efficient component penetration in the program areas have been driven by a group of customers who made large purchases for their facilities.

Note: As in all specialized surveys of this sort, the level of nonresponse was very high, especially in the nonprogram area. In the program area, roughly 10 times as many customers were contacted as those who completed the survey. In the nonprogram area, the ratio was 8:1. However, for this type of nonresidential survey it is typical that at least half of the contacts are made with potential respondents who do not qualify for the survey or in which a decision-maker is never reached. Even so, nonresponse of 60 percent is typical. High levels of nonresponse are also due in part to the demands of the sampling plan, which allocated the sample among 30 cells defined by sector and number of employees. It suggests that those who responded to the survey were likely to be interested in the subject. However, the penetration rates and other key parameters estimated from the survey results are consistent with information from Census and shipment data. Moreover, since the response rate was low in both the program and nonprogram areas, whatever upward biases that may have occurred in estimates of market penetration would have affected both the program and the nonprogram areas.

Table 6-6
Comparison of Program and Nonprogram Areas
Establishments that Purchased Efficient Components by Market Segment: 1992 - 1997

	Percentage of Establishments that Purchased Efficient Components: 1992-1997			
	Electronic Ballasts		T-8 Lamps	
Market Segment	**Program Area**	**Nonprogram Area**	**Program Area**	**Nonprogram Area**
1 Office/Corp. Own	32.2%	28.4%	18.7%	16.6%
2 Office/Lease	26.1%	26.1%	43.0%	8.8%
3 Retail/Sole	18.2%	12.5%	5.7%	9.0%
4 Retail/Chain	30.1%	19.4%	11.7%	21.5%
5 Institutional	63.8%	8.8%	4.6%	16.8%
6 Other	16.7%	28.7%	21.0%	3.1%
All Segments	**28.6%**	**20.7%**	**15.2%**	**11.6%**

Spillover

Spillover has been defined as any reduction in energy consumption or demand that is due to an energy efficiency program, other than reductions due to measures or actions taken by participants as part of the program. Among participants, spillover may occur when facilities managers decide to purchase efficient lighting components without subsidies on the basis of favorable experience with efficient components that were purchased through the program. Among nonparticipants, spillover may occur if facilities managers have learned about the sponsors' support for the purchase of efficient components and factor this knowledge into their own decisions to purchase such equipment without applying for program rebates. Spillover is an important indicator of market effects because it measures the extent to which customers have assimilated sufficient information about efficient components to purchase them on their own.

For this study, program area respondents were classified as having made spillover purchases if they:

- Reported purchasing efficient fluorescent lighting components during the study period without applying for rebates.
- Reported being aware of or participating in the sponsors' programs prior to making the above purchases.

- Indicated that their knowledge or experience of the sponsors' programs were either "Very Important" or "Somewhat Important" factors in their decision to purchase efficient fluorescent lighting components.

Table 6-7 shows the percentage of establishments that were classified as having made spillover purchases based on the above criteria. Twenty-eight percent of the program participants (population weighted) reported having made spillover purchases, as did nine percent of nonparticipants. We did not attempt to estimate the volume of spillover purchases based on the survey results. A number of the sponsors' periodic program evaluations have developed such estimates, usually based on a combination of self-reports and discrete choice analysis of customer survey data. In the most recent PG&E evaluation, spillover (both participant and nonparticipant) was estimated at 14 percent of gross program savings.[5] Other studies have developed a wide range of spillover estimates. However, when combined with participation rates of 20 to 25 percent, it is clear that the programs have reached a sizable percentage of customers.

Table 6-7
Indicators of Program Spillover Effects

	Percentage of Establishments Reporting Spillover Purchases	
Market Segment	**Participants**	**Nonparticipants**
1 Office/Corp Own	81.5%	13.7%
2 Office/Lease	0.0%	8.2%
3 Retail/Sole	0.0%	11.5%
4 Retail/Chain	55.1%	3.8%
5 Institutional	25.4%	5.2%
6 Other	6.9%	6.5%
All Segments	**28.3%**	**9.1%**

6.2.2 Program Effects on Product Knowledge

Knowledge of Product Benefits

In addition to lower operating and life-cycle costs, electronic ballasts and T-8 lamps offer a number of advantages over electro-magnetic ballasts and T-12 lamps. These include:

- Longer useful life.
- Significantly less lumen degradation over time.

[5] Quantum, 1997a.

- Higher lumen output in standard configurations.
- Better color rendition.
- Generally, a more attractive appearance.

T-8 lamps may have disadvantages in some applications. These include higher levels of glare due to the higher concentration of the light source in fixtures without diffusers. This can be particularly troublesome in areas housing intense computer use. However, there are technical and design solutions to this problem, including the use of lenses and indirect lighting.

One potential index of program impacts is the extent to which program area customers are aware of the full range of the benefits of efficient fluorescent lighting components, compared with nonprogram area customers. Table 6-8 shows the percentage of customers who reported purchasing electronic ballasts or T-8 lamps that mentioned various advantages of electronic ballasts. Within the program area, the responses are broken down by participants and nonparticipants. The responses summarized in Table 6-8 indicate the following.

- A significantly higher percentage of customers in the nonprogram area (39 percent versus 16 percent in the program area) were unable to name any advantages to using efficient components. Among program participants, this portion was only 2 percent.
- The only benefit which nonprogram area customers could identify (without prompting) was lower operating costs, which roughly one-half of efficient component users named. A significant percentage of program area customers (in particular, program participants) were able to name a number of advantages, including lower operating cost, longer useful life, and a variety of other legitimate benefits that we grouped into the "other" category.

Table 6-8
Perceived Advantages of Efficient Equipment

	Program Area			Nonprogram
	Participant	Nonpartic.	Total	Area
Did Not Answer	2.2%	62.4%	15.9%	39.0%
Lower operating cost	28.3%	21.5%	26.7%	45.2%
Longer useful life	52.1%	2.7%	41.0%	1.2%
Other	14.1%	0.8%	11.2%	1.3%

Program Effect on Product Awareness

Our analysis of the program area survey responses indicates that the sponsors' programs had a pronounced effect on customers' awareness of efficient fluorescent components. Table 6-9 shows the floorspace-weighted percentage of customers who report that they made their first purchase of efficient components through the sponsors' programs. For PG&E, this portion is 80 percent; 87 percent for San Diego Gas & Electric.

Table 6-9
Floorspace-Weighted Percentage of Customers Who Made First Purchase of Efficient Fluorescent Components Through the Sponsors' Programs

Market Segment	PG&E	SDG&E
1 Office/Corp. Own	100.0%	30.2%
2 Office/Lease	74.1%	100.0%
3 Retail/Sole	60.7%	100.0%
4 Retail/Chain	100.0%	81.9%
5 Institutional	92.1%	89.1%
6 Other	90.4%	52.2%
All Segments	**79.8%**	**86.7%**

Table 6-10 displays program participants' responses (unprompted) to a question which explored why they had not used efficient fluorescent components prior to participating in the program. The most frequent first response (74 percent of all participants in the sample) was that they were not aware of the measures prior to participating in the program. The next most frequently mentioned reason (51 percent as a second mention) was that the rest of their facilities used standard equipment, and that they were reluctant to deal with multiple forms of equipment in their facilities. The third most frequently mentioned reason for not using efficient components (19 percent as a second mention) was that they were too expensive compared to other models.

The relatively low representation of the "first cost" barrier in these responses may reflect the timing of the survey versus the timing of program participation. Both program sponsors have been operating commercial lighting programs since the mid-1980s. Through 1993 - 1994, the incremental cost of electronic ballasts and T-8 lamps were substantial. Since then, as discussed in Section 6, these incremental costs have decreased significantly. It is possible that customers were referring in their minds to current market conditions when answering the questions whose responses are summarized in Table 6-10.

Table 6-10
Reasons Why Program Participants Did Not Use
Efficient Fluorescent Lighting Components Prior to Participation (Unprompted)

	First Mention	Second Mention
Not aware of at time	73.6%	
Too expensive compared to other models	0.2%	18.7%
Electronic ballasts not reliable	0.7%	1.4%
Not readily available from distributors		2.9%
Energy savings not adequate	0.4%	0.2%
Company policy to use magnetic ballasts	2.4%	0.5%
Rest of facility(ies) uses standard equipment		51.1%
We lease space		0.1%

It is also interesting to note the “market barriers” that received little or no mention. These include doubts about the reliability of electronic ballasts, lack of availability, skepticism about the level of energy savings available from the efficient components, and split incentives due to lease arrangements. About 9 percent of all establishments in leased space (27 percent weighted for floorspace) reported participating in the sponsors’ programs.

6.2.3 Program Effects on Organizational Infrastructure

Some analysts believe that the availability of staff and procedures to conduct cost-benefit analyses of lighting purchases will mitigate resistance to higher first cost and facilitate adoption of efficient equipment. Indicators of the presence of organizational infrastructure to handle these tasks include:

- The presence of an energy manager on staff.
- The application of investment-type criteria, such as payback periods or life-cycle costing to lighting equipment selection.
- The adoption of policies to purchase efficient equipment.

Moreover, one could hypothesize that the sponsors’ programs encouraged customers to put one or more of these elements of organizational infrastructure in place in order to take advantage of the availability of rebates and technical assistance.

To test these hypotheses, we analyzed survey data to address the following questions.

- To what extent was the appointment of an energy manager, the application of investment criteria, or the adoption of purchase policies associated with the selection of efficient equipment?

- To what extent was the appointment of an energy manager, the application of investment criteria, or the adoption of purchase policies associated with the sponsors' programs?

In all three cases we found that the indicators were closely associated with adoption of efficient equipment. We also found that, for program area customers, adoption of the behaviors was very closely associated with program participation. However, we also found that, while there were differences between the program area and nonprogram areas in terms of adoption of the behaviors described above, the differences were fairly small and not statistically significant.

Tables 6-11 and 6-12 illustrate these findings. We did not include customers in the leased office sector in the calculations summarized in Table 6-11 because very few of these customers reported that they made lighting equipment selections for their facilities.

Table 6-11
Penetration of Electronic Ballasts and Energy-Related Behaviors: Program Area Customers

	Penetration of Electronic Ballasts	
Behavior	**Adopted Behavior**	**Did Not Adopt Behavior**
Appointed energy manager	48%	24%
Apply investment criteria to lighting purchases	78%	22%
Adopted policy to purchase electronic ballasts	80%	20%

Table 6-12
Relationship between Availability of Programs and Adoption of Energy-Related Behaviors

	Program Area			Nonprogram
Behavior	**Participant**	**Nonparticipant**	**All**	**Area**
Appointed energy manager	76%	13%	67%	43%
(90% Confidence Interval)			*(22%)*	*(18%)*
Apply investment criteria to lighting purchases	41%	3%	34%	27%
(90% Confidence Interval)			*(23%)*	*(16%)*
Adopted policy to purchase electronic ballasts	43%	2%	34%	16%
(90% Confidence Interval)			*(23%)*	*(15%)*

7 SUPPLY-SIDE MARKET EFFECTS AND SURVEY RESULTS

7.1 INTRODUCTION

In this section, we present the direct results from our primary interviews on market barriers, effects, and utility program attribution. A series of individual market effects analyses are also presented which synthesize individual supply-side actor results. The section is organized as follows:

- Overall Analysis of Supply-Side Market Effects, Program Attribution, and Durability.
- Survey Results: Ballast Manufacturers.
- Survey Results: Lamp Manufacturers.
- Survey Results: Luminaire Manufacturers.
- Survey Results: Distributors.
- Survey Results: Designers.
- Survey Results: Installers.

The critical part of this section is the overall analysis of market effects, which is presented first (see Section 7.2). The purpose of the subsections that follow the analysis of market effects (Sections 7.3 to 7.8) is primarily informational rather than analytical. In these subsections, we present, in full detail, all of the relevant results obtained from our supply-side interviews. These sections provide the raw information from which our analysis of market effects is drawn. Additional information on the samples underlying the results presented in this section are provided in the *Supply-Side Characterization* and *Sampling Methods* sections of this report, as well as the *Introduction*.

7.2 OVERALL ANALYSIS OF SUPPLY-SIDE MARKET EFFECTS, PROGRAM ATTRIBUTION, AND DURABILITY

In this section, we provide our analysis and findings regarding hypothesized supply-side market effects, the extent to which these effects are attributable to sponsors' programs (or utility programs, in general), and the likely durability of any effects for which there is convincing evidence. Our goal is to utilize all of the primary and secondary information collected as part of this and other studies in as objective and consistent a manner as possible. Our basic approach is to systematically organize the collected information into evidence, whether supporting, refuting, or ambiguous, and then to synthesize the various pieces of evidence to come to an informed assessment of the key questions at hand. This information provides the supply-side basis for our overall market effects analyses presented in Section 5.

7.2.1 Market Effects Analyzed and Framework

The supply-side and government-code market effects hypotheses that we investigate in this section include the following:

- Changes in incremental prices over time.
- Changes in product quality and features.
- Differences in shipment patterns of efficient equipment.
- Changes in manufacturers' production patterns.
- Changes in promotion and market strategies.
- Changes in specification practices.
- Increased use of efficiency as competitive strategy.
- Changes in stocking practices.
- Changes in government building codes.
- Increases in new market entrants, e.g., businesses such as lighting management contractors, ESCOs that concentrate on efficient lighting.

For each supply-side hypothesis, or group of hypotheses, we have organized the information developed from our primary research into a tabular format. In each of these tables we present the following:

- *Hypothesized Market Effect*: The stated hypothesis.
- *Evidence*: Individual pieces of evidence from our primary research both for or against the hypothesis.
- *Utility Program Attribution*: Results pertinent to assessing *the extent to which* the effect is attributable to sponsors' program interventions (or those of utility programs, in general).
- *Durability*: Information, factors, or analysis relevant to forecasting the likely durability of the effect (if any).

The purpose of this tabular format is to summarize the many individual results obtained from our supply-side survey results, while *separately* making assessments as to our conclusions from the preponderance of the evidence. This is important because of the sheer volume of quantitative and qualitative results obtained from our supply-side research, which included six market actor substudies and approximately 250 interviews. This presentation format should help readers to quickly access and review the results, assess our conclusions, and use the information, if they so desire, to draw their own conclusions.

Untangling the effect of sponsors' interventions from market events that may have otherwise occurred is a formidable research challenge. Nonetheless, we believe that our results are exceedingly useful empirical aids in answering attribution questions as best as possible on a case-by-case basis for each hypothesized market effect. An important distinction that we wish to emphasize is our focus on a *continuum* of possible attribution versus an analysis that seeks a discrete (i.e., binary-based) answer to this question. We believe that a more useful analysis of attribution is one that acknowledges and describes degrees of this prospective phenomenon as well as the interactive nature of market effects discussed at the outset of this section.

7.2.2 Changes in Incremental Costs

If the incremental costs of an efficient measure decrease from levels that initially resulted in financial performance that was well over end-users' thresholds, to levels that are subsequently below such thresholds for large fractions of the market, such changes may be sustainable because of the positive feedback relationships involved. That is, when incremental costs drop below economic thresholds for the majority of customers, the resulting increase in demand is likely to result in capacity and production increases that result in economies of scale that reduce production costs further. This kind of positive feedback loop can result in a "take-off" effect for the new product as discussed previously.

Reductions in incremental costs for electronic ballasts and, to a lesser extent, T-8 lamps were cited throughout our supply-side interviews as playing the most critical role in increasing the penetration of these products. ***There is overwhelming evidence, in our opinion, to support the hypothesis that the incremental costs for electronic ballasts and T-8 lamps were reduced significantly over the 1992-1996 study period.*** Additional information on estimates of the price changes themselves is presented from the California Measure Cost Studies (studies were conducted in 1992, 1994, and 1996).

Evidence of Change

As summarized in Table 7-2, we collected a variety of evidence related to this hypothesis from a number of different sources. In addition, we provide in our analysis in this section a summary of relevant cost estimates from the California Measure Cost Studies (MCS) conducted in 1992, 1994, and 1996. We present this information first as a backdrop for our findings from the primary surveys conducted for this market effects study.

Results from the 1996 CADMAC Measure Cost Study[1]

We present in Table 7-1, a summary of end-user ballast and lamp prices in both 1992 and 1996. The estimated prices of electronic ballasts ranged from $35 to $60 per ballast in 1992 depending

[1] The information in this subsection was developed from several measure cost studies conducted by XENERGY between 1992 and 1996. The point estimates presented are properly viewed as mean estimates developed across samples of costs. Though useful analytically, it is important to recognize that measuring mean market prices is extremely difficult in practice, and that the variation of actual prices in the marketplace is very large.

on the number of lamps controlled, whereas typical magnetic ballast costs were roughly $25 in 1992. These prices had changed dramatically by 1996. In 1996, estimated prices for electronic ballasts had dropped to $20 to $25 (depending on the number of lamps controlled). Interestingly, estimated prices for magnetic ballasts also dropped over the same period. This is likely in response to competition from the electronic ballasts. Even so, the percentage and absolute change in incremental prices for electronic ballasts still decreased significantly.

As shown in Table 7-1, T-8 lamp prices also decreased significantly over the study period, from approximately $3.90 per lamp in 1992 to $2.40 in 1996.

Table 7-1
Estimated Changes in Retail Prices for Electronic Ballasts and T-8 Lamps, 1992-1996

Technology	1992 Retail Price	1996 Retail Price	% Change in Prices	1992 Incremental Prices	1996 Incremental Prices	% Change in Incremental Price
4 Lamp EB	$60	$25	-58%	$10	-$5	-150%
3 Lamp EB	$55	$25	-55%	$5	-$5	-200%
2 Lamp EB	$35	$20	-43%	$10	$5	-50%
2 Lamp MB	$25	$15	-40%			
32 Watt T-8	$3.90	$2.40	-38%	$1.40	$0.65	-54%
34 Watt T12	$2.50	$1.75	-27%			

Sources: California Measure Cost Studies (XENERGY, 1992, 1994, & 1996)

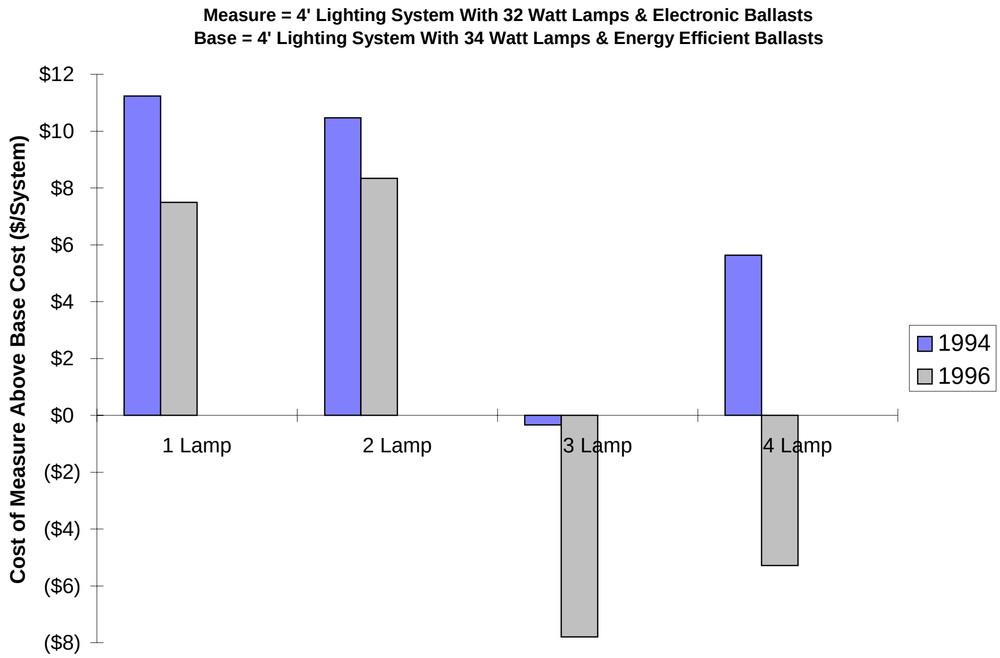
Figure 7-1 shows incremental costs for T-8 lamps with electronic ballasts over the base case, which consists of standard energy-efficient ballasts and 34-watt, T-12 lamps. The 3-lamp and 4-lamp high-efficiency systems have negative incremental costs because a single electronic ballast is able to drive three or four lamps, whereas two standard ballasts are needed for the same function. In Figure 7-2 below, we show the change in estimated costs for the 4-lamp system, including data from the 1992 MCS. This cost trend shows a dramatic change in estimated incremental costs between 1992 and 1996.

The principal driver of the reduction in the high-efficiency fluorescent system costs shown above is the reduction in the incremental costs of the electronic ballast. The change in incremental costs for the electronic ballast is shown in Figure 7-3. Note that the costs for the 3-lamp and 4-lamp electronic ballast is compared against two standard efficiency ballasts, as standard ballasts are only able to drive two lamps.

Table 7-2
Market Effects Summary: Reduced Incremental Costs and Prices

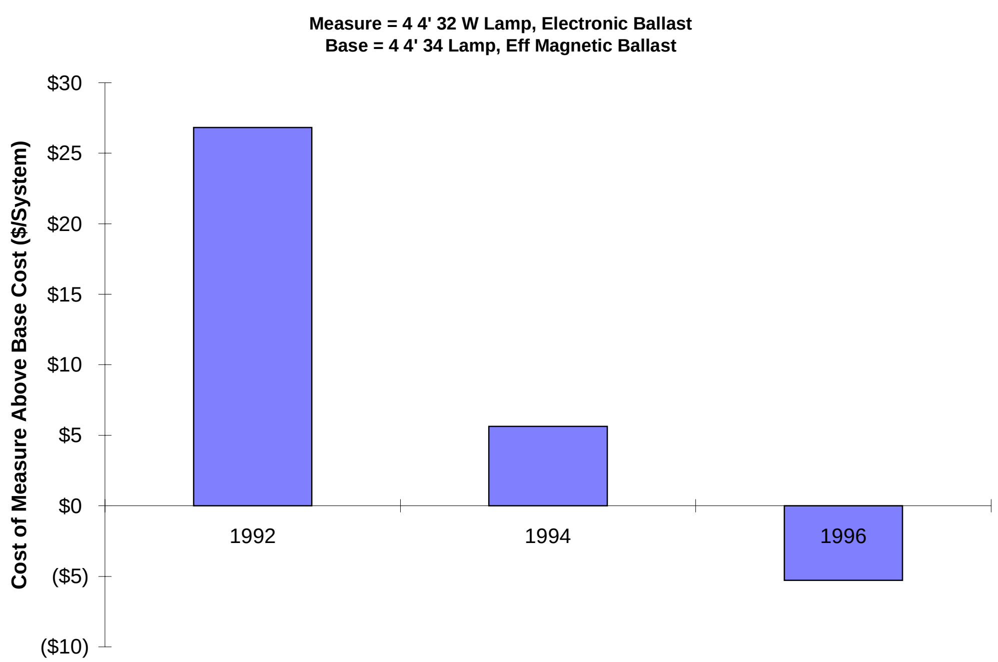
Market Actor	Hypothesized Market Effect: *Reduced Incremental Costs and Prices for Ballasts and Luminaires*		
	Evidence of Change	**Utility Program Attribution**	**Durability of Effect**
Manufacturers	Six of nine luminaire mfrs. stated that the cost to consumers was reduced. Some EB mfrs. said EB product costs were 2 to 3 times that of magnetic in early 1990s. Current cost ratio estimate was 1.5:1.	Half of the luminaire mfrs. indicated that programs contributed to reduced prices via demand stimulation and production increases. 3 of 6 EB mfrs. said programs increased size of production runs. Only 2 EB mfrs. stated that programs contributed directly to reduced EB costs, however, majority believe programs increased demand. Huge production increases resulted in low costs. Increased number of competitors may have led to more cost competition and pressure to improve production processes.	Production level should be long-lasting.
Distributors	High cost was stated as the most important barrier in 1991. Respondents stated that prices have come down significantly. Respondents also were able to quantify reduction in incremental costs between 1994 and current.	Majority believed rebates led to increased demand and reduced cost to end user. Average reported reduction in incremental EB price was approximately 50 percent.	Downstream depends on supply and demand forces.
Designers	Cost difference was most cited barrier in 1991. Majority indicated barrier has been eliminated.	Approximately 80 percent indicated that the utility programs helped in lowering the cited barriers.	N/A
Installers	The most frequent barrier reported for 1992 was price. Almost all asserted that barriers identified have either been eliminated or substantially reduced.	A few cited effect on price reduction and increased awareness and credibility effect.	Downstream depends on supply and demand forces.

Figure 7-1
Incremental Costs for Fluorescent 4-Foot Fixtures, 1994- 1996



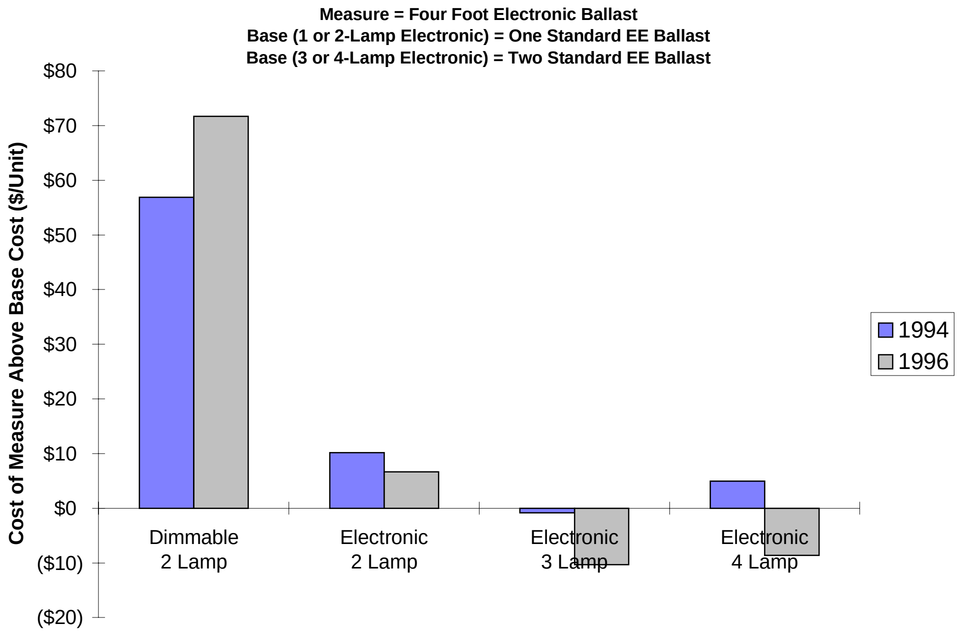
Source: XENERGY, 1996. CADMAC Measure Cost Study.

Figure 7-2
Incremental Costs for Fluorescent 4-Foot, 4-Lamp Fixture, 1992-1996



Source: XENERGY, 1996. CADMAC Measure Cost Study.

Figure 7-3
Incremental Costs for Electronic Ballast, 1994-1996



Source: XENERGY, 1996. CADMAC Measure Cost Study.

Primary Research Results from this Study

All of the principal supply-side actors were extensively interviewed with respect to issues related to changes in incremental costs. To begin with, all of the downstream supply-side actors (distributors, designers, and installers) consistently cited high incremental costs as the primary barrier to adoption of efficient lighting technologies in 1991 (note that these were retrospective citations). Supporting this perception is the fact that although the average year the manufacturers in this study began production of electronic ballasts was 1987, penetration levels in 1991 were less than 5 percent (of course, reliability concerns, which are addressed later in this section, also played a role in these early low penetrations). Lamp manufacturers also indicated that they began selling T-8s to the U.S. market in the mid- to late 1980s and that penetration levels were similarly small.

In addition to being consistent in their citations of high incremental costs as a major barrier in 1991, downstream supply-side interviewees were also completely consistent in their statements that the incremental cost barrier has been significantly reduced today, if not eliminated in some segments. Ballast manufacturers were also fairly consistent in claiming that costs have been reduced to consumers. A few manufacturers also provided an indication of the extent to which incremental production costs have changed over the study period. These respondents estimated that electronic ballast production costs were two to three times higher than magnetic ballast costs in 1991, but that this had been reduced to a factor of around 1.5 today.

Some corroborating evidence for the production cost factors reported above can be gleaned from the measure cost study results presented in Table 7-1. Although the retail price estimates for electronic ballasts shown in the table are only 1.4 times higher than those for magnetic in 1992, this comparison probably understates the production costs. Note that the costs for magnetic ballasts also decreased significantly between 1992 and 1996, from $25 to $15, respectively. Since magnetic ballasts were a mature technology in 1992, it is possible that a portion of the reduction in magnetic resulted from reductions in margins (this would be consistent with responses from some manufacturers indicating that magnetic ballasts are still a higher margin product than electronics). If $15 is closer to the competitive retail price of magnetic ballasts and we compare this figure to the 1992 electronic ballast price, we obtain a retail ratio of 2.3. If we assume for the moment that downstream actors' markups are the same for both types of ballasts[2], then this provides a reasonable proxy for the difference in production costs in 1992, which is consistent with what manufacturers reported to us in the current study. In addition, the retail price increment factor for the 1996 prices (again in Table 7-1), is 1.33, which again is consistent with the figures reported to us by ballast manufacturers in the current study.

Turning now to the issue of T-8 cost and price increments, one lamp manufacturer stated that their incremental cost difference when production first began was two times greater for T-8 bulbs than energy savers, while another said that this increment was merely 1.25 times greater. Both of the lamp manufacturers responded that the current incremental difference in production costs is 1.1 to 1.15 times greater for the T-8 lamp. Retail price factors for T-8 relative to energy saver lamps can be calculated from the estimates provided in Table 7-1. These factors are roughly 1.5 for 1992 and 1.4 for 1996.

Other corroborating evidence for the extent of the changes in incremental prices was obtained from the distributor surveys conducted for this study. These results are presented in Tables 7-3 below. The distributor results show levels of changes in incremental prices over the 1994 to 1997 period similar to those presented from the measure cost studies in Table 7-1.

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[2] This assumption is supported by distributor interviews conducted as part of the 1994 and 1996 Measure Cost Studies.

Table 7-3
Distributors' Average Incremental Price Estimates, 1994 and 1997

Territory	Average Price Increment (in dollars) for:			
	Elec. Ballast 1997	Elec. Ballast 1994	T-8 Lamp 1997	T-8 Lamp 1994
Program	9.5	18.4	1.1	1.7
Nonprogram	11.2	17.5	1.0	1.9
	Percent Change in Incremental Price Estimates, 1994-97			
Program	-48%	--	-35%	--
Nonprogram	-36%	--	-47%	--

Based on the preponderance of the evidence, we are confident that the hypothesized reduction in incremental costs for electronic ballasts, T-8 lamps, and efficient luminaires (because they use these components) has occurred.

Utility Program Attribution

Whether or not the sponsors' and other utilities' lighting programs caused the observed reduction in incremental prices was investigated through several lines of inquiry. As presented in the Supply-Side Results section, we asked manufacturers a series of questions regarding the effect of utility programs on a variety of their production-related processes and decisions, including timing of production runs, size of runs, cost reductions, regional shipment and promotion patterns, and technical specifications.

The results of these inquiries were mixed in that, for most of the items, two to four of the six ballast manufacturers interviewed indicated that utility programs had a significant effect on incremental costs, while the remaining respondents indicated that they did not. In particular, only two of six said that the programs were directly responsible for reductions in incremental costs. Also, none of the lamp manufacturers stated that utility rebate programs had an effect on T-8 prices relative to energy saver lamps. We are, however, unconvinced of this particular self-report of limited program attribution. Other evidence leads us to believe that the programs, in fact, did play an important role in reducing (or accelerating the reduction) of incremental electronic ballast and T-8 lamp costs. For example, one of the two ballast manufacturers who said that the programs did lead to reduced incremental production costs explained that in the early 1990s electronic ballast production processes were full of inefficiencies that were only worked out once production volumes were ramped up significantly.

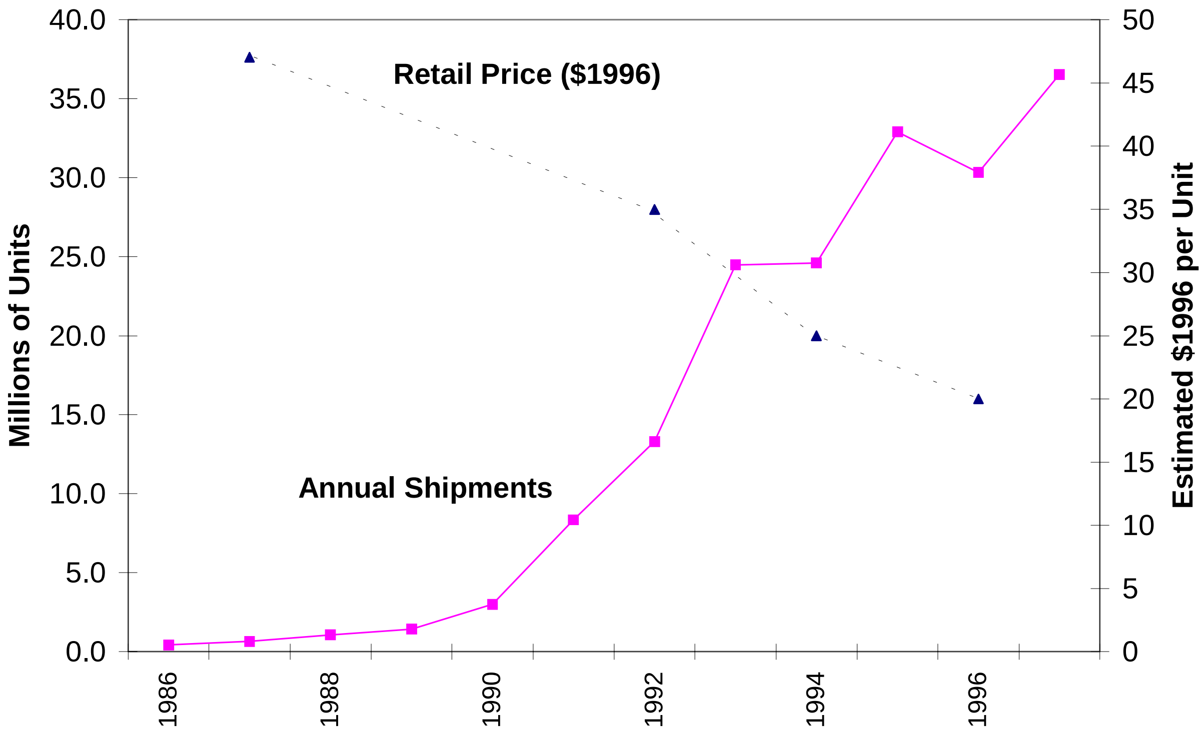
When asked what effect the programs had on reducing market barriers (which were identified as high incremental cost and reliability), all of the ballast manufacturers who responded stated that the programs helped to overcome these barriers. In an open-ended follow-up, they stated that increased customer demand was the mechanism by which these reductions occurred. In addition, three of the six ballast manufacturers (representing approximately 50 percent market share) stated that the rebate programs affected the timing and size of their production runs. All six said that the programs had a strong effect on regional shipment patterns. Also, one of the lamp manufacturers who stated that utility rebates had no effect on T-8 lamp prices also said that utility rebate programs had a positive effect on what was mentioned as a barrier to acceptance by distributors and manufacturers' reps, "selling technology with a higher price as compared to energy savers and commodity lights."

In addition to the individual production events, we asked whether, on an *overall* basis, the California rebate programs specifically affected production-related decisions. In this case, four of the six ballast manufacturers (representing well over 50 percent of the market share) and two of the three lamp manufacturers (representing two-thirds of the lamp market) indicated that they would not have made the same production-related decisions in the absence of the California rebate programs and that the reason, once again, was increased end-user demand.

What then to make of this evidence? On one hand, only two of the six ballast manufacturers and one lamp manufacturer directly credit the programs with reductions in incremental production costs. On the other hand, the majority of vendors clearly believe the programs significantly increased product demand. Given that these program-induced increases in product demand seem to be the driving force behind improved production processes that resulted in reduced costs, then these reductions themselves are causally related to the programs. This kind of volume-cost relationship is a virtual truism in most manufacturing processes and is clearly at work for these products, as shown for electronic ballasts in Figure 7-4. In fact, by correlating price changes and shipment volumes, we can see that the steepest part of the price reduction curve coincides with the exponential increase in shipments between 1992 and 1996, which themselves parallel steep increases in sponsors' and other U.S. utilities' electronic ballast rebate programs (see Section 5 for further discussion of California and national rebate expenditures).

We believe that sponsors' programs played a significant role in reducing production costs for electronic ballasts and T-8 lamps over the study period. It is difficult, however, to make exact quantification of the extent of their contribution on a percentage or temporal basis. For example, other factors, such as reduction in the costs of electronic components (in the case of ballasts), may also have been at work.

Figure 7-4
Electronic Ballast Shipment and Retail Price Data Over Time



Sources: XENERGY, 1988, 1994, 1996; U.S. Census Bureau. Ballasts, Current Industrial Report MQ36B.

Durability

We are reasonably confident that the reductions in incremental <u>production</u> costs are likely to be long lasting. There is no reason to believe that improvements in electronic ballast or T-8 lamp production efficiencies will regress. It is possible, however, that the costs of magnetic ballast will continue to drop as well in response to the serious competition posed by electronic ballasts. Ballast manufacturers are by no means necessarily neutral with respect to the two technologies, as some manufacturers obtain more revenue from one or the other of these products and at least one manufacturer reported that magnetic ballasts were a higher margin product. On the other hand, magnetic ballasts are a mature technology and the increased competition from electronic ballasts since 1992 seems to have already reduced margins for magnetics, as evidenced by decreases in magnetic prices. Similarly, the price of energy-saver lamps appears to have been reduced over the study period as well. This also may be due to competition from T-8 lamps. For both electronic ballasts and T-8 lamps, however, the net effect has been a reduction in absolute incremental prices over the study period.

On the wholesale and retail sides, whether or not the current incremental price differences persist will be a function of the balance between supply and demand forces. These prices are governed as much by willingness to pay as they are by production costs. Thus, if demand were to rise sharply and significantly outstrip supply, electronic ballast prices might actually rise. Our belief, however, is that there is a great deal of electronic ballast capacity now available and that demand and supply are likely to remain relatively balanced, barring any major changes in the industry (e.g., a national electronic ballast standard, or large players suddenly going out of business).

7.2.3 Changes in Product Quality

In this section we discuss market effects that are related to product quality. The importance of product quality to this study relates squarely to the fact that the poor reliability of electronic ballasts in the early 1990s was cited as a critical barrier to their acceptance in the marketplace by roughly a third of the downstream supply-side vendors and four of the six ballast manufacturers interviewed. In addition, electronic ballast reliability was cited by some T-8 lamp manufacturers as a significant barrier to T-8 penetration because of their association in the marketplace. There is little doubt that reliability was a significant problem with the otherwise promising electronic ballast technology. It is important to remember, however, that the electronic ballast reliability problem did not begin in the early 1990s but, rather, in the mid-1980s when these products were first fully commercialized. Of note here is the fact that there was little if any evidence of reliability problems in any primary or secondary research concerning T-8 lamps.[3]

Given that reliability remained a problem in the early 1990s, a key question for this study is whether or not any improvements in reliability occurred and, if so, whether these improvements are attributable to utility and sponsors' programs, and whether the improvements are likely to persist. Each of these issues is explored, in turn, below.

Evidence of Change

We assert that the evidence for improvements in electronic ballast reliability is extremely strong. As presented in Table 7-4, reliability improvement was consistently reported across all of the supply-side segments interviewed. One manufacturer estimated that product failure rates were as high as 10 to 20 percent at the peak of the reliability problem, but that failure rates today had been reduced to 0.5 percent. Utility program staff were also consistent in stating that failure rates had been significantly reduced over the 1992-1996 period. Further evidence for the existence of this effect should be available from California utilities' fourth-year retention surveys being conducted under the California M&E Protocols.[4]

[3] Two of the manufacturers interviewed for this study introduced their electronic ballasts in the early 1980s, two in the late 1980s, and two in the early 1990s. See also BPA, 1997. *Service Life of Energy Conservation Measures*, prepared for the Bonneville Power Administration by XENERGY Inc., in which electronic ballast reliability problems were documented through a Delphi survey of industry experts.

[4] Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management Programs, as adopted by the California Public Utilities Commission Decision 93-05-063.

Utility Program Attribution

The question as to whether the decrease in electronic ballast failure rates can be attributed to utility or sponsors' programs is difficult to answer convincingly. There are two opposing arguments with respect to this issue. First, the case against utility program attribution centers on the hypothesis that programs caused a sharp increase in demand for electronic ballasts in 1991, 1992, and 1993, which caused manufacturers to quickly ramp up production processes at a time when manufacturers had not adequately solved pervasive reliability problems. Additionally, the rapid increase in demand allowed less reliable new manufacturers to enter the market. There are several arguments that can be made, however, that run counter to this hypothesis. First, because reliability problems had plagued electronic ballasts from the time of their introduction in the mid-1980s, it is difficult to establish whether the failure *rate* actually increased during the early 1990s or whether the failure rate was the same and simply the increase in the absolute *volume* of failures created a stronger perception of the reliability problem throughout the industry.[5]

Second, it is also possible that sponsors' programs contributed to a reduction in the failure rate that occurred in the mid-1990s and continues today. This could have occurred through two mechanisms. Although unable for legal reasons to prohibit lower reliability brands from the rebate programs, sponsors tightened other product specification requirements such as those for total harmonic distortion (THD) and ballast factor. Program staff indicated in interviews that these specifications were used as proxies for product quality in the expectation that higher quality products with better performance specifications would also have lower failure rates. The other mechanism by which sponsors' programs and utility programs in general may have reduced failure rates is the opposite of the first argument presented: Competitive pressure and increased program demand may have forced successful companies to improve reliability to maintain and expand market share.

[5] Because the scope of this study covered the period 1992 to 1996, we did not quantify the extent of the reliability problem in the years prior to 1992. This information could be developed through additional retrospective research.

Table 7-4
Market Effects Summary: Improved Electronic Ballast Reliability

Market Actor	Hypothesized Market Effect: *Improved Electronic Ballast Reliability*		
	Evidence of Change	**Utility Program Attribution**	**Durability of Effect**
Manufacturers	Four of six said reliability was a critical barrier in 1991. All respondents believe reliability problems have been eliminated. One mfr. stated failure rate reduced from 10-20% to 0.5%.	Pro - Competitive pressure and increased program demand forced successful companies to improve reliability to maintain and expand market share. sponsors' programs set THD and BF levels that required higher quality products. Con - Increased demand from programs may have contributed to problems as capacity ramped up too quickly and new entrants with lower reliability came into the market.	Should be long lasting for current technology ..
Distributors	Most distributors that cited reliability as barrier in 1991, indicated barrier had been reduced.	General statements that programs helped reduce previous barriers	N/A
Designers	For barriers in '91, cost difference and reliability issues were most cited. Nearly all designers felt that the barriers were greatly reduced or eliminated. Percent citing reliability as barrier declined from 31% in 1991 to 2% currently (program area). Non-program area decline was from 10% to 0%.	Approximately 80 percent indicated that the utility programs helped in lowering the cited barriers.	N/A
Installers	Of 19 responses, reliability was the second most frequently cited barrier in '91 (31%). Almost all asserted that the barrier had either been eliminated or substantially reduced. Respondents consistently stated that reliability is much better today.	N/A	N/A

Given the absence of convincing primary research results on both sides of the attribution question, our confidence with respect to a clear causal relationship between sponsors' programs and improved electronic ballast reliability is low.

Durability

Reductions in electronic ballast failure rates are attributable to improved production processes, more reliable components, and improved testing and quality control procedures. ***These improvements were made across manufacturers and are unlikely, in our opinion, to regress***. One potential source of temporary regression is in the area of electronic components, which are often imported. Confined instances of reliability problems from such component shipments may still occur.

7.2.4 Changes in Specification, Promotion and Market Strategies

Several of the most important hypothesized market effects with respect to the sponsors' 1992 to 1996 lighting programs have to do with changes in downstream vendors' specification, promotion, sales, and competitive positioning strategies. The hypothesis is that these supply-side vendors have significantly increased their levels of promotion and specification of T-8 lamps and electronic ballasts, and that these business practices will continue in the absence of program support for these products.

We asked distributors, designers, and installers a series of questions focused on ascertaining changes in the role lighting efficiency plays in their businesses. Details on the individual question responses are provided in Section 3 and later in this section. Our objective here, is to concisely summarize these results and to look across them for trends with respect to the larger market effects hypotheses. To aid in this process, we provide the information presented in Table 7-5, which summarizes our findings with respect to changes in competitive positioning, specification, and promotion practices.

Evidence of Change

We found a great deal of consistency in the responses obtained from distributors, designers, and installers with respect to their own assessments of whether they would continue specifying and promoting T-8 lamps and electronic ballasts in the absence of the sponsors' programs. For example, in all three cases, over 70 percent stated that they would maintain their specification practices in the absence of the programs *and* that they would continue promoting and selling efficient lighting equipment. Similarly, over 75 percent of all three market actors stated that energy-efficient lighting was "very" or "somewhat" important to their competitive position (roughly 50 percent cited "very important").

Our confidence in both the individual market actor results and the results across these three actors is relatively high. There are several supporting results for this effect. First, we conducted fairly large numbers of surveys (note that these results are based on over 70 interviews), which we believe adds credence to the results obtained. Second, the results themselves consistently show that large percentages of these market actors maintain that their efficiency-based practices will continue in the absence of utility program incentives. And, third, there is no strong reason to believe that interviewees' are gaming their responses in either direction.

We note that there are always two sides to the issue of whether self-reported results can be fully trusted. For example, for this study, an argument could be postulated that supply-side vendors are proud of their influence in the market, want to take credit for anticipating market changes, and are reluctant to credit third-party entities like utilities and government agencies with shifts in their business models. On the other hand, in this particular case, one could also argue that, if anything, supply-side vendors might be expected to respond in ways that they thought might bring about an increase or reinstatement of lighting rebates (i.e., they would respond in ways opposite to those presented in Table 7-5, essentially saying "Provide the market with rebates or it will regress!"). We believe that there is no convincing evidence in the data for either of these gaming postulates, and that, to the contrary, the consistency across and within interviewees' responses provides sound evidence for the hypothesized changes in specification, promotion, and competitive positioning practices.

Finally, we note that, in addition to our primary research results, another recent study conducted by Heschong-Mahone for the California Energy Commission, found similarly high levels of acceptance for energy-efficiency fluorescent lighting among lighting designers.[6]

[6] Lighting Efficiency Technology Report, Volume IV: Recommendations Report, prepared by Heschong Mahone Group for the California Energy Commission, Contract # 400-95-012, May 1997. Note that the unit of analysis used in the designer interviews conducted for this study was generally expressed in terms of energy and LPD levels relative to current Title 24 Standards. As was found in our study (see Section 3), most designers agreed that exceeding the current standard by 10 percent is "feasible and easy" and many reported routinely beating standards by 20 percent or more. It is generally agreed (among industry experts and designers) that beating the current standards by 10 to 20 percent would routinely involve utilization of electronic ballasts and, probably, T-8 lamps.

Table 7-5
Market Effects Summary: Changes in Competitive Positioning, Specification, and Promotion Practices

Market Actor	Hypothesized Market Effect: *Changes in Competitive Positioning, Specification, and Promotion Practices**		
	Evidence of Change	**Utility Program Attribution**	**Durability of Effect**
Distributor	Roughly two-thirds believe market share for T-8/EB will increase or stay the same in the absence of rebates. 14 of 16 in-depth respondents reported EE was "very" (11) or "somewhat" important to competitive position. The overwhelming reason cited was because of customer demand for EE products. Almost 90 percent reported they would not change specification practices in the absence of rebate programs. Roughly three-fourths stated they would not change promotion and sales policies of EE equipment in absence of rebate programs.	General statements that programs helped reduce previous barriers. Since many distributors will continue to stock, specify, and promote *in response to customer demand*, attribution becomes a function of the extent to which end-user demand levels are attributed to the programs.	Tend to stock based on market demand, somewhat less proactive than other actors who are more directly engaged with end users.
Designer	A very high percentage of program distributors reported that EE was "somewhat" or "very" important to their business (89%). The reported percentage of cases in which EE is specified increases dramatically from 1992 to 1997, to over 80 percent in both program and nonprogram areas. Most (70 percent) stated that they would not change specification practices in absence of utility rebate programs. Eighty-eight percent indicated that they would not change the level of effort used to promote and sell EE equipment if rebate programs terminated.	Reported importance does not vary greatly between program and nonprogram areas, but nonprogram levels may be recent spillover. Reported increase in specification levels was twice as high in program area in '92, but reported levels are now the same in both areas. Approximately 80 percent indicated that the utility programs helped in lowering barriers over study period.	Many reported that they pro-actively believe EE increases the value of their services. Others stated that they do it because the market now "expects" EE as part of service. Vast majority of designers interviewed are very confident T-8/EB is here to stay and will continue to promote.

Table 7-5, cont.
Market Effects Summary: Changes in Competitive Positioning, Specification, and Promotion Practices (continued)

Market Actor	Hypothesized Market Effect: *Changes in Competitive Positioning, Specification, and Promotion Practices**		
	Evidence of Change	Utility Program Attribution	Durability of Effect
Installer	Three-fourths stated EE was "very" (53 percent) or "somewhat" important to competitive position. Seventy-one percent stated they would continue to specify EE equipment regardless of utility rebate program activity. Eighty-three percent indicated they would not change the level of effort used to promote and sell EE equipment if rebate programs terminated.	Several cited effect on price reduction and increased awareness and credibility effects. Since many installers will continue to specify and promote *in response to customer demand*, attribution becomes a function of the extent to which end user demand levels are attributed to the programs (see Demand-Side Findings).	Reason for importance of EE to position and continued specification and promotion is split between "proactive believers" and "market responders." But both believe importance will continue. A smaller segment of "unconverted" remains.

*Probes of the issue were included in the distributor, designer, and installer in-depth surveys. Also, note that the confidence levels reported are based on the available primary, supply-side evidence presented in the table, e.g., evidence on customer demand attribution is not factored into these results (these results are synthesized in Section 5).

Utility Program Attribution

The supply-side evidence alone, presented in Table 7-5, provides only a moderate level of confidence that the observed changes in downstream vendors' business practices are attributable to sponsors' programs. Supporting evidence includes the fact that the majority of distributors, designers, and installers give the programs substantial credit for reducing the initial cost of the products to customers. More importantly, for the multiplier benefits that resulted from these reductions in first cost, namely, increased customer awareness of the technologies and increased *credibility* for the vendors and their recommendations in the eyes of the customer.

Results on the importance of EE lighting to businesses in the nonprogram area, however, are relatively close to those obtained from the program area. For example, 77 percent of the nonprogram area designers said that EE lighting is "very" or "somewhat" important to their competitive position, versus 88 percent in the program area. Similarly, distributors in the program area were no more likely to cite the importance of energy efficiency to their competitive position than those in the nonprogram areas. It is possible, of course, that the high levels of importance ascribed to energy efficiency in the nonprogram areas may be partially a spillover effect from major utility programs in California, New England, and other areas. The large, sudden, and ***lagging*** (by about two years) percentage increases in the stocking, penetration, and specification of efficient lighting equipment over the 1992 to current time period (see Supply-Side Results later in this section) is a likely indication of supply-side spillover as well. Such spillover is hypothesized, based on the evidence that the reductions in incremental costs of electronic ballasts are attributable to the major utilities' program efforts. The New England C&I Lighting Market Transformation and Baseline Study completed in 1997 also concluded that spillover from major utility lighting programs to supply-side vendors (principally among designers) was likely to have occurred in Louisiana.[7]

Changes in supply-side actors' business practices are linked in their perceptions to changes in consumer demand, and customers' increased confidence in the technologies themselves. Thus, attribution of the changes in supply-side actors' business practices correlates to attribution of several of the other market effects examined; in particular, changes in incremental prices, improvements in product quality, and changes in end users' awareness, knowledge, and purchasing processes and patterns. ***Thus, based on the importance of utility and sponsors' programs in driving the initial demand increase for these technologies, and the causal relationship between these increases and the market activities of downstream vendors, a significant portion of the changes in business practices observed with respect to efficient lamps, ballasts, and fixtures should be attributed to sponsors' programs.***

[7] New England C&I Lighting Market Transformation and Baseline Study, Easton Consultants, 1997. The principal mechanism hypothesized for spillover to designers in Louisiana was professional information sharing between designers in program and non-program areas through conferences and professional organizations.

Durability

The likely durability of the changes in supply-side actors' business practices is related to two key factors: the extent to which they continue to proactively promote T-8 lamps and electronic ballasts, and the extent to which customers continue to demand these products. To probe these issues, we utilized a series of open-ended follow-ups to the business practices questions discussed above to let respondents describe their perceptions of the current and future market for energy-efficient lighting in their own terms. In particular, we believe it is useful to examine interviewees' open-ended responses to the following questions:

- *In terms of maintaining your firm's competitive position, how important is stocking energy-efficient equipment? Why?*
- *What is the main reason you believe the market share of T-8 electronic ballast systems will increase or stay the same in the absence of utility programs?*
- *If lighting rebate programs were to terminate today, do you think you would change your specification or equipment selection practices for 4-foot fluorescent lighting? If so, why?*
- *If lighting rebate programs were to terminate today, do you think you would change the level of effort you put into promoting and selling efficient fluorescent lighting? If so, why?*

We have already discussed above the fact that roughly three-fourths of interviewees responded to the close-ended portions of these questions with consistent statements that indicate their bullishness with respect to the importance and role of efficient lighting equipment in their business practices. We now provide, below, a summary of the *why* behind these responses (see the Supply-Side Results section for complete results). Note that responses to the competitive positioning and specification and promotion in the absence of rebate program questions were very similar:

- Of the two-thirds of distributors who believed the market share for T-8 lamps and electronic ballasts would increase or stay the same in the absence of rebates, key reasons cited included: "Customers are more educated," "There is little price difference," and "Manufacturers will continue to promote."
- Key reasons cited by supply-side vendors for the importance of EE lighting to their competitive position and why they will continue specifying and promoting these products in the absence of incentive programs include:

  Distributors - Almost all cited customer demand for the products.

  Designers - The most important reasons cited were that: "EE is an important element of the design process," "We believe in it," and "Our job is to provide expertise, EE is part of this."

  Installers - Responses were more mixed, and tended to split between "We believe in it," and "Customers now expect it."

Based on the pattern and consistency of these responses, we believe that the downstream vendors (distributors, designers, and installers) now fall into three basic groups with respect to ongoing efficiency-related business practices:

- ***Proactive True Believers*** - This group is convinced of the intrinsic value of T-8 lamps and electronic ballasts, both in terms of energy savings and overall product quality, including reliability, light quality, lumen maintenance, and service life. This group will proactively promote, based on their belief that selling these products is good for their business and their customers.
- ***Market Responders*** - This group recognizes the benefits of efficient lighting products and cites significant reductions in barriers to their use; however, their *modus operandi* is responding to what customers request, as opposed to driving customers' decisions. This group plans to continue promoting and specifying efficient products but only because they expect customers to continue demanding these products.
- ***The Unconverted*** - This is by far the smallest of the three segments and represents a group of vendors that continues to resist these technologies. The key reasons they cite are high incremental prices and concerns about product quality.

Though it is difficult to precisely estimate the percentage breakdown of firms in the three segments above, we estimate that 80 percent to 90 percent of vendors are about evenly split between the first two groups, *Proactive True Believers* and *Market Responders*, while the remaining 10 to 20 percent fall into the *Unconverted* category.

The large numbers of Proactives and Market Responders leads us to conclude that there is a strong likelihood that the changes in business practices observed are likely to continue in the future. If customer demand were to sag, however, the Market Responders would be more likely to shift away from the efficient technologies as well, whereas the Proactives are more likely to try to convince customers of the benefits of continuing to use efficient lighting. Thus, like most of the other effects addressed in this section, the durability of the changes in business practices is causally linked to the continuance of other market changes, particularly on the demand side.

7.2.5 Changes in Manufacturers' Production Patterns

We asked each of the manufacturer respondents to tell us whether utility programs affected a number production and shipment related decisions. Their responses are summarized in Table 7-6 and in the latter survey results subsections. As indicated in the table, the primary changes reported were in regional shipment and promotion patterns, increases in production capacity, and changes in technology specifications. In terms of attribution of these changes to utility programs, no consistent patterns emerged.

All ballast respondents indicated that rebates affected the regional pattern of shipments, while three of six indicated that rebates affected the size of their production runs. All of the remaining factors (Timing of Production Runs, Relative Price, Design/Technical Specification, and

Regional Pattern of Promotions) were stated as being affected by at least two of the six manufacturers interviewed. When we asked on an *overall* basis what they would have done in the absence of rebate programs in California, four of six stated that they would not have made similar decisions with respect to the production factors listed in the table. While each of the factors by themselves provide some evidence for the effect of utility programs on manufacturers' production decisions, the answer to the overall impact question indicates that the programs did affect the majority of manufacturers.

For T-8 lamps, two of the three manufacturers stated that both the regional pattern of shipments and promotions were impacted by utility programs over the study period. One manufacturer each said that rebate programs affected the timing of production runs, the size of production runs, the incremental costs, and the technical specifications. At the same time, one of the lamp manufacturers stated that none of the production and marketing decisions were directly impacted by utility programs. We also asked respondents to sum up across these factors whether or not they would have made similar production- and promotion-related decisions in the absence of utility programs. Two of the three respondents said that their firms would not have made the same decisions with respect to T-8 lamps in the 1990s. The fact that two of the three stated that several aspects of production and promotion were affected by rebate programs is significant, given that each respondent represents approximately one-third of the national market.

Our conclusions with respect to production and shipment related changes are as follows:

- Evidence that certain changes occurred is reasonable, primarily regional shipment patterns, increases in production runs, and changes in technical specification.
- However, manufacturer self-reports indicate only moderate attribution of utility program influence, which is inconsistent with their attribution of program-induced demand increases.
- Since the production and shipment factors addressed in Table 7-6 are mostly variable changes in production processes, durability is only assured insofar as it relates to the durability of other effects, principally reduced incremental costs and increased customer demand.

In short, none of these factors are as compelling indicators of program-induced market effects as those previously discussed in this section.

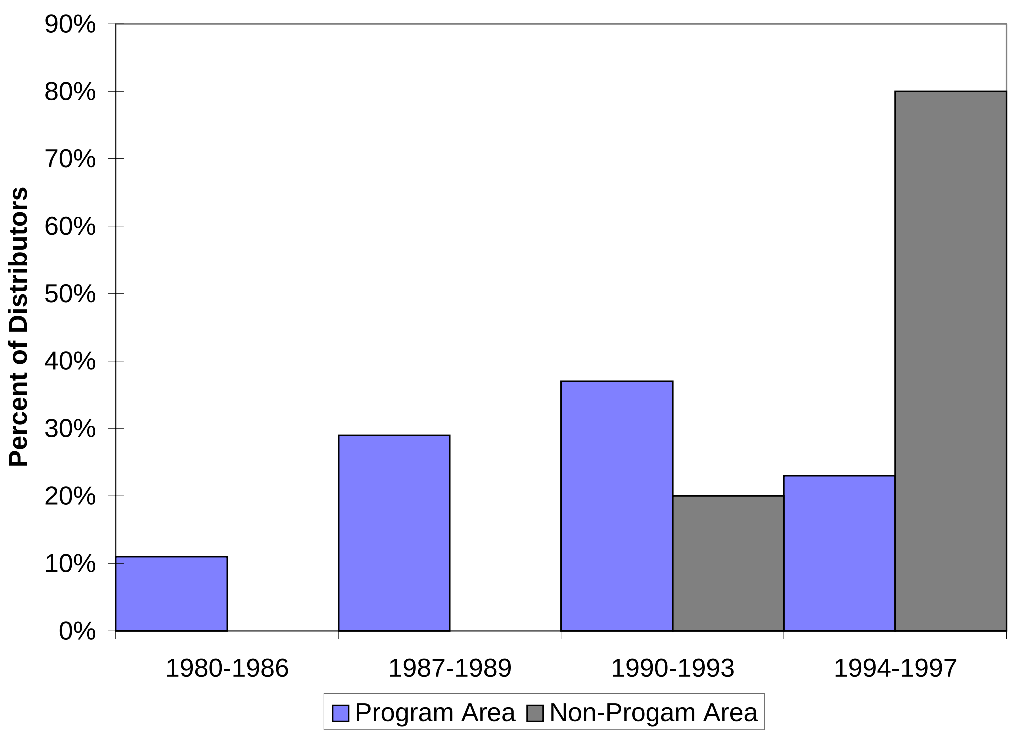
Table 7-6
Market Effects Summary: Changes in Manufacturers' Production and Shipment Patterns

Manufacturer	Hypothesized Market Effect: *Changes in Manufacturers' Production Patterns*		
	Evidence of Change	Utility Program Attribution	Durability of Effect
Ballast			
Regional Shipments	Higher than proportional share of national shipments went to California.	All respondents indicated that rebates affected the regional pattern of shipments.	Dependent on perceived demand patterns.
Size of Prod. Runs	Rapid increase in demand required larger production runs.	Four of six indicated that rebates affected the size of their production runs.	Decline possible, four of six believe sales to decrease w/out rebates.
Timing of Runs	—	Three of six said timing of production runs was affected.	
Specifications	Reductions in total harmonic distortion.	Only two of six said design and technical specifications were affected.	Product improvements likely to persist.
Luminaire			
Regional Shipments	Higher than proportional share of national shipments went to California.	Three of five affirmed program effect.	Dependent on perceived demand patterns.
Size of Runs	Rapid increase in demand required larger production runs	Two of five affirmed program effect.	Dependent on perceived demand (components can be easily regressed).
Timing of Runs	—	One of five affirmed program effect .	
Specifications	Change in specification was shift to T-8 and EB components	Five of five affirmed program effect.	
Lamps	Slightly higher than proportional share of national shipments went to California. 1 mfr reported building major new production plant for T-8s.	2 of 3 mfrs stated that both the regional pattern of shipments and promotions were impacted by programs. One manufacturer each said that rebates affected the size of production runs, the incremental costs, and the technical specifications.	T-8s require different production line. Mfrs. expect demand to continue in absence of programs.

7.2.6 Changes in Stocking Practices

In Figure 7-5, we present histograms of the year in which distributors began stocking electronic ballasts in the program and nonprogram areas. As the results indicate, stocking patterns are dramatically different between the two areas. Approximately 80 percent of distributors in the program areas began stocking electronic ballasts between 1980 and 1993, with the majority doing so in the 1987 to 1993 time period. In the nonprogram areas, 80 percent of distributors began stocking electronic ballasts ***after*** 1993. The 40 percent of program area distributors that began stocking before 1990 were likely induced to do so by a combination of sponsors' programs in the 1980s (particularly PG&E's, which were much larger in the mid-1980s than SDG&E's[8]) and Nonresidential Title 24 building codes that became effective in 1987. The large distributor stocking increase in the program area that occurred between 1990 and 1993 coincides with the increased rebate-based activities of sponsors in the marketplace. ***We conclude that of the sponsors' programs, those preceding 1992 as well as those after played an important role in increasing the availability of electronic ballasts through increased stocking of these products by distributors.***

Figure 7-5
Distribution of Year in Which Distributors Began Stocking Electronic Ballasts



[8] For example, PG&E conducted over 10,000 nonresidential audits between 1984 and 1986.

7.2.7 Changes in Government Building Codes

As we discussed in Section 4, revisions to California's Title 24 commercial lighting standards are scheduled to be formally approved in May 1998. These revisions will require lower lighting power densities (LPDs, expressed in watts per square foot of lighting load) than currently allowed. The LPD allowance has not been revised since 1987. In Table 7-7 below, we provide a summary of the reductions in LPDs for key building types. As can be seen from the table, these changes will reduce LPDs for key building types by approximately 15 to 20 percent, depending on building type. Although these reductions are not as strong as were lobbied for by some parties, notably PG&E, it is generally agreed that they will virtually require luminaires with T-8 lamps and electronic ballasts.

Table 7-7
Pending 1999 Title 24 LPD Revisions for Key Building Types

Building Type	Revised Title 24	Existing Title 24	Percent Decrease
Low Bay Work Buildings	1.0	1.2	17%
Grocery Store	1.5	1.8	17%
C&I Storage Buildings	0.7	0.8	13%
Medical Buildings and Clinics	1.2	1.5	20%
Office Building	1.2	1.5	20%
Religious, Auditorium, Convention	1.8	2.0	10%
Restaurants	1.2	1.5	20%
Retail and Wholesale Store	1.7	2.0	15%
Schools	1.4	1.8	22%

According to our interview the with project manager at the CEC in charge of review of the standards, the LPD revisions have recently been approved by the CEC and the building standards board. The new standards will take effect in the beginning of 1999, though they may be delayed a few months after the planned January 1999 start date.

With respect to the roles of various stakeholders in the process, the following observations were provided by staff at the CEC:

- The design community was the primary group involved in the design of the revised LPDs - they were by far the largest in number. Retail designers were most resistant to lowering LPDs.
- PG&E and SDG&E were also involved in the process.

- Interestingly, there were no end-user groups (retail associations, hospital associations, etc.) involved in the revision process, yet evidence suggests that retailers will have a tough time meeting the new LPDs. However, the retailers' voice was heard through some of the designers, who stated the initial round of proposed LPDs were too low.
- NRDC was also very involved.

The process itself, went as follows:

- An initial revision was proposed that included lower LPDs than those ultimately adopted (0.8 for office) in late 1996 and early 1997.
- A workshop was held to seek consensus.
- Revisions were made at levels between those of the original proposals and current levels.
- A second workshop was held in which very few changes were made.
- The proposed standards were approved by the CEC and sent off to the building standards board for approval.

Our contact indicated that the CEC "eased up on the LPDs" because the model they were using did not incorporate indirect lighting. Indirect lighting was deemed an important priority, given glare problems of CRTs, and the group did not want to reduce the LPDs too much and undermine designer's ability to improve the glare problem.

The issues with respect to the retail sector loomed large in the process. Retailers find it difficult to meet code with all the accent lighting they use, so wherever a 4-foot fixture is hung they put in a T-8 EB system to generate some "wiggle room." This issue was voiced loudly by some of the designers interviewed in this study as well.

The changes to the Title 24 LPD standards are very likely to lock in T-8 lamps and electronic ballasts as the de facto standard technologies for new construction in California. There are two principal pieces of evidence that sponsors' programs contributed significantly to the permanent market effect. First, and most importantly, the current LPD standards have been in place for almost a decade despite the fact that electronic ballasts and T-8 lamps have been available from the outset of these standards in 1987. Lighting levels were initially set below those requiring these technologies because of concerns about the reliability, availability, product features (THD levels) and life-cycle economics of these measures.

The CEC and building standards board declined to revise the standards throughout the 1990s despite increasing levels of penetration and acceptance of these technologies. This is not surprising, given that the standards setting process is often a lagging function that attempts to capture residual efficiency opportunities remaining after significant portions of the market have been transformed. This lagging role of the Title 24 standards process was articulated by one of the key CEC staff members involved in the standards analysis process in the 1980s and early 1990s.

It is only now that reliability has improved, incremental costs have decreased, and the penetration and acceptance levels are widespread, that the standards are being revised. Given our previously presented conclusions with respect to the role of sponsors' programs in increasing demand, reducing incremental costs, increasing downstream supply-side vendors' specification and promotion, and increasing end users' requests for these technologies (in several, though not all segments), ***we conclude that sponsors' programs should be credited with playing a significant role in creating the conditions necessary for the revised standards***. In addition, we have evidence that PG&E, in particular, supported lower standards than were adopted and that the impacts of their programs demonstrated the required market acceptance to go forward with the revision.

7.2.8 Increases in New Market Entrants (Management Contractors and ESCOs)

In Section 3, we discussed trends within the installation sector, namely the evolving and expanding market of the lighting maintenance firm. Utility programs have had a second order effect upon this trend in that the reduction in program funding led to the pursuit of new revenue streams by companies dependent upon utility dollars. Moreover, the increase in the outsourcing of lighting maintenance has coincided with the reduction in utility rebate dollars. We spoke with five firms currently active in or considering entering the lighting maintenance market; all four entered or are considering entering the market in response to the reduced profitability in the retrofit market. A quote used earlier in this report merits reciting as it gives strong evidence to this trend. The quote is from a June 1997 press release from a vice president of Sylvania Lighting Services: "Due to changes in the marketplace brought about by utility deregulation, and the decline of demand-side management (DSM) and utility rebate programs, there has been a shift from the retrofit market to the maintenance service market."

Given that these firms are disposed to use energy-efficient technologies (some have formal policies to replace failed magnetic ballasts with electronic ballasts), the degree to which reduced utility funding drove them into the maintenance market may generate a positive effect upon energy efficiency. This is not to say that utility programs created the market for lighting maintenance. In fact, the outsourcing of business operations is a widespread trend found in numerous other sectors of the economy and we do not presume utility programs impacted end users (outsourcing firms) in this way. Rather, by shrinking the retrofit market, reducing utility programs forced energy service companies to adapt and seek new markets. There is no conclusive evidence that the net impact of outsourcing maintenance to lighting maintenance firms caused a reduction in energy usage. Further research is required to assess this consequence. However, it is apparent that the lighting maintenance market has expanded and continues to expand, providing companies once dependent upon utility programs with new market opportunities.

7.3 BALLAST MANUFACTURER INTERVIEW RESULTS

7.3.1 Key Results

- The consensus among the interviewed manufacturers is that the electronic ballast has been accepted by the market because reliability concerns and prices have declined; they do not feel electronic ballasts currently face any significant market barriers.
  - ⇒ However, significant market barriers were cited as existing during the early 1990s. Interviewees stated that the most important barrier to initial customer acceptance was reliability.
- All six ballast manufacturers interviewed also stated that the reduction in utility rebate programs has had an impact on the sales of electronic ballasts (the degree of impact was mixed, with several stating the effect has been minimal, while one said the effect was "drastic").
- When asked what would happen to electronic ballast sales in the absence of utility programs, four out of six stated that there would be a decline in sales.
- National sales figures for 1997 (which include a XENERGY estimate for the fourth quarter), show electronic ballast market share possibly at their highest level (roughly 50 percent). This contradicts manufacturer reports of a decline in electronic ballast sales because of reductions in utility rebates.
- All respondents indicated that rebates affected the regional pattern of shipments; while four of six indicated that rebates affected the size of their production runs.

7.3.2 Market Barriers

The consensus among manufacturers interviewed is that the technology has been accepted by the market as reliability concerns and prices have declined. They do not feel electronic ballasts currently face any significant market barriers, as stated explicitly by one of the largest manufacturers. However, significant market barriers existed upon wide-scale introduction of electronic ballasts in the early 1990s. According to ballast manufacturers interviewed, the most important barrier to initial customer acceptance has been reliability. Four out of six manufacturers cited reliability as the initial market barrier, although manufacturers state that reliability is no longer a problem for them nor a barrier for customers. One manufacturer stated that "the current failure rate is 0.5 percent, while the rate between 1991 and 1993 was 10 to 20 percent for the industry."

When asked what barriers exist with distributors and contractors, the most frequent answer was their preoccupation with first cost. One stated that distributors are inclined to stock and sell magnetic ballasts, since it is a low first cost business. Another stated that adding expensive brands to an already long list of brands made convincing distributors to stock these items difficult. The same individual stated that as electronic ballasts have increased in acceptance, convincing distributors to stock electronic ballasts has become less of a challenge.

7.3.3 Market Effects

Each manufacturer interviewed was asked whether or not utility rebates affected a number of key aspects of their business operations. These responses are provided anonymously in Table 7-8 below. All respondents indicated that rebates affected the regional pattern of shipments; while three of six indicated that rebates affected the size of their production runs. All of the remaining factors (Timing of Production Runs, Relative Price, Design/Technical Specification, and Regional Pattern of Promotions) were stated as being affected by at least two of the six manufacturers interviewed. When we asked on an overall basis what they would have done in the absence of rebate programs in California, four of six stated that they would not have made similar decisions with respect to the production factors listed in the table. While each of the factors by themselves provide some evidence for the effect of utility programs on manufacturers' production decisions, the answer to the overall impact question indicates that the programs did affect the majority of manufacturers.

Table 7-8
Ballast Manufacturers' Reported Effects of Utility Rebates on Business Operations

Did utility rebates affect the following decisions? (✔ = Yes)							
Business Operation	Total	Company					
		A	B	C	D	E	F
Timing of production runs	3	✔	✔				✔
Size of production runs	3	✔			✔		✔
Price (relative to magnetic ballasts)	2	✔	?				✔
Regional pattern of shipments	6	✔	✔	✔	✔	✔	✔
Design or technical specifications	2		✔	✔			
Regional pattern of promotions	3	✔	✔	✔			
Similar decisions in absence of programs? (✔ = No)							
"Would your Company have made similar decisions if there were no rebate programs in California?"	4	✔	✔	✔	✔		

All six ballast manufacturers interviewed also stated that the reduction in utility rebate programs has had an impact on the sales of electronic ballasts. The following are verbatim explanations and observations of manufacturers on the impact of reduced utility rebate programs:

- There has been a "drastic effect...magnetic ballasts cost $10 and electronic $14 ...the price pressure will cut short-term market share of electronic ballasts."

- “The sale of electronic ballasts peaked in 1994. As rebates declined there has been a trend back to magnetic ballasts.”
- “There has been a 30-35 percent drop in electronic ballast penetration.”
- “The decrease in utility rebates has slowed the growth rate of electronic ballast penetration.”
- “The decrease of utility programs reduced the sales in the areas where utility programs were.”

Note that these responses are inconsistent with the national ballast share data presented in Section 3 and many of the opinions of distributors, designers, and installers presented later in this section.

When asked what would happen to electronic ballast sales in the absence of utility programs, four out of six stated that there would be a decline in sales. However, two of the respondents provided a caveat stating that California is more “energy conscious” and that the reduction in sales would be less relative to other areas of the country with utility programs. One manufacturer claimed that the absence of utility programs has not had a negative impact on their sales of electronic ballasts, claiming that their sales levels have increased significantly since the decline of the programs. He did note that their market share was very small at the height of utility programs.

When asked what the difference in electronic ballast shares have been in California compared to the national share, four out of six manufacturers stated that the share is higher in California, providing the following explanations:

- The California market share has been "much higher."
- “There is still funding and incentive programs in Southern California as opposed to New England.”
- “We have not seen as much of a drop in sales” in California.
- “Our market share has been growing in California because it was very small to start with three years ago - it’s still growing.”

When asked what would happen in 1999 if all utility programs were terminated, four out of six stated that the share of electronic ballasts would decline. One respondent stated that it “depends on the market, the commercial sector will decline, but government will not be affected.” The sixth respondent did not know what would happen. For those that answered that market share would decrease, the average estimated decrease was 17 percent.

When asked “What effects do you think utility programs had on customers?” the following responses were given:

- They “spurred demand.”

- They "decreased the price of ballasts, and allowed manufacturers to get their costs down."
- They "helped a lot - offset the initial cost, got within $2 to $3 of standard magnetic ballasts."

When asked "What effects do you think utility programs had on distributors and contractors?" the following responses were given:

- "Everyone got into the business and was suddenly an expert."
- "There was a pass-through effect because most contractors and distributors didn't care."
- "Everything has become more competitive now that rebates have disappeared - ESCOs sprang up because of rebates, it was hard to sell energy efficiency before rebate programs."

We also asked if other factors had greater, less, or about the same influence on production and marketing decisions as utility programs. These results are provided in Table 7-9 below. The results of this battery were mixed, as manufacturers held widely disparate views of the relative influence of these other factors compared to utility programs.

Table 7-9
Ballast Manufacturers' Assessments of Importance of Other Internal Activities and External Events Compared with Utility Programs

Condition	Number of Respondents Saying the Influence of Other Factors Compared with Utility Influence Was:		
	Greater Than	Less Than	About the Same As
Performance of the product in international markets	2		
Analysis of historical domestic sales figures		1	1
Internal market research	1	2	
Analysis of production costs		3	
Analysis of alternative investments for fixed plant			1
Government codes and standards	1		
Government programs, such as Green Lights	2		

Finally, in the absence of utility programs, manufacturers stated that the following factors would contribute to continued market acceptance of electronic models:

- End-user education.
- Federal government education efforts.
- The profit motive facing ESCOs.

- The trend of decreasing electronic ballast prices.
- Increase in energy prices.

7.4 LAMP MANUFACTURER INTERVIEW RESULTS

All three of the major lamp manufacturers were interviewed for this study. Each of these three manufacturers represents roughly one-third of the highly concentrated national lamp market. Interviewees were national and regional sales managers.

7.4.1 Key Results

- Respondents stated that utility programs had a positive effect on the growth of T-8 lamp market share, but provide conflicting accounts of the absolute importance of programs compared to other factors:
  - ⇒ Two of the three respondents said that their firms would not have made the same decisions with respect to T-8 lamps in the 1990s without utility rebate programs.
  - ⇒ Respondents also stated that other factors (such as their own market analysis and government standards and programs) were more influential than utility programs.
- Two factors cited as having been affected by utility programs by two of the manufacturers were their regional patterns of shipments and promotions of T-8s.
- Respondents were bullish on the future of T-8 lamps in the absence of utility support.
- Interestingly, manufacturers interviewed believed T-8 lamps face minimal market barriers today and identified electronic ballasts as the principal barrier faced by the lamps in the past.

7.4.2 Market Barriers

When asked what market barriers exist for T-8 lamps, one manufacturer stated that there are currently none. He stated “we can’t make enough of them [T-8 lamps],” asserting that customers have fully accepted the technology. He also stated that initial barriers were primarily technology driven, not price driven, identifying three specifically: (1) some T-8s require a different socket, (2) poor reliability of electronic ballasts, and (3) end users’ “fear of new technology.” However, he did state that the period from product introduction to market acceptance was relatively short and that he would like to have the same “laboratory to market” time frame for other products.

Another manufacturer interviewed stated that the key barrier to the adoption of T-8 systems was the reliability and availability of electronic ballasts. The third manufacturer indicated that it was cost justification for the end user, awareness of the product, and concern for reliability of electronic ballasts that were the main barriers to the adoption of T-8s.

7.4.3 Market Effects

Lamp manufacturers assert that utility programs have had a positive impact on market penetration. One of the major manufacturers stated that, “Between 1991 and 1995, as we came out of the recession, harsh economic conditions created a bottom line focus, and financing efficiency was hard to justify. Utilities came in and provided the needed financing.” This is confirmed by another major manufacturer who stated that utility programs have significantly accelerated the penetration of T-8 systems, while still another manufacturer acknowledged the positive effects the utility programs had on customers, distributors, and contractors. Two of the manufacturers explicitly stated that the share of T-8 systems is higher on “both coasts” due to utility programs and environmental requirements. One major manufacturer stated that 60 percent of their *current* 4-foot fluorescent sales nationwide are accounted for by T-8 lamps and 75 percent in California. By contrast, the same manufacturer stated that in 1994 the nationwide penetration was 20 percent and the California penetration was 35 percent. Another manufacturer indicated that they also sold a higher percentage of T-8s in California than in their other markets, 40 percent domestically and 45 percent in California. Those percentages were slightly lower in 1994, with 30 percent T-8 sales domestically and 35 percent T-8 sales in California.

Lamp manufacturers were asked whether utility rebates affected a number of production and business-related decisions, both for energy-saver lamps in the 1980s and for T-8s in the 1990s. The results for each of the manufacturers queried are provided in Table 7-10 and Table 7-11. Interestingly, respondents provided the same answers for both technologies. For T-8 lamps, two manufacturers stated that both the regional pattern of shipments and promotions were impacted by utility programs over the study period. One manufacturer each said that rebate programs affected the timing of production runs, the size of production runs, the incremental costs, and the technical specifications. At the same time, one of the lamp manufacturers stated that none of the production and marketing decisions were directly impacted by utility programs. We also asked respondents to sum up across these factors whether or not they would have made similar production and promotion related decisions in the absence of utility programs. Two of the three respondents said that their firms would not have made the same decisions with respect to T-8 lamps in the 1990s. The fact that two of the three stated that several aspects of production and promotion were affected by rebate programs is significant, given that each respondent represents approximately one-third of the national market. Finally, we asked manufacturers whether a series of other factors had greater, lesser, or relatively the same amount of influence on T-8 production and marketing decisions. These results are shown in Table 7-12. For the most part, respondents stated that other factors were more influential than utility programs.

Table 7-10
Lamp Manufacturers' Reported Effects of Utility Rebates on Energy Saver Lamp Operations

Did utility rebates affect the following decisions? (✔ = Yes)			
	Company		
Business Operation	**A**	**B**	**C**
Timing of production runs			✔
Size of production runs	✔		
Price (relative to magnetic ballasts)			✔
Regional pattern of shipments	✔		✔
Design or technical specifications			✔
Regional pattern of promotions	✔		✔

Table 7-11
Lamp Manufacturers' Reported Effects of Utility Rebates on T-8 Lamp Operations

Did utility rebates affect the following decisions? (✔ = Yes)			
	Company		
Business Operation	**A**	**B**	**C**
Timing of production runs			✔
Size of production runs	✔		
Price (relative to magnetic ballasts)			✔
Regional pattern of shipments	✔		✔
Design or technical specifications			✔
Regional pattern of promotions	✔		✔
Investment in specialized production facilities			
Similar decisions in absence of programs? (✔ = No)			
"Would your Company have made similar decisions if there were no rebate programs in California?"	✔		✔

Table 7-12
Lamp Manufacturers' Assessments of Importance of Other Internal Activities and External Events Compared with Utility Programs on T-8 Lamp Decisions

Condition	Number Saying the Influence of Other Factors Compared with Utility Influence was:		
	Greater than	Less than	About the same
Performance of the product in international markets		1	1
Analysis of historical domestic sales figures	1	1	
Internal market research	1		1
Analysis of production costs	1		
Analysis of alternative investments for fixed plant	1		
Government codes and standards	1		1
Government programs such as Green Lights	2		

When asked how a hypothetical absence of all utility programs would affect future sales, respondents stated that they believed T-8 lamp market share would remain the same in California. The implication of their observations is that, although utility programs had a significant impact in increasing penetration, the technologies are now established and mainstream, and utility programs are no longer needed to convince end users to purchase the technology.

Finally, when asked what would happen in 1999 if all utility programs were terminated, all of the lamp manufacturers stated that the share of T-8 lamps would remain about the same. One manufacturer responded that the "emergence of ESCOs" would contribute to future growth in the absence of utility programs.

7.5 LUMINAIRE MANUFACTURER INTERVIEW RESULTS

7.5.1 Key Findings

We present below the key luminaire manufacturer responses addressing market barriers to efficient luminaire sales and possible market effects of utility programs.

- "High Initial Cost"[9] was cited by the majority of respondents as the primary barrier to the adoption of efficient luminaires. Lack of awareness of efficient products and their benefits was also cited.

[9] We recognize that "first cost" is not an agreed upon market barrier and, in particular, is not included as a barrier in Eto, et al., 1996. In this section, our focus is on reporting respondents' own assessments of market barriers in their own terms. The

--Most manufacturers believed that utility programs helped to overcome these barriers through reductions in costs to the end user and increased customer awareness.

- When asked what effects utility programs have had on distributors and contractors, five out of nine said that awareness of energy efficiency, and therefore promotion of energy efficiency was improved as a result of the programs.

  --Two manufacturers also stated that energy efficiency still is not in the mindset of these market actors and that there was relatively little influence on contractors and distributors other than "awareness of rebates" rather than improved "energy consciousness."

- We asked about the impact of current reductions nationally in utility program funding; the results were mixed. Five out of 10 stated that they did not think reductions in utility program funding have affected trends in the market share of fixtures with efficient features, while the other five stated that the share of efficient fixtures has been impacted.
- When asked, 'If all programs to support efficient fluorescent lighting products were to terminate today, do you think your market share in 1999 would be higher, lower, or about the same as it is today, nationwide?,' only three out of 10 responded that the share would be lower. Most stated that the share of efficient technology would be about the same.
- Luminaire manufacturers primarily sell to lighting distributors, with a small portion of total luminaire sales going through alternative channels. Seven of the 12 manufacturers interviewed estimated that at least 80 percent of their sales were to distributors, including the four largest companies.

7.5.2 Market Barriers

According to the manufacturers we interviewed, the most significant barrier to the purchase of luminaires with efficient features is first cost. Out of 11 responses, seven manufacturers cited initial cost as the most significant challenge they have encountered. One major manufacturer asserted that the price barrier is caused by the contractor and distributor because they are "looking for the best price," yet end users and designers are interested in long-term cost savings offered by energy-efficient equipment. Because luminaire manufacturers deal principally with distributors and installers and not end users, their perceptions of end users' preferences should be discounted. Only two of the manufacturers state barriers different from first cost. One asserted that, although no longer a major barrier, reliability was a significant barrier in the early 1990s. The other manufacturer stated that efficient products can be more difficult to install and maintain, especially if controls are part of the design.

issue of first cost is addressed further in our analysis of market barriers across the various supply- and demand-side interviews conducted.

7.5.3 Market Effects

Generally, luminaire manufacturers expressed a high regard for utility programs, stating almost unanimously that the programs have a had a positive impact on energy-efficient lighting. When asked what effects utility programs have had on their customers, most luminaire manufacturers stated that the programs reduced the price and increased awareness. Six out of nine respondents stated that the cost to consumers was reduced, while four out of nine specifically stated that utility programs increased customer awareness of energy efficiency.

When asked if utility programs helped to overcome barriers associated with installers, designers, and distributors, ten out of 12 stated that the programs did help to overcome barriers; the other two respondents did not know; none of the respondents said no. When asked what effects utility programs have had on distributors and contractors, five out of nine said that awareness of energy efficiency, and therefore promotion of energy efficiency, was improved as a result of the programs. One manufacturer stated that a “new marketing outlet” was created, giving contractors and distributors another selling point for their services. Two of the manufacturers stated that energy efficiency still is not in the mindset of these market actors and that there was relatively little influence on contractors and distributors other than “awareness of rebates,” rather than improved “energy consciousness.” Selected verbatim responses include:

- “The utility programs brought about awareness of the products and the support they gave to the products made them a proven technology. The programs helped T-8 and EE lighting to stand on its own.”
- “They created new marketing outlet for suppliers and heightened their awareness.”
- “The programs influenced these people to specify efficient equipment more often.”
- “These groups have an incentive to maximize their profits, so they are aware of the rebate money - it’s not so much energy consciousness.”
- “The programs promoted the savings of these types of fixtures and controls. The utilities worked with contractors and ESCOs to utilize them.”
- “They increased awareness.”

With regard to the impact of utility programs on customers, the manufacturers provided the following observations:

- “The original rebates forced the issue of the savings and the proven ability of the T-8s. They made it obvious that T-8s were the way to go for new construction and retrofit. The economic boom during that time also helped.”
- “The customers are more aware and they ask for the energy-efficient lighting products.”
- “They certainly received inexpensive goods, but didn't receive quality goods in all cases.”

- “The rebates for ballasts made it more attractive to customers who were retrofitting or had new construction to save extra money and energy.”
- “They improved customer knowledge through education.”

When asked if utility programs helped to overcome the market barriers each respondent identified, nine out of 11 respondents answered yes. The other two said that they did not know.

When asked what specific effects utility programs have had on the adoption of energy-efficient luminaires, manufacturers made several different assertions. A few of the observations are cited below:

- “The awareness brought more demand for the products which increased production, shipping, and sales. The energy-efficient products were specified in more markets since they were well known and utility-backed. The products offered rebates, energy savings, cost savings, and were mass produced.”
- “In program areas, demand increased, although there was no national impact from DSM on manufacturing demand”

We asked manufacturers what the impact of reduced utility program funding has been on sales of luminaires with efficient features; the results were mixed. Five out of 10 stated that they did not think reductions in utility program funding have affected trends in the market share of fixtures with efficient features, while the other five stated that the share of efficient fixtures has been impacted. When we asked each to explain their response, they provided the following:

- “The absence of utility programs slows down the market for retrofits (T-12 to T-8 replacements). If you are putting in a new fixture it would not be affected, since the technology is proven/established as far as contractors and designers are concerned.”
- “DSM started the ball rolling, but there is currently a high level of awareness of the economic benefits of commercial EE lighting.”
- “Our sales dropped because of the reduced incentives.”
- “The efficient systems are accepted technology, they are now the norm.”

When asked, “If all programs to support efficient fluorescent lighting products were to terminate today, do you think their market share in the 1999 would be higher, lower, or about the same as it is today, nationwide?,” only three out of 10 responded that the share would be lower. Most stated that the share of efficient technology would be about the same.

We provide in Table 7-13 below, a summary of respondents’ assessments of whether utility rebates affected a variety of supply-related decisions.

Table 7-13
Did utility rebates affect the following decisions? (✔ = Yes)

		Company									
Business Operation	**Total**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Timing of production runs	1	✔									
Size of production runs	2	✔			dk		✔				
Price (relative to magnetic ballasts)	5	✔	✔		dk	✔			✔	✔	
Regional pattern of shipments	3	✔	✔		dk	✔					
Design or technical specifications	5	✔	✔		dk	✔			✔		✔
Regional pattern of promotions	3	✔	✔		dk				dk		✔

dk = Don't Know

When asked, on an overall basis, if decisions regarding company operations would have been different in the absence of DSM programs in California, six out of 12 said that they would. Five stated that their decisions would not have been different, while one manufacturer did not know. Specific responses included the following:

- "It is very difficult and time consuming trying to 'up-sell' these products. DSM provided a market for the T-8 fixtures and the payback was good at providing a lower price for the products."
- "Title 24 is more important; DSM had a larger impact on the East Coast."
- "Yes, because high electronic ballast prices would have been cost-prohibitive."
- "The programs helped accelerate our efforts and awareness. It helped to increase our production."

Finally, when asked what factors would contribute to continued growth in penetration of efficient systems, the luminaire manufacturers provided the following responses:

- "Awareness of the products, savings potential, and a proven technology. Global warming situation has also increased awareness as well as concern for conserving and improving use of energy consumption. The U.S. government is retrofitting."
- "Cost of electronic ballasts is dropping each month.
- "Manufacturers will push for better technology."
- "It is a proven technology and everyone is always looking to save energy and costs."
- "The cost of energy is the driver."
- "Reliability and energy savings of the technologies."
- "Product design and increased efficiency."

7.6 DISTRIBUTOR INTERVIEW RESULTS

7.6.1 Key Findings

- High cost was stated as the most important barrier to efficient lighting equipment sales in 1991, followed by reliability (references were to ballast failure rates). Other concerns mentioned included customer education/reluctance to try new products and light quality.
- Fourteen of the 18 in-depth respondents who indicated there were barriers in 1991, stated that the barrier they reported had been reduced. Respondents also stated that prices had come down significantly (often, in respondents' words, "due to increased demand spurred by rebates") and that reliability had greatly improved as well.
- Thirteen of the 18 in-depth respondents also indicated that utility programs contributed to reducing these barriers. Respondents in the larger phone-house survey also pointed overwhelmingly to the effect of rebates in spurring customer demand for efficient lighting products.
- Consistent with the responses above, almost half of in-depth program area distributors stated that there were no remaining barriers to efficient equipment purchase today.
- Distributors in the program areas generally began stocking T-8 lamps and electronic ballasts in 1990, whereas those in nonprogram areas did not begin stocking them on average until 1993-1994.
- Reported penetrations of electronic ballast and T-8 lamps were several times higher in the sponsors' territories in 1991, roughly two and a half times as high in 1994, and about two times as high in 1997. These results suggest that the penetration gap between program and nonprogram areas is closing.
- Finally, the majority of respondents stated that they believed sales would stay about the same in the absence of the sponsors' lighting programs, while about one-third believed their sales would decrease, and only less than one-in-10 predicted an increase.

7.6.2 Market Effects and Barriers

There were four principal approaches that were employed to investigate market barriers and potential market effects in the distributor interviews. These approaches included:

- Direct querying with respect to changes in perceived barriers.
- Requests for sales shares for efficient fluorescent lighting products and initial year of stocking.
- Inquiries with respect to *expected* specification and sales practices in the absence of programs.

Each of these modes of inquiry are discussed in the subsections that follow.

Market Barriers

Respondents' assessments of the barriers to energy-efficient lighting equipment in 1991 and currently are presented in Table 7-14 and Table 7-15. High cost was stated as the most important barrier in 1991, followed by reliability (references were to ballast failure rates). Other concerns mentioned included customer education/reluctance to try new products and light quality.

Table 7-14
1991 Barriers to EE Lighting Components [In-depth results only]

Thinking back to 1991, what was the main obstacle to using or specifying T-8 lamps, electronic ballasts, and 2-lamp fixtures?		
Report Barrier	**Most Important**	**Next Most Important**
Price too high	58%	42%
Reliability	16%	32%
Other: Customer education/inertia	11%	
Light amount or quality	11%	
None/No Answer	5%	26%
Total	100%	100%

- Fourteen of the 18 (83 percent) respondents who indicated there were barriers in 1991, stated that the barrier they reported (see table above) had been reduced (most stating that the reduction had been "significant"). Corresponding to the barriers listed in the table above, respondents also stated that prices had come down significantly (often, in respondents' words, "due to increased demand spurred by rebates") and that reliability had greatly improved as well.

Consistent with the responses above, almost half of program area distributors stated that there were no remaining barriers to efficient equipment purchase today. A minority continued to cite high cost, customer education/awareness, and reliability. In addition, one respondent indicated that a problem today was that contractors were not willing to take the time to investigate the efficient equipment.

Table 7-15
Current Barriers to EE Lighting Components [In-depth only]

What do you believe is the most important remaining barrier to using T-8 lamps, electronic ballasts, and 2-lamp fixtures?		
Reported Barrier	**Most Important**	**Next Most Important**
None	47%	58%
Price too high	21%	11%
Other: Customer education/awareness	16%	11%
Reliability	11%	0%
Contractors won't take time	5%	0%
Light amount or quality	0%	0%
Availability	0%	21%
Total	100%	100%

Market Effects

In probing distributors' own assessments of whether the sponsors' programs contributed to the reported reduction in barriers, 13 of the 18 (72 percent) in-depth respondents also indicated that utility programs contributed to reducing these barriers. Verbatim responses to this probe are provided in Table 7-16.

Similarly, as shown in Table 7-17, respondents to the larger phone-house survey also stated that the primary effect of programs was to increase product demand, while few distributors mentioned other factors such as increased customer and contractor education.

Table 7-16
In-Depth Distributor Verbatims vis-à-vis Effect of Programs on Reducing Barriers

Do you think that utility energy-efficiency programs contributed to reducing this barrier to using efficient fluorescent lighting equipment? If so, how?
Yes, rebates reduced price.
Yes; rebates and marketing effort.
Yes; rebates were enough... especially if customers lights are on all day.
Yes, the push from rebates helped greatly, pushed competition.
Yes, legitimized the industry, people liked rebates.
Yes, flyers, seminars, audits also helped.
Yes, rebates put competition in place.
Yes, consumer awareness about color [rendition] due to program.
Yes, rebates themselves made the decision - would not have been the boom in '94 without rebates.
Yes. They helped make the EE lighting affordable for their customers and created a large demand for them. Manufacturers started making more of them and the prices dropped.
Yes. Their backing showed it was a proven technology. Rebates provided incentive and made selling easier.
Yes. The programs provided an avenue of reaching the customers and educating them. Provided incentives for customers to purchase energy-efficient lighting technology. The utility backing/recommendation of certain products helped in selling them.
In some ways. The rebates have created additional sales by offering customers an option to purchase these items at a lower price. But the programs have been more burdensome than a help.

Table 7-17
Description of Effect of Utility Programs on Distributors' Sales of EE Lighting (Phone-House, Program Area Only)

What was the most important way in which utility programs made it easier or more worthwhile to stock and sell electronic ballasts and T-8s?	
Response	**Number of Responses**
Rebates increased demand	35
Don't know	2
Educated customers about benefits	2
Educated contractors/designers about benefits	2
High volume decreased price	1
Support convinced customers of value	1
Total	**43**

Stocking and Share of Efficient Products

In order to examine prospective market effects further, we asked several additional questions aimed at ascertaining changes in stocking, sales, and the effect of discontinuation of lighting programs. In Table 7-18 we present the average year distributors began stocking efficient equipment. Distributors in the program areas generally began stocking T-8 lamps and electronic ballasts in 1990, whereas those in nonprogram areas did not begin stocking them on average until 1993-1994. This provides a strong indication of the effect of those sponsor programs that predate the study period addressed in this report (i.e., programs that ran prior to 1992).

Table 7-18
Average Year Distributors Began Stocking EE Products (Phone-house Results)

Territory	Average Year Distributors Began Carrying:		
	T-12 - 34 Watt	T-8 Lamps	Electronic Ballasts
Program	1988	1990	1990
Nonprogram	1991	1993	1994

Distributors' estimates of the percent of their sales accounted for by efficient fluorescent lighting products are provided in Table 7-19 (these data also are presented graphically in Figure 7-6 through Figure 7-8). According to these estimates, penetrations of electronic ballasts and T-8 lamps were several times higher in the sponsors' territories in 1991, roughly two and half times as high in 1994, and about two times as high in 1997. These results suggest that the penetration gap between program and nonprogram areas is closing.

Table 7-19
Distributors' Reported Technology Penetration by Year

Technology	Area	% Annual Market Share by Year		
		1997	1994	1991
T-8 Lamps	Program	51	27	11
	Nonprogram	29	12	3
Electronic Ballasts	Program	55	29	17
	Nonprogram	27	13	3
Efficient Fixtures	Program	42	20	7.6
	Nonprogram	16	3	0

Figure 7-6
Distributors' Reported T-8 Lamp Penetrations

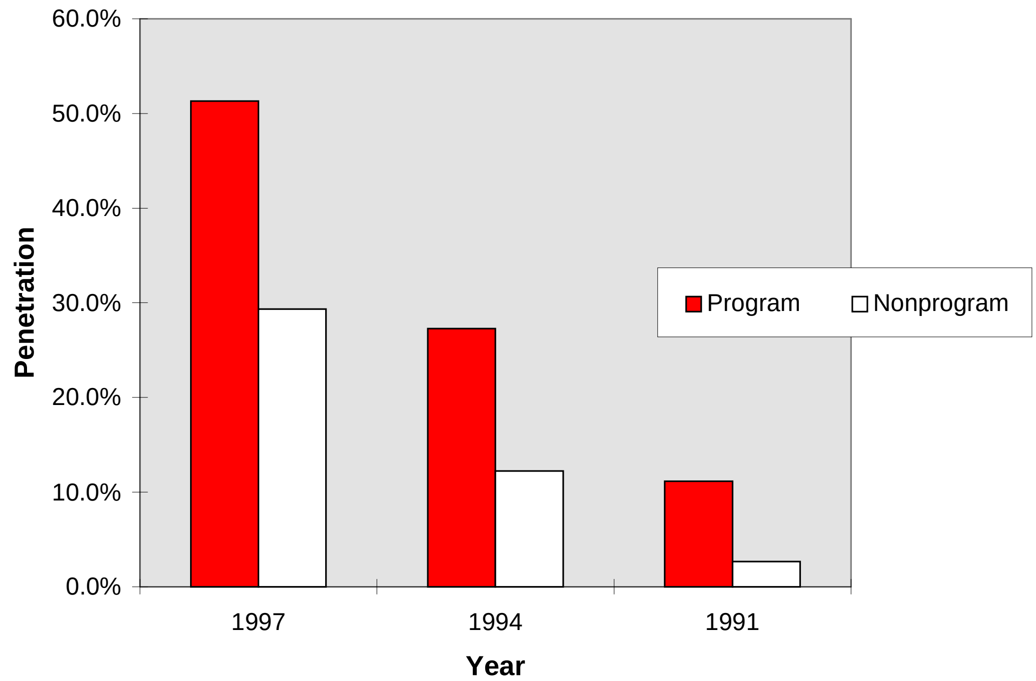


Figure 7-7
Distributors' Reported Electronic Ballast Penetrations

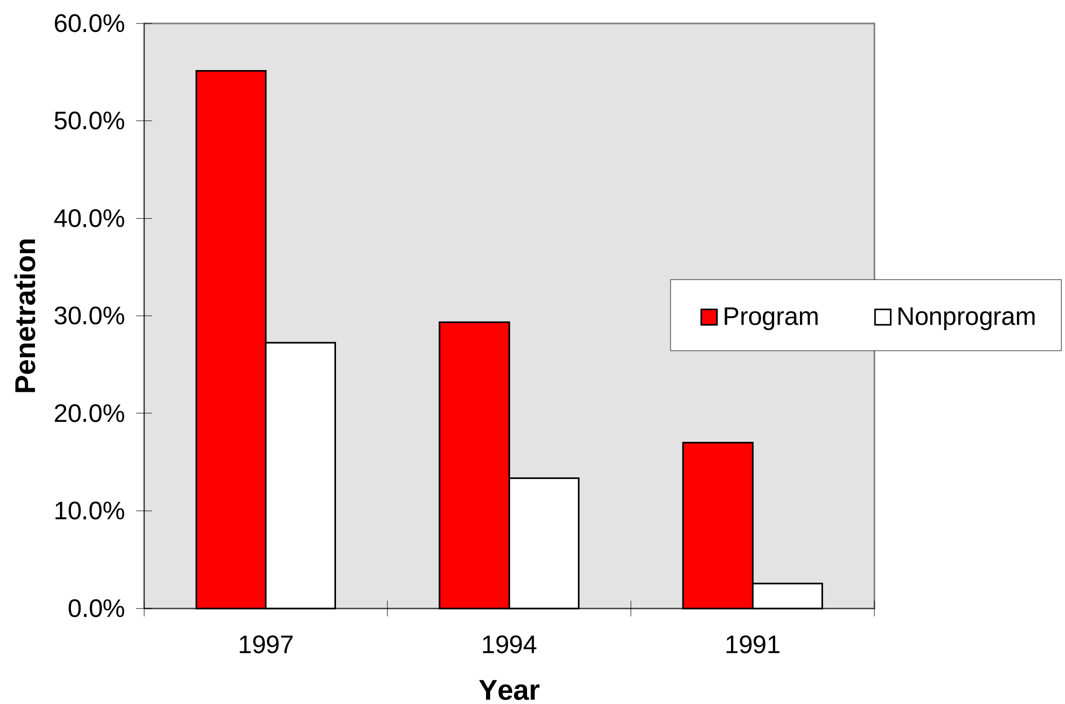
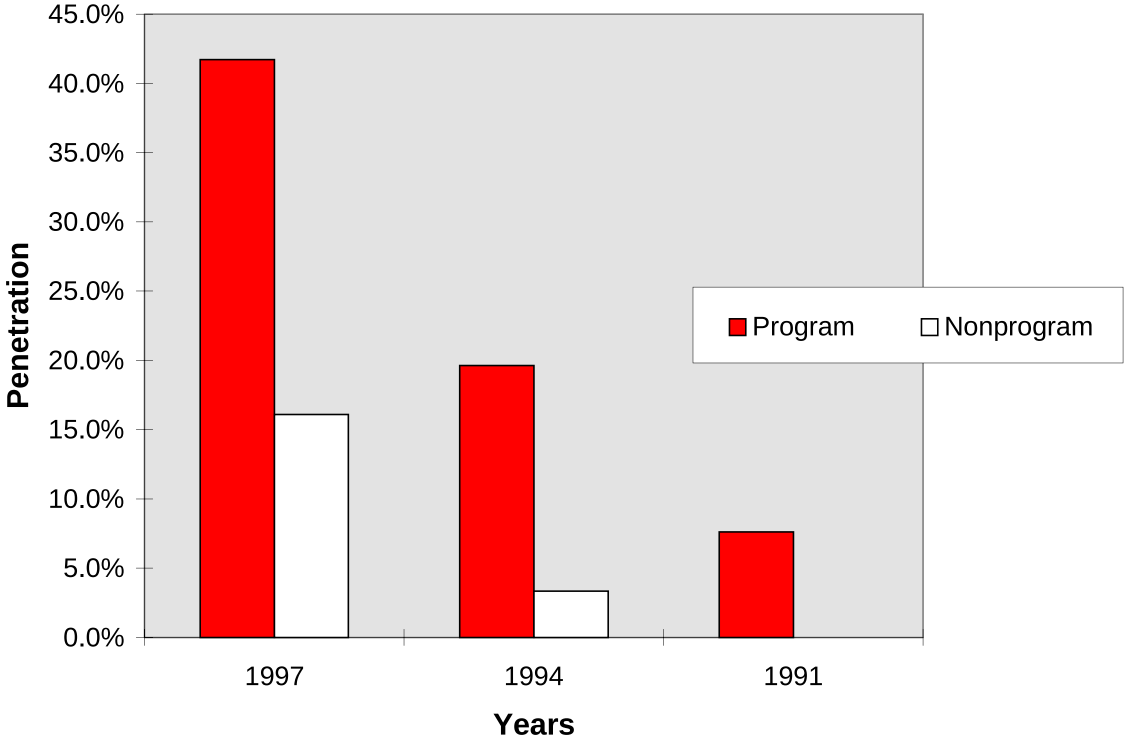
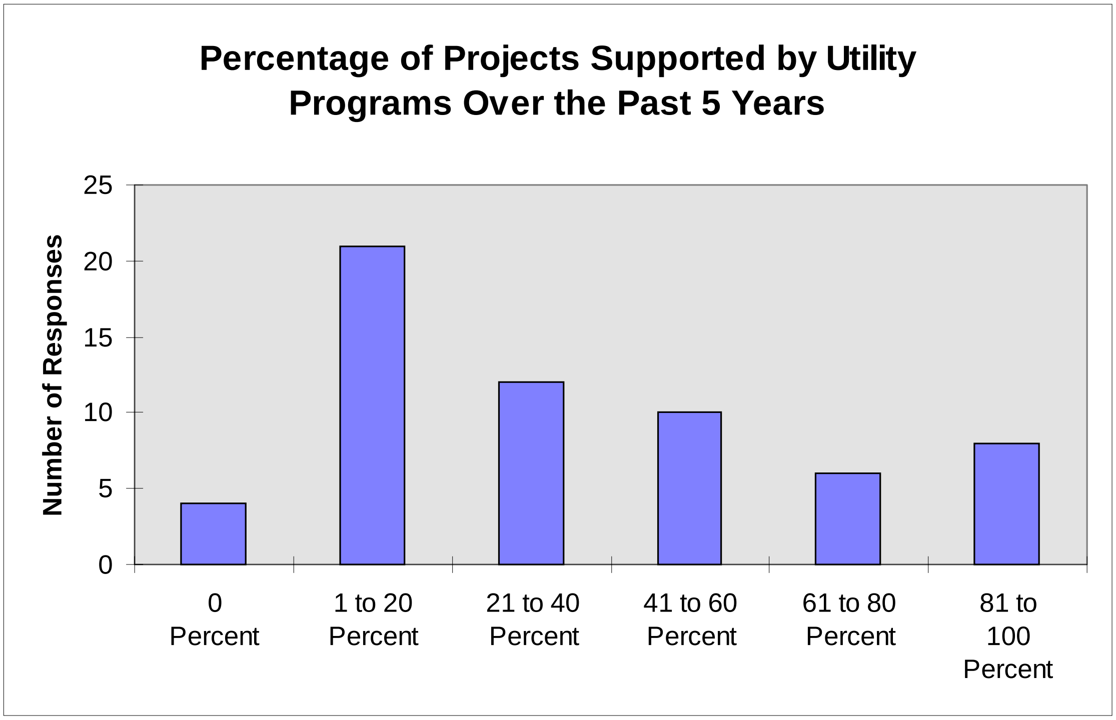


Figure 7-8
Distributors' Reported Efficient Fixture Penetrations



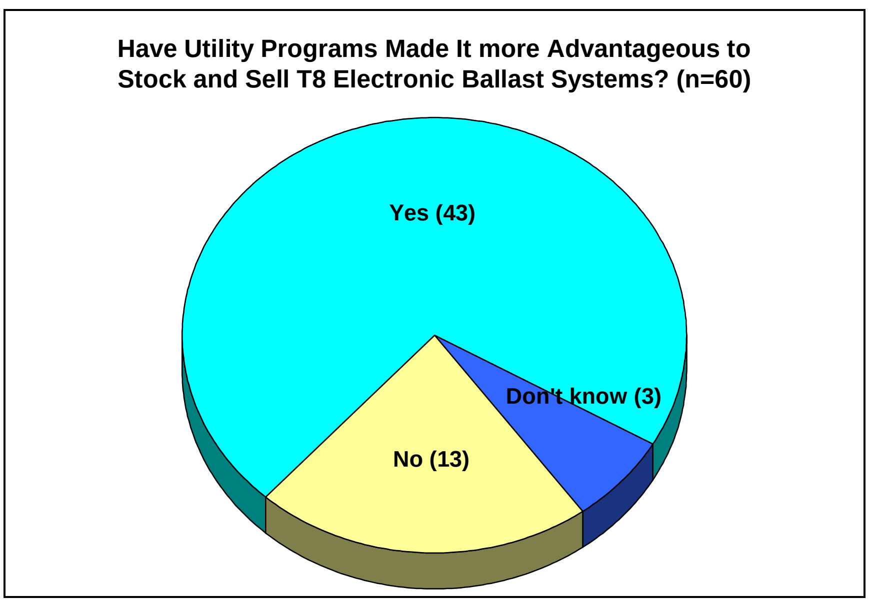
Respondents in the program areas were asked several questions aimed at assessing the effect of termination or changes in sponsors' programs on their business. To begin with, we asked distributors to estimate the percentage of their high-efficiency fluorescent lamp and ballast sales over the past five years that were supported with utility programs. These results are presented in Figure 7-9. For those responding to this question, the average was 32 percent of sales, a fairly large percentage. Perhaps more significantly, only 10 percent of distributors estimated that none of sales of high-efficiency lamps and ballasts were supported by sponsors' programs. This is another indication of the broad reach of the sponsors' programs during the study period. Approximately 70 percent of respondents indicated that utility programs made it more advantageous to stock and sell efficient equipment over the study period, as indicated in Figure 7-10.

Figure 7-9
Percent of Distributors' High-Efficiency Fluorescent Sales Reported to be Supported by Utility Programs (Phone-House, Program Area Only)



Total number of respondents is 42; average response is 32 percent.

Figure 7-10
Effect of Utility Programs on Distributors' Sales of Electronic Ballasts (Phone-House, Program Area Only)



We then asked whether program area distributors believed their sales of efficient equipment would increase, decrease, or stay about the same if utility programs did not continue. The majority stated that they believed sales would stay about the same, while about one-third believed their sales would decrease, and less than one-in-10 predicted an increase (see Table 7-20).

Table 7-20
Distributors' Assessment of the Effect on EE Sales of Termination of Programs (Program Area Only)

	If utility programs were terminated today, would you expect the share of your total fluorescent system sales represented by efficient equipment to increase, decrease, or stay about the same in 1998?		
Distributor Type	**Decrease**	**Increase**	**Stay the Same**
Electric Supply (n=27)	19%	7%	74%
Industrial Supply (n=12)	50%	0%	50%
Lighting Supply (n=7)	43%	14%	43%
Manufacturer Rep (n=3)	33%	33%	33%
Total Phone-House (n=49)	31%	8%	61%
Total In-Depth (n=17)	*38%*	*6%*	*56%*

Breakdowns of the respondents' reasons for their opinions on changes in the share of efficient lighting in the absence of programs are provided in Table 7-21 and Table 7-22. Key reasons for confidence in the market share staying the same or increasing are beliefs that customers are now more educated, incremental prices have decreased, and that other supply-side actors will promote them. Conversely, those who stated a belief that the share would decrease maintain that the rebates are necessary to grab end users' attention.

Table 7-21
Breakdown of Distributors' Stated Reasons for Market Share of EE Lighting to Stay the Same or Increase in the Absence of Programs (Phone-house, Program Area only)

What is the main reason you believe the market share of T-8 electronic ballast systems will increase or stay the same in the absence of utility programs?	
Response	**% of Responses**
Educated customers	39%
Little or no price difference	13%
Other	11%
Manufacturers will promote	11%
Federal standards	8%
Designer and contractor promotion	5%
Don't know	5%
So many in place already	5%
New state building codes	3%
Total	**100% (n=38)**

Table 7-22
Breakdown of Distributors' Stated Reasons for Market Share of EE Lighting to Decrease in the Absence of Programs (Phone-house, Program Area only)

What is the main reason you believe the market share of T-8 electronic ballast systems will decrease in the absence of utility programs?	
Response	**Number of Responses**
Without rebates fewer interested customers	19
Don't know	1
Many customers don't care about savings	1
Without rebates reduced economic benefits	1
Total	**22**

Hypothetical Post-Program Specification and Sales Practices

Distributors were extremely bullish with respect to their projected specification and promotion of T-8 lamps and electronic ballasts in the absence of rebate programs. As shown in the figures below, roughly three-fourths of in-depth respondents indicated they will continue to promote and specify these technologies. The two key reasons for continuing to specify and promote these products are that the distributors themselves now believe the products to be "best" or they believe that customers will continue to want these technologies and they must provide them to remain competitive. In Section 6 of this report, we provide a segmentation developed around these responses and those to similar questions. Note that *differences in profit margins are not cited* as reasons for maintaining or changing specification and promotion practices. This is consistent with our belief, based on previous research conducted on the California Measure Cost Studies, that most downstream actors are technology-neutral with respect to these technologies because they do not apply different sets of mark-ups to efficient versus inefficient equipment.

Finally, we also asked the in-depth interviewees, “In what percentage of cases would you say customers object to specification of T-8s and electronic ballasts?” On average, in-depth respondents stated that this currently occurred in less than 5 percent of cases. Among those respondents who indicated a percentage greater than zero, all but one indicated that they tried to work with those customers to overcome their objections [Note: Based on in-depth interviews only].

Figure 7-11
Distributors' Projected Specification and Promotion Practices in the Absence of Programs [In-depth only]

If lighting rebate programs were to terminate today, do you think you would change your specification or equipment selection practices for 4-foot fluorescent lighting?	If lighting rebate programs were to terminate today, do you think you would change the level of effort you put into promoting and selling efficient fluorescent lighting?

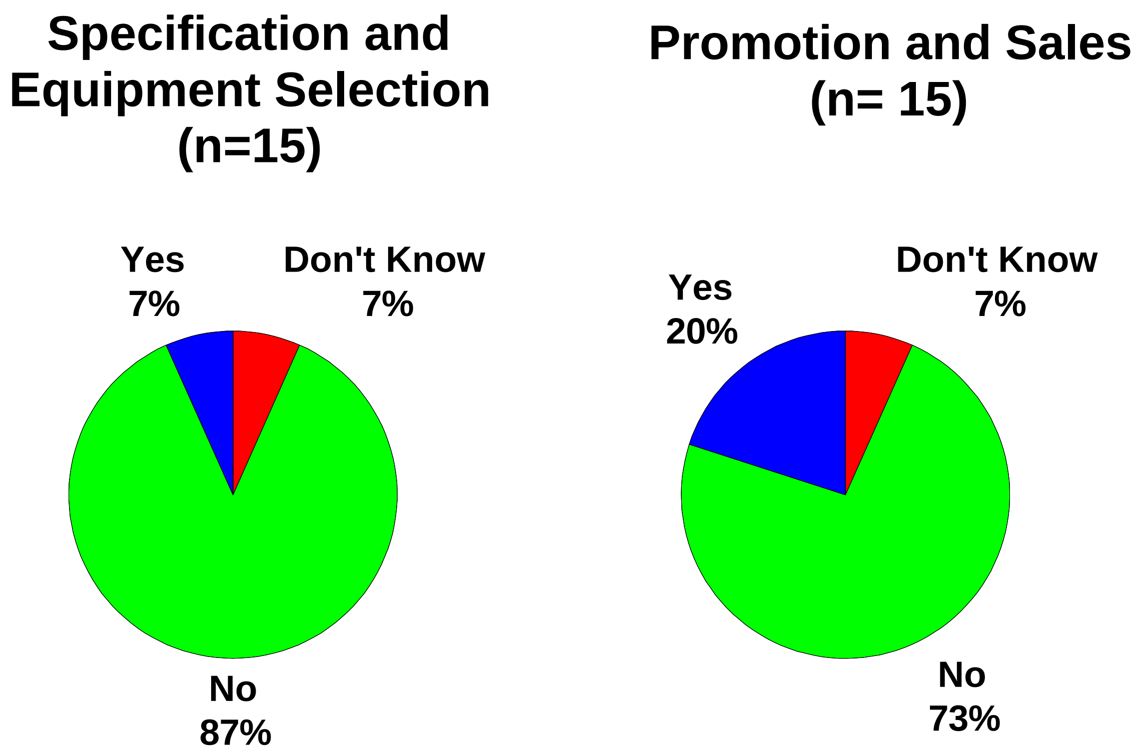


Table 7-23
Distributors' Projected Specification of EE Lighting Equipment in Absence of Programs

If lighting rebate programs were to terminate today, do you think you would change your specification or equipment selection practices for 4-foot fluorescent lighting? If so, why?	
Response	**Verbatim on "Why"**
No	He believes in EE lighting equipment and would recommend it regardless of utility programs. His customers not only want a cheap price but they want to save on energy costs.
No	They were enhanced by the rebates but they are now a proven technology. Customers will buy them regardless of the rebates, customers ask for them.
No	Believe it is the best to use energy-efficient technology, would promote it anyway.
No	This type of equipment is necessary for them to remain competitive. These items sell based on their energy-saving components and money-saving value.
No	Believe in energy-efficient equipment.
No	Important to know what is the best technology.
No	Rebates now are not driving much sales activity - low in 1997.
No	No need to.
No	Believe it is the best stuff.
No	They wouldn't, but customers might (*want less EE specification*).
No	[But will] have to work harder to capture, educate the potential market.
Yes	The rebates do not match with most of the equipment that they sell. They would make more money selling the items they want than carrying the items for the programs.

Table 7-24
Distributors' Projected Sales and Promotion of EE Lighting Equipment in Absence of Programs

If lighting rebate programs were to terminate today, do you think you would change the level of effort you put into promoting and selling efficient fluorescent lighting? If so, why?	
Response	**Verbatim on "Why"**
No	This type of equipment is necessary for them to remain competitive. These items sell based on their energy-saving components and money-saving value.
No	They were enhanced by the rebates but they are now a proven technology. Customers will buy them regardless of the rebates, customers ask for them.
No	Never know when rebate programs will be reinstituted.
No	Need added value to transaction - need to upgrade, still have inventories of efficient equipment.
No	Know what is the best technology.
No	It is a great selling point to offer customers a quality product with energy-savings components while saving them money in the long term.
No	He believes in EE lighting equipment and would recommend it regardless of utility programs. His customers not only want a cheap price but they want to save on energy costs.
No	Believes in energy-efficient equipment.
Yes	Need [broader] strategic effort.
Yes	Focus will change to small retail bulb sales.
Yes	Need to bring customer back into fold - educate and sell. [*Note: This appears to be a reference to influence over customer decision-making, away from the utility back to the vendor*.]

7.6.3 Measure Cost Information

Measure cost information obtained from the distributor surveys is presented in Table 7-25 and Table 7-26. Note that incremental electronic ballast costs seem high, and that the standard deviation for the 1997 incremental ballast cost in the program area is $6.

Table 7-25
Distributors' Average Incremental Price Estimates, 1994 and 1997 (Phone-house only)

	Average Price Increment (in dollars) for:			
Territory	Elec. Ballast 1997	Elec. Ballast 1994	T-8 Lamp 1997	T-8 Lamp 1994
Program	9.5	18.4	1.1	1.7
Nonprogram	11.2	17.5	1.0	1.9
	Percent Change in Incremental Price Estimates			
Program	-48%	--	-35%	--
Nonprogram	-36%	--	-47%	--

Table 7-26
Distributors' Average Incremental Price and Payback Estimates (In-depth only)

	Percent Difference in Price	Average Payback
Ballast	22.4%	2.0
Lamp	23.5%	2.1

7.7 DESIGNER INTERVIEW RESULTS

7.7.1 Key Findings

- For barriers in 1991, cost difference and reliability issues were again most cited.
- Nearly all of the designers felt that the barriers that existed in 1991 had been greatly reduced or eliminated (program and nonprogram territories).
- Approximately 80 percent of designers indicated that the utility programs helped in lowering the barriers to adoption of energy-efficient lighting.
- Title 24 regulations were mentioned by several of the respondents as being major factors in lowering the barriers to adoption.
- Responses for assessment of current obstacles indicate that initial cost is the primary remaining concern for some designers.
- Most (70 percent) of the designers interviewed stated that they would continue to specify efficient equipment regardless of utility rebate program. An even greater proportion of designers indicated that they would not change the level of effort used to promote and sell efficient lighting equipment if utility rebate programs were terminated (88 percent saying they would not change promotional efforts).

⇒ The key reasons cited were twofold: "We believe in these technologies" and "As experts, we consider it our job to include efficient technologies in our practices."

- Reported levels of specification of T-8 lamps and electronic ballasts were very high for 1997 in both program and nonprogram areas (over 80 percent). These levels seem higher than what is supported by other information collected in this study, particularly in the nonprogram areas; but may reflect designers' targeted roles in particular market events (e.g., new construction and remodeling).

7.7.2 Utility Program Activity

Participation in utility rebate programs varied greatly by the type of designer. In Table 7-27, we present the breakdown of participation in programs by designer type for the PG&E and SDG&E program territories. Several observations are warranted:

- Not surprisingly, contractors and ESCOs utilized the utility rebate programs more than other designers (41 percent and 70 percent of the time, respectively).
- Architectural firms participated in the lowest percentage of rebate programs, at 6 percent. It was indicated in conversations with architects that they feel themselves very far removed from the rebate transaction, also indicating that they often knew little about utility program qualifications and whether or not their specifications resulted in rebate applications.
- Program participation stayed the same for most architects and lighting designers over the past two years, while engineers, contractors, design-build firms and distributors all reported a decrease in program activity recently.

Table 7-27
Designers' Program Participation Trends

Design Type	Current Program Participation	Trend in Past Two Years			
		Increase	Decrease	Stayed Same	Don't Know
Architectural firm (n=7)	6%	0%	11%	56%	33%
Engineering firm (n=12)	31%	17%	50%	25%	8%
Distributor (n=4)	20%	0%	100%	0%	0%
Lighting designer (n=17)	22%	0%	31%	69%	0%
ESCO (n=4)	70%	-	-	-	-
Contractor (n=7)	41%	17%	83%	0%	0%
Total (n=51)	31%	6%	63%	25%	7%

7.7.3 Market Barriers and Effects

Four principal approaches were employed to investigate market barriers and potential market effects in the designer interviews. These approaches include:

- Direct querying with respect to changes in perceived barriers.
- Requests for current and past T-8 and electronic ballast specification percentages.
- Inquiries with respect to *expected* specification and sales practices in the absence of programs.

Each of these modes of inquiry are discussed in the subsections that follow.

Reported Changes to Barriers

Designers were questioned directly about their perceptions of the market barriers to using and specifying efficient lighting equipment (T-8s, electronic ballasts, and 2-lamp fixtures). Designers indicated what they felt to be the major obstacles or barriers to using or specifying efficient lighting equipment back in 1991 (see Table 7-28) and what they feel are currently obstacles to using such equipment (Table 7-29):

- Nearly all of the designers felt that the barriers that existed in 1991 had been greatly reduced or eliminated (program and nonprogram areas).
- For barriers in 1991, cost difference and reliability issues were by far the most cited. A couple of designers indicated that they felt T-12s and magnetic ballasts were superior for their durability and lower harmonic distortion, as well as value for the money.
- Title 24 regulations were mentioned by several of the respondents as being major factors in lowering the barriers to adoption.
- Responses for assessment of current obstacles indicate that initial cost is the primary remaining concern for some designers.
- With respect to the “other” concerns about technology cited by nonprogram designers, most of these refer to contractors’ and end users’ “fear” of new technologies. This was apparently a kind of catch-all term to some designers that embodied lack of awareness and knowledge as well as organizational practices.

Table 7-28*
Designer Reported Barriers in 1991 to Using or Specifying T-8s and Electronic Ballasts

	Program Territory		Nonprogram Territory	
Obstacle/Barrier	**Most Important**	**Next Most Important**	**Most Important**	**Next Most Important**
Customer - Price too high	39%	35%	33%	33%
Customer - Concerns about reliability	9%	10%	10%	0%
Customer - Light amount, quality	7%	3%	0%	0%
Contractor - Value for money	0%	3%	10%	0%
Contractor - Reliability	31%	10%	10%	22%
Contractor - Light amount, quality	2%	6%	0%	0%
Contractor - Availability	2%	13%	14%	22%
Concerns about technology★	0%	13%	19%	11%
Customer education★	0%	0%	0%	11%
Not industry standard★	2%	3%	0%	0%
Lowered rates reduced incentives★	0%	0%	5%	0%
No obstacle	6%	3%	0%	0%
Total	**100%**	**100%**	**100%**	**100%**
Sample	**51**	**30**	**22**	**11**

* Note that responses with a ★ correspond to “Other” responses

Table 7-29*
Designer Reported Current Barriers to Using or Specifying T-8s and Electronic Ballasts

	Program Area		Nonprogram Area	
Obstacle/Barrier	**Most Important**	**Next Most Important**	**Most Important**	**Next Most Important**
Customer - Price too high	29%	17%	19%	0%
Customer - Concerns about reliability	5%	0%	6%	0%
Customer - Light amount, quality	2%	8%	0%	50%
Contractor - Value for money	0%	8%	0%	0%
Contractor - Reliability	2%	8%	0%	0%
Contractor - Light amount, quality	2%	0%	0%	0%
Contractor - Availability	2%	8%	0%	0%
Lack of education★	2%	17%	0%	0%
Bad publicity in industry for equipment★	5%	0%	0%	0%
Lack of rebates★	2%	0%	6%	0%
Lack of flexibility★	2%	0%	0%	0%
Lack of urgency to switch★	2%	0%	6%	0%
Dispersal costs★	0%	0%	6%	0%
Utility involvement★	0%	8%	0%	0%
Lack of particular phosphors★	0%	0%	6%	0%
ASHRAE approval★	0%	0%	6%	0%
Whether to use T5s★	0%	0%	13%	0%
Temperature sensitivity★	0%	0%	0%	50%
No obstacle★	39%	25%	31%	0%
Total	**100%**	**100%**	**100%**	**100%**
Sample	**42**	**14**	**21**	**2**

* Note that responses with a ★ correspond to “Other” responses

Approximately 80 percent of designers who responded to the question concerning utility energy-efficiency rebate programs’ contribution to reducing barriers indicated that the utility programs helped in lowering the barriers to adoption of energy-efficient lighting. The remaining 20 percent stated that the programs did not help or were only a slight factor in the market.

Current and Past Specification Practices

Designers also were asked about their current and past specification practices for efficient lighting equipment. Table 7-30 below shows the percentages of T-8s and electronic ballasts specified by type of design firm between 1992 and 1997 for program and nonprogram territories. It should be understood that the equipment specified is not necessarily the equipment installed. These statistics represent the specification only, not the percentages of efficient equipment installed. Below are a number of observations on the responses:

- The reported level of specification of T-8 lamps and electronic ballasts are higher than what is supported by other information collected in this study, particularly in the nonprogram areas.
- Current reported specification levels were virtually the same in the program and nonprogram areas. At a minimum, the high current levels of reported specification of efficient lighting equipment in the nonprogram areas may indicate that a rapid diffusion process with respect to acceptance of these technologies has occurred in the nonprogram areas.
- Nonprogram design firms showed a considerably higher increase in efficient equipment specification between 1992 and 1997 than did program firms (65.1 percent vs. 39 percent).

Table 7-30
Specification of T-8 Lamps and Electronic Ballasts

Design Type	Year	Program Territory Specification %age	% Change - Program	Nonprogram Territory Specification %age	% Change - Nonprogram
Architectural firm	1997	68.2%	26.0%	87.5%	77.5%
	1992	42.2%		10.0%	
Engineering firm	1997	87.2%	47.3%	96.3%	84.4%
	1992	39.9%		11.9%	
Distributor	1997	70.0%	22.5%	*78.3%*	59.1%
	1992	47.5%		*19.2%*	
Lighting designer	1997	86.9%	38.3%	88.8%	49.4%
	1992	48.6%		39.4%	
ESCO	1997	95.0%	47.5%	100.0%	90.0%
	1992	47.5%		10.0%	
Contractor	1997	84.4%	50.4%	77.2%	66.2%
	1992	34.0%		11.0%	
Total Average	**1997**	**82.2% (n=57)**	**39.0%**	**86.2% (n=24)**	**65.1%**
Total Average	**1992**	**43.2% (n=55)**		**21.1% (n=22)**	

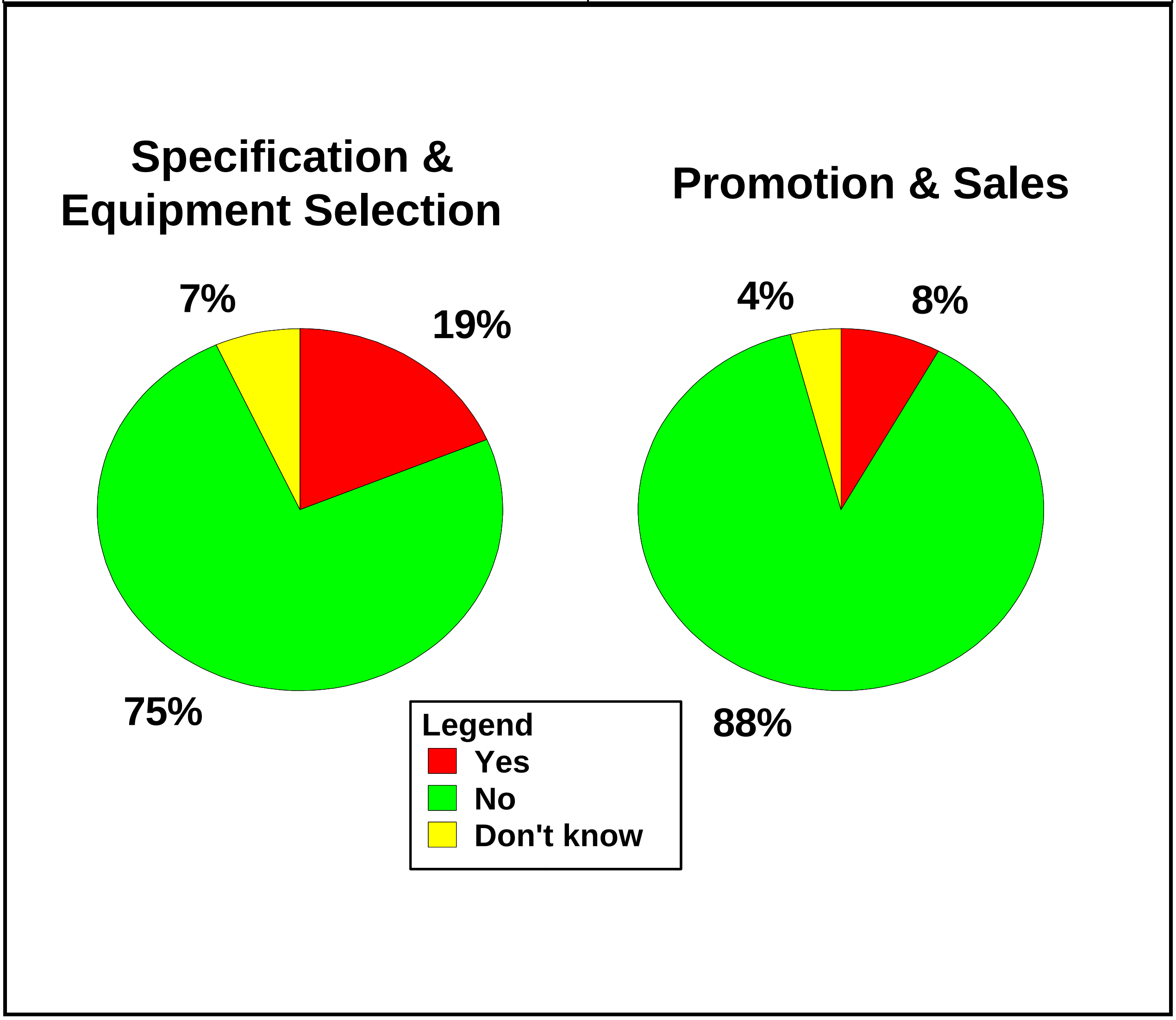
* Note that nonprogram ESCO figures are based on one sample point

Hypothetical Post-Program Specification and Sales Practices

Another means by which we sought to investigate whether or not market changes have occurred among designers was by asking them to state what their specification, sales, and promotion strategies would be in the absence of the programs. Most (70 percent) of the designers interviewed stated that they would continue to specify efficient equipment regardless of utility rebate program activity, while only roughly 20 percent indicated that their specification practices with respect to efficient equipment would change (see Figure 7-12). An even greater proportion of designers indicated that they would not change the level of effort used to promote and sell efficient lighting equipment if utility rebate programs were terminated (8 percent saying they would change promotion and selling effort, 88 percent saying they would not).

Figure 7-12
Percentage of Designers Who Report They Would Continue Specifying and Promoting T-8 Lamps and Electronic Ballasts in the Absence of Utility Rebate Programs

If lighting rebate programs were to terminate today, do you think you would change your specification or equipment selection practices for 4-foot fluorescent lighting?	If lighting rebate programs were to terminate today, do you think you would change the level of effort you put into promoting and selling efficient fluorescent lighting?



The key reasons stated for maintaining current specification and promotion practices with respect to efficient equipment included: “it is the best technology available,” “no need to change, our projects don't really consider rebates, they are only a bonus,” “T-8s make sense, better efficiency, better product,” and “the technologies are standard today, don't need utility's backing.”

The most common reasons given by designers for saying they would change their equipment selection decisions included: “we would go back to doing electrical contracting without rebates,” "insufficient economic incentive," "probably go for cost rather than other factors," and "fixtures w/o rebate would cost owner more."

Note that the majority of respondents' answers as to why they would or would not change the effort to promote and sell efficient lighting equipment was the same as their answers for the previous question concerning whether or not they would change equipment selection decisions if utility rebate programs were terminated.

As mentioned under the Distributor subsection, in Section 6 of this report, we provide a segmentation developed around responses to our specification, promotion, and competitive position (reported in Section 3) questions. Once again, note that *differences in profit margins are not cited* as reasons for maintaining or changing specification and promotion practices.

7.7.4 Program Improvement Opinions

Designers expressed a wide array of opinions about improvements that could be made to utility rebate programs to increase the use of efficient lighting technology. The most common responses included simplification of the programs and applications, and education of both the public and designers on lighting technology and rebate program activity. A representative sample of the different suggestions made for improving efficiency programs is shown in Table 7-31.

Table 7-31
In-Depth Designer Verbatims vis-à-vis Potential Program Improvements to Promote the Specification and Use of Efficient Lighting Equipment

Category	How do you think utility energy-efficiency programs could be improved to more effectively promote the use and specification of energy-efficient lighting equipment?
Advertising/Education	Increase rebates, TV advertisement aimed at those responsible for the bill.
	Educate the public.
	Increase knowledge of efficient technology in contractors and developers.
	Focus on mom and pop type facilities - direct advertising towards these groups.
	Improve communication & information dissemination.
	More advertising on the programs offered by the utilities; she has no idea what they are offering. They should offer credits for all types of fixtures. There should be programs geared.
Program Logistics	Talk to those out there selling product, be more available for help with program related work.
	Focus on visual environment, negotiate energy budget with large customers before construction.
	Be more conscious of contractor side of business, quicker on responses, quicker for rebate payment to customer, train employees to better understand lighting business and relate better to customers.
	Simplify the forms, they are a hassle and often not worth the time or effort.
	Get information out to those who design - they "don't get in information on rebates" - need to know more.
	The utilities should offer incentives for total energy saved on a project instead of rebates for certain types of energy-efficient equipment. Utilities should have an overall approach to savings for a project and not just specific attributes.
	More knowledgeable utility reps.
	Need to get all utilities to standardize.
Other	Increase the efficiency of the utility, eliminate subsidies for them.
	Interest free loans to do upgrades, subsidize upgrades (like ZIP program for insulation).
	Do something for designers, and stop focusing on ESCOs - promote design practices.
	More rebates, cover more technologies under rebates, start program up again.

7.7.5 Influence of Title 24 Lighting Compliance

Designers were also questioned regarding Title 24 compliance and its influence on lighting specification. Table 7-32 shows the breakdown of calculation methods used by designers for Title 24 compliance. The most common method used to calculate Title 24 compliance was the Area Category Method, the method of choice for engineering firms, distributors, and lighting designers (42 percent of all methods). The method least often employed was the Performance Approach (8 percent of all methods).

Table 7-32
Title 24 Lighting Compliance Methods

	Complete Building Method	Area Category Method	Tailored Method	Performance Approach
Architectural firm (n=8)	38%	25%	25%	13%
Engineering firm (n=15)	33%	53%	7%	7%
Distributor (n=4)	0%	50%	25%	25%
Lighting designer (n=16)	25%	44%	25%	6%
ESCO (n=1)	0%	0%	100%	0%
Contractor (n=3)	67%	33%	0%	0%
Total	**29%**	**42%**	**19%**	**8%**

Designers were also questioned regarding the necessity of using T-8s and electronic ballasts to meet current and revised Title 24 lighting power allowances (see Table 7-33). There was a significant difference in the percentage of designers saying that T-8s and EBs are necessary to pass Title 24 code currently (18 percent) versus whether they would be needed for the revised Title 24 allowances (38 percent). This leads to the conclusion that designers are only moderately aware of the likely effect of the proposed standards (which are likely to virtually require T-8s and electronic ballasts, see Government and Code Chapter). Nearly half of the designers were unsure about lighting equipment selection decisions under the revised code.

Table 7-33
Necessity of Using T-8s and Electronic Ballasts to Meet Current and Revised Title 24 Power Allowances

	Arch. firm	Engineering firm	Distributor	Lighting designer	ESCO	Contractor	Total
Current (count)	(n=10)	(n=11)	(n=3)	(n=16)	(n=1)	(n=5)	(n=47)
In all cases	30%	27%	33%	19%	0%	0%	18%
In some cases	50%	73%	67%	63%	0%	40%	49%
Not at all	0%	0%	0%	13%	100%	60%	29%
Don't know	20%	0%	0%	6%	0%	0%	4%
Revised (count)	(n=9)	(n=10)	(n=3)	(n=15)	(n=1)	(n=5)	(n=44)
In all cases	33%	80%	33%	40%	0%	40%	38%
In some cases	11%	10%	33%	20%	0%	0%	12%
Not at all	0%	10%	0%	7%	0%	0%	3%
Don't know	56%	0%	33%	33%	100%	60%	47%

Designers frequently mentioned the practice of achieving below-allowance power levels in nonlighting areas of the building, such as HVAC systems, to allow greater-than-allowance lighting levels. This was a more common practice in the retail segment where higher lighting levels are preferred by owners. It should also be noted that three designers stated that they felt Title 24 codes had more to do with reducing the barriers to efficient lighting technology than did utility rebate programs.

With respect to lighting specifications versus code (see Table 7-34 below), 76 percent of reported projects were said to fall below Title 24 allowances, while only 18 percent were reported to beat standards by 20 percent or more.

Table 7-34
Percent of Lighting Designs that Fall Below Title 24 Lighting Power Standards and 20% Below Lighting Power Standards

	Projects Below Title 24 (count)	Projects 20% or More Below Title 24 (count)
Architectural firm	71% (n=10)	16% (n=8)
Engineering firm	92% (n=12)	18% (n=12)
Distributor	53% (n=4)	6% (n=4)
Lighting designer	73% (n=16)	24% (n=14)
ESCO	0% (n=1)	0% (n=1)
Contractor	88% (n=6)	17% (n=6)
Total	**76% (n=49)**	**18% (n=45)**

7.8 INSTALLER INTERVIEW RESULTS

7.8.1 Key Findings

- Once again, high first cost and reliability were the most cited barriers to adoption of efficient fluorescent lighting equipment in 1991.
- Again, consistent with the other supply-side market actors' responses, the majority of respondents indicated that these initial barriers had been significantly reduced or eliminated.
- Approximately 85 percent of installers reported having at least one project supported by sponsors' programs. This indicates widespread awareness and exposure to the programs. Those few indicating that none of their projects were supported were either not the appropriate entity for handling rebates, or were at firms with policies eschewing rebates to avoid becoming dependent on this intervention.
- Over 70 percent of installers state that they would continue specifying and promoting T-8 lamps and electronic ballasts in the absence of programs. Most of the reasons cited center on the perception that these technologies are now accepted and desired by customers.

7.8.2 Market Barriers and Effects

According to the contractors we interviewed, the most important reason preventing adoption of efficient lighting equipment in 1992 was the higher initial price. Of 19 responses to our market barrier question, seven stated that the price was too high for the customer. The second most frequent response category, with five individuals stating that it was the most important, was reliability of the technology both from a customer and an installer perspective. Two others provided related responses by claiming that a "fear of new technology" was the primary barrier.

Table 7-35
Installer Reported Barriers in 1991 to Using or Specifying T-8s and Electronic Ballasts

Thinking back to 1991, what was the main obstacle to using or specifying T-8 lamps, electronic ballasts, and 2-lamp fixtures?		
Response	**Program**	**Nonprogram**
High Price	9	2
Reliability	5	2
Light Quality	3	0
Availability	1	1
Fear of new technology	2	1

Almost all of those installers interviewed asserted that the barriers they identified as inhibiting the market in 1992 have either been eliminated or substantially reduced. The respondents as a group stated that reliability and pricing, the two primary barriers, are much better for T-8 electronic ballast systems today. Out of 15 responses, only two indicated that barriers remained and one of those stated that the primary barrier in his estimation, price, has only a “little” impact.

Installers’ estimates of their penetration rates of high efficiency lighting equipment over the study period are presented in the table below. Because of small sample sizes, however, and the potential high representation of ESCOs and Lighting Management companies in the sample, we do not consider these figures accurate estimates of market averages.

Table 7-36
Installer Reported Penetration Rates of Efficient Lighting Equipment

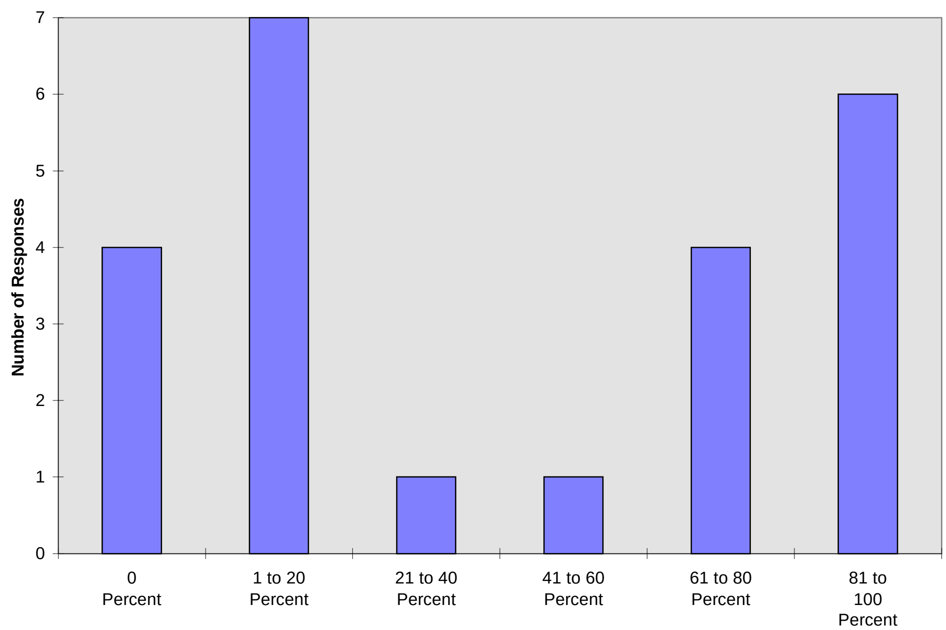
	1996		1994		1992	
Technology	Program *	Non-program**	Program	Non-program	Program	Non-program
T-8 Lamps	74	61	51	43	15	17
Electronic Ballasts	75	58	54	47	18	14
2-Lamp Fixtures	33	35	30	17	28	20

*Program sample size ranges from 22 (for 1996) to 17 (for 1992).

**Nonprogram sample sizes range from 8 (for 1996) to 1 (for 1992 fixtures).

The degree to which installers' projects were supported by sponsors' programs over the past five years is presented in Figure 7-13. As indicated in the figure, approximately only 15 percent of installers reported having no projects supported by sponsors' programs during the study period.

Figure 7-13
Percentage of Installers' High-Efficiency Fluorescent Projects Supported by Sponsors' Programs



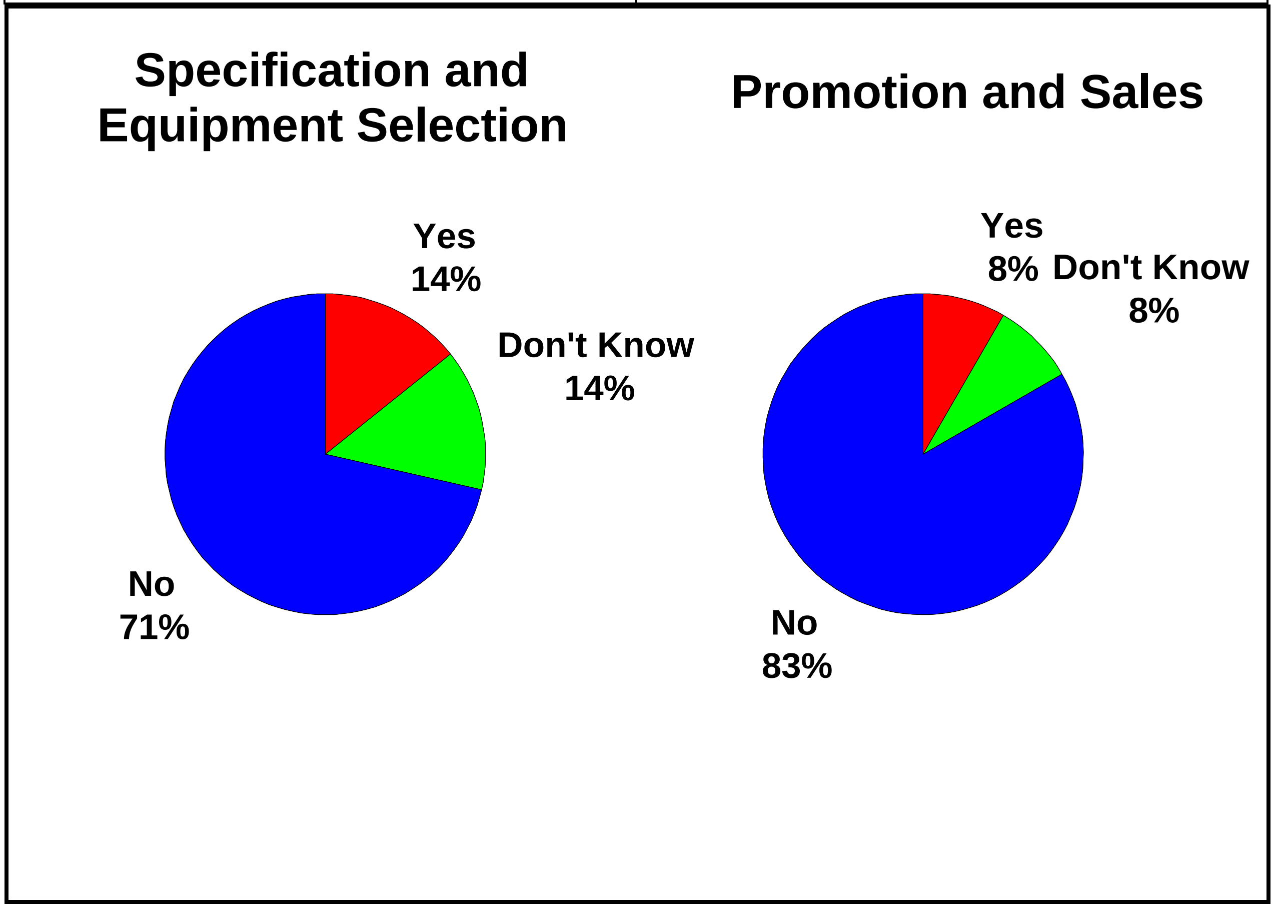
It also appears that the level of installer involvement in utility programs is bimodal. As displayed in Figure 7-13, most installers interviewed were either heavily dependent upon utility programs for their sales (60 to 100 percent) or not at all dependent upon the programs (0-20 percent). For those who were not dependent upon programs there was, in most cases, either one of two explanations provided. First, the installer was not involved in the specification, so there was no involvement in the program. Or second, in minimizing business risk, the installer did not want to depend upon utility programs for revenue. For those who were heavily involved in the programs over the past five years, the companies asserted that the rebates were important to obtaining projects. In response to the decline of the utility programs, many of the companies saw a decline in the number of retrofit projects and were compelled to enter other markets, typically lighting maintenance. According to a few respondents, some installers are suffering financially because of the reduced number of retrofit projects - companies have gone under and there is anticipation that some existing companies may do the same.

Hypothetical Post-Program Specification and Sales Practices

Once again, an overwhelming majority of the vendors stated that they intend to continue specifying and promoting T-8 lamps and electronic ballasts in the absence of continued rebate programs. Reasons were similar to those provided by other vendors as well falling into the following groups: "We believe in these products," "Customers are demanding these products," and "We do not use the rebate programs currently." Again, as mentioned under the Distributor subsection, in Section 6 of this report, we provide a segmentation developed around responses to our specification, promotion, and competitive position (reported in Section 3) questions. Once again, note that *differences in profit margins are not cited* as reasons for maintaining or changing specification and promotion practices.

Figure 7-14
Percentage of Installers Who Report They Would Continue Specifying and Promoting T-8 Lamps and Electronic Ballasts in the Absence of Utility Rebate Programs

If lighting rebate programs were to terminate today, do you think you would change your specification or equipment selection practices for 4-foot fluorescent lighting?	If lighting rebate programs were to terminate today, do you think you would change the level of effort you put into promoting and selling efficient fluorescent lighting?



Individual explanations of the above responses are provided in the tables below.

Table 7-37
Installers' Reasons for Projected Specification Practices in the Absence of Programs

Response	Verbatim
Yes	Need the programs to meet the customers' parameters and they are always looking for a payback.
Yes	Sales of energy-efficient equipment might drop a little - customers drive the process.
Yes	Without rebates to offset the added cost, less energy-efficient equipment will be specified.
Yes	The owner won't get a rebate, so its less of an incentive to buy energy-efficient.
No	Rebate programs are not part of our programs.
No	We do not use efficient technologies that often.
No	For retrofit projects rebates don't matter, the perceived value is there.
No	We believe in energy-efficient products and that customers want them. In order to retain and obtain customers we need to offer them products of high quality, energy savings, and low price.
No	Energy savings will always be an important component of the customers needs and specifications.
No	The customers want these products. To remain competitive we need to use these products and we need to bid on projects at a savings to the customer both in energy and their wallet.
Don't know	Market share will decrease for less sophisticated companies.

Table 7-38
Installers' Reasons for Projected Sales and Promotions Practices in the Absence of Programs

Response	Verbatim
Yes	We wouldn't focus on it as much, they'd be harder sales.
No	Energy efficiency is important for the customer.
No	T-8 technology is known and it is what the customers want, it won't change. We always specify low-power ballasts.
No	They just don't make a difference.
No	We believe in energy-efficient products and that customers want them. In order to retain and obtain customers we need to offer them products of high quality, energy savings, and low price.
No	We believe in the products and the savings in energy and money that they bring to their customers.
No	The energy and money savings are very important to their customers.
No	We'll still promote energy efficiency - we're a retrofit business.
Don't know	Owners see the savings in the long run, they are generally savvy enough to use common sense in choosing lighting equipment.

7.8.3 Installers Incremental Price Estimates

For those installers interviewed in the program area, the average percentage price difference between electronic ballasts and magnetic ballasts was 18 percent. For those interviewed in the nonprogram area, the average price difference was 14 percent. These percentage differences are somewhat below those estimated by distributors (which was 22 percent in the program area, see Table 7-26). For those installers interviewed in the program area, the average percentage price difference between T-8 lamps and T12 energy saver lamps was 28 percent. For those interviewed in the nonprogram area, the average price difference was 20 percent. Note that all of these installer-reported figures are slightly below the estimated incremental price differences presented from the California Measure Cost Studies in Table 7-1.

8 PROGRAM SUGGESTIONS

In this section we provide suggestions for sponsors and policy makers to consider regarding lighting program efforts in the commercial market. Whether continued intervention in the commercial lighting market is warranted is not addressed here. We leave that decision to the sponsors and relevant government agencies.[1] This section concludes with a summary of recommendations provided directly by the supply-side actors that we interviewed.

8.1 IMPLICATIONS FROM FINDINGS

Our suggestions are based on the findings of this study regarding the effects of the sponsors' programs on the commercial lighting markets and on the structure and general conditions of those markets. The key findings are as follows.

- The use of efficient fluorescent components as standard practice varies greatly across market segments on both the demand and supply sides.
- Even in segments of relatively high market penetration, there are opportunities to gain market share with smaller customers, and by influencing replacement purchases.
- Ample technical opportunities exist (beyond specifying efficient components) to reduce commercial lighting energy. We did not probe customer awareness of these strategies, but it is likely to be low, given that only 29 percent of all establishments reported purchasing electronic ballasts in the five years prior to the survey.
- A high concentration of ballast and lamp production by just a few firms leaves open the possibility of price increases, especially if manufacturers perceive that customers value the superior performance and cost-effectiveness of efficient equipment. The same pattern was observed in the Adjustable Speed Drives market, where stiff price competition led to consolidation of production and ultimately price hikes in the face of increased volume. Price hikes would threaten the durability of market changes.

In light of these key findings, changes or additions to utility programs that support efficient fluorescent lighting should target one or more of the following objectives:

- Expand the number and variety of establishments that adopt electronic ballasts and T-8 lamps.

[1] Determination of whether to continue intervention in commercial lighting markets requires a great deal of information and analysis beyond the scope of this study.

- Identify and exploit remaining “unconverted” spaces in market segments that have been receptive to efficient fluorescent lighting equipment.
- Support the development and promotion of design practices and control strategies that further reduce fluorescent lighting use and Lighting Power Densities.
- Strengthen the commitment among customers and suppliers to the use of efficient products in the face of reduced financial incentives from utilities and possible price hikes from manufacturers.

Below we present program design suggestions, grouped according to their primary objectives.

8.1.1 Initiatives to Broaden the Market for Efficient Fluorescent Components

Target interventions on those market segments that have not been significantly impacted, as of yet, by changes in the marketplace (e.g., Office Lease, Retail/Sole, and Other). Information could be developed on a customized basis using a variety of research methods to determine the most effective messages and message presentation approaches for each segment. It may be effective, for example, to present information to these customers that shows how far they lag behind their competitiors in responding to changes in the commercial lighting marketplace.

Target interventions toward smaller customers that have not been, as of yet, significantly impacted. As reported in Section 2, Sponsors’ programs were extremely successful in penetrating large percentages of the floorspace in their service territories (77 percent and 64 percent of SDG&E and PG&E’s floorspace, respectively, are reported to have participated in Sponsors’ programs). But when viewed against the number of establishments, the participation levels are modest (13 percent and 21 percent for SDG&E and PG&E, respectively). Obviously it is more cost-effective to market to larger customers. This fact notwithstanding, lack of success with smaller customers warrants increased attention from both market transformation and equity perspectives. Again, focused analysis and research on how to *cost-effectively* reach and motivate smaller customers will be required to tap into this group’s potential. The general lack of interest in efficient lighting among smaller retailers and office occupants may suggest the use of direct install approaches.

Include distributors in supply-side outreach, education, and information activities. As discussed in Section 3, distributors play more of a role in the marketplace than simply selling wholesale products. In fact, slightly *more* of their product sales go to end users than to installers. In these cases, the distributor is the only supply-side vendor interacting with the end user and therefore has opportunities to affect purchasing decisions. Distributors will generally take a reactive approach (i.e., they want to anticipate market demands and to have in-demand products in stock). They will focus less on proactively stimulating demand for particular products, although market conditions may force changes in this arena. The success of sponsors’ programs in changing the stocking, promotion, and specification practices of distributors (documented in Section 7) should be reinforced and built upon.

Investigate and promote, as appropriate, the trend toward lighting maintenance contracts, particularly vis-à-vis the low penetration segments. As discussed in Section 3, lighting maintenance firms are emerging that focus on replacement, maintenance, cleaning, and repair of end users' lighting equipment. Some of these firms have evolved from firms whose business was initially focused on efficient lighting retrofitting. This trend seems partly a response to decreases in utility rebates programs. These companies are currently targeting retail chains and property management firms and continue to include efficient lighting products in their core offerings. Assisting these firms in developing contracts (that include efficient fluorescent replacement requirements) *with smaller and sole-proprietor customers* is another means by which further transformation may be possible. Validating and co-promoting the benefits of these services to end users may be one approach.

8.1.2 Initiatives to Capture Remaining Savings in Receptive Market Segments

For end-user sectors in which the penetration of efficient components is already high, focus programs on the provision of technical information and design assistance. The market for efficient fluorescent lighting components purchased by institutional customers and office building owner-occupants is fairly saturated. Any further program efforts oriented to these segments should focus on converting the remaining facilities through targeted education and design assistance programs. This may be a worthwhile area in which to cooperate with the U.S. EPA's *Energy Star Buildings Program.* This program is explicitly designed to promote good lighting design and selection practices.

Sharpen the focus of market intervention activities in the replacement market. The replacement market accounts for 41 percent and 55 percent of ballast and lamp purchases, respectively, in sponsors' service territories, yet had the lowest penetration level (31 percent) of electronic ballasts of the five market events, compared with levels in New Construction/ Remodeling (38 percent), Renovation (54 percent), and Retrofit (48 percent). This is not surprising, given that replacement decisions tend to be more reactive than proactive. When an the product burns out, end users and suppliers tend to utilize the most readily available and cheapest item. In addition, the decision criteria and decision-makers may change when items are being replaced, as opposed to upgrades or reviews that may involve greater dollar amounts and design considerations (i.e., on-site maintenance personnel may handle equipment burnout replacements, whereas a larger lighting decision may involve a facilities manager, financial officer, lighting designer, engineer, ESCO, etc.). Information might be developed for managers that acknowledges their success in using high-efficiency lighting during major space changes, but that also reminds them of the cost increases incurred without strict replacement policies.

8.1.3 Initiatives to Increase the Use of Efficient Fluorescent Lighting Designs

Programs oriented to the new construction and renovation markets should focus on the promotion of efficient lighting layouts, use of advanced controls, and innovative lighting

components. Within most end-user segments, the use of electronic ballasts and T-8 lamps in new construction and renovation is standard. Programs that address lighting efficiency in these markets should focus on promoting efficient layouts of typical components as well as field applications of newer technical approaches. These include indirect lighting, T-5 equipment, advanced controls, and daylighting.

Continue working with designers to expand the role of efficient design practices. Designers have now widely converted to efficient fluorescent components. Their business is focused, however, on optimal design that meets clients' needs along various criteria, not only that of energy efficiency. Designers view lighting as a holistic process. Efforts by PG&E to promote efficient lighting design are likely to resonate with this segment at this stage of the market's development, more than would a continued focus on efficient lamps and ballasts. In addition, designers are likely to appreciate and utilize new tools that improve their services cost-effectively, such as the PG&E Energy Center's heliodon (TecMRKT Works, 1997).

8.1.4 Initiatives to Strengthen Commitment of Current Users to Efficient Technologies

Take steps to increase the number of firms with policies to purchase efficient fluorescent equipment. Despite relatively high penetration levels overall for efficient ballasts and lamps, the percentage of firms that have formal policies to purchase efficient fluorescent equipment is low, both in number of establishments and in percentage of floorspace. Across the sponsors' territories, only roughly 6 percent and 34 percent of establishments and floorspace, respectively, have such policies. On an establishment and segment basis, some of the figures were woefully low (e.g., *only 1%* of Retail/Sole and Other businesses have policies to purchase efficient fluorescent equipment). Economic lighting savings in these segments are unlikely to be achieved without an increase in the use of investment criteria by these customers. Working to promote and establish such policies with customers could have an enormous impact on the low penetration segments.

Monitor and analyze the activities of retail Energy Service Providers (ESPs) in the direct access market. The direct access market for electric commodity is in its infancy in California. A great deal of research is currently being conducted on these emerging markets. However, much of this research is proprietary and sponsored by unregulated entities.[2] Energy-efficiency policy makers in California need to understand the role of energy-efficiency services in this new marketplace. Many conflicting opinions have been offered regarding whether these markets will drive toward commodity-cost minimization only, or whether suppliers will be successful in packaging value-added services focused on total cost reductions on both sides of the meter. We

[2] For example, XENERGY recently completed the third phase of a three-year Retail Wheeling Multiclient Study. This study has over 40 sponsors, many of which are unregulated utility affiliates. Under this study we have conducted approximately 5,000 end-user surveys in pilot and emerging markets throughout the country, including California. These studies include investigations of the role of value-added services, including energy efficiency and renewables, in the stated and revealed decision calculus of customers.

note that many ESPs have not been actively engaged in the efficiency policy changes occurring in California over the past year. Opinions from these firms should be solicited and their prospective role in creating sustainable efficiency markets further investigated over the next three years.

8.2 SUGGESTIONS FROM SUPPLY-SIDE VENDORS'

We end by presenting recommendations provided by supply-side vendors themselves. At the end of our in-depth interviews with them, we asked: "*How do you think utility energy efficiency programs could be improved to more effectively promote the use and specification of efficient lighting equipment*?" Tables 8-1 to 8-3 provide selected verbatim recommendations from distributors, designers, and installers, respectively. There are several interesting trends to note from these open-ended responses:

- Increasing advertising and information dissemination was widely recommended across market actors. There are several dimensions of increased information that vendors highlighted, including:
  - ⇒ Increased advertising to end users, including mass media, will help to increase awareness and confidence in the benefits of efficient lighting because of the *credibility effect* of utility endorsement of efficient products and practices.
  - ⇒ Information campaigns should focus on *segments* of the market that have had lower penetration levels of efficient fluorescent lighting technologies (e.g., small, non-chain retail).
- Distributors and installers called for continued incentives, as well as a shift toward providing rebates to themselves rather than directly to end users. This recommendation was made despite the fact that the majority of these vendors believe the rebates are no longer the key driver to sales of electronic ballast and T8 lamps.
- Designers focused more on the need for improved understanding of their side of the business and more attention to integrated lighting design solutions rather than on lighting equipment components.

Table 8-1
In-Depth Distributor Verbatim Comments vis-à-vis Potential Program Improvements to Promote The Specification and Use of Efficient Lighting Equipment

Category	How do you think utility energy-efficiency programs could be improved to more effectively promote the use and specification of efficient lighting equipment?
Expand Advertising/Information	Increase awareness, more public commercials.
	More advertising—increase awareness; communicate that current installations are outdated.
	More product exposure toward consumer, contractor, and designer.
Rebates & Expand Advertising/Information	Continue rebate programs; improve dissemination of marketing materials.
	Continue with rebates; utilities make unfeasible recommendations, work more with distributor (joint sales calls).
	Incentives should go to distributors, go to who has the product on the shelves—distributors have huge customer base so no need to chase customers.
	Increase rebate, not always enough of a rebate to push a customer over the edge—3-yr. payback is too long, make programs more reliable.
	Increase the rebates, education to end users, mailings, coupons.
	Keep rebate programs, provide education brochures that are easy to understand.
	Offer more rebates for a wider variety of items. The utilities should conduct more advertising. Distributors always carry the banner for the programs.
	PG&E should ramp up marketing, as in 1995-96.
	Rebates should be extended beyond the end-user and include contractors (it will get them motivated). There is so much work now that you don't really need to market or to offer rebates to push the products.
	Utilities should subsidize the vendors directly to eliminate the red tape. Conduct more advertising.
Other	Don't allow non-local contractors/reps to take advantage of utility programs.
	Utilities should get out of the lighting business and stay with the energy business. Utilities don't know enough about lighting to understand what the necessary actions and problems are related to the industry.

Table 8-2
In-Depth Designer Verbatims vis-à-vis Potential Program Improvements to Promote The Specification and Use of Efficient Lighting Equipment

Category	How do you think utility energy-efficiency programs could be improved to more effectively promote the use and specification of efficient lighting equipment?
Advertising/Education	Increase rebates, TV advertisement aimed at those responsible for the bill.
	Educate the public.
	Increase knowledge of efficient technology in contractors and developers.
	Focus on mom and pop-type facilities—direct advertising towards these groups.
	Improve communication & information dissemination.
	More advertising on the programs offered by the utilities. I have no idea what they are offering. They should offer credits for all types of fixtures.
Program Logistics	Talk to those out there selling product, be more available for help with program-related work.
	Focus on visual environment, negotiate energy budget with large customers before construction.
	Be more conscious of contractor side of business, quicker on responses, quicker for rebate payment to customer, train employees to better understand lighting business and relate better to customers.
	Simplify the forms, they are a hassle and often not worth the time or effort.
	Get information out to those who design—we don't get information on rebates—need to know more.
	The utilities should offer incentives for total energy saved on a project instead of rebates for certain types of energy efficient equipment. Utilities should have an overall approach to savings for a project and not just specific attributes.
	More knowledgeable utility reps.
	Need to get all utilities to standardize.
Other	Increase the efficiency of the utility, eliminate subsidies for them.
	Interest free loans to do upgrades, subsidize upgrades (like ZIP program for insulation).
	Do something for designers, and stop focusing on ESCOs—promote design practices.
	More rebates, cover more technologies under rebates, start program up again.

Table 8-3
In-Depth Installer Verbatims vis-à-vis Potential Program Improvements to Promote The Specification and Use of Efficient Lighting Equipment

Category	How do you think utility energy-efficiency programs could be improved to more effectively promote the use and specification of efficient lighting equipment?
Expand Advertising/Information	Utilities need to do more advertising on their programs. Customers respect the utility's opinion when they do inspections of equipment and recommend certain items. They need to promote a wider variety of items.
	Simplify process of receiving rebate. Direct marketing, flyers in facility owner's bill. Spread knowledge.
	More marketing—publicize rebate information.
	More articles/brochures sent to owners/managers of facilities—increase awareness.
	Better marketing of what they are selling, what the problems of existing systems are, and what can be done. Get people to think about alternatives to what technology they have now.
	Advertise rebate programs to both contractors and end users.
	Advertise more.
Improve/expand products and specifications	Utilities need to work with the industry to know what products should be included in the rebates and to understand how the market works. Rebates have not usually been for the most cost-effective or useful technologies.
	The utilities need informed and technically competent reps advising customers on specs. The reps are giving bad specs. There is too much paperwork and [too many] hoops to jump through to get the rebates.
	The programs need to cover more technologies that are important in the market. The utility auditors need to gain more of an understanding of the industry, not learn as they conduct the audits. Should provide rebates on overall energy savings.
Program logistics	It is very cumbersome to get the rebates. We spend a large portion of our time answering customers' calls concerning their rebate checks and contacting the utilities trying to find out where the rebate checks are.
	Increase rebates, keep program in place for longer time—this will help the marketing of the programs.
Other	[Focus more on] Under-served areas—multifamily residential, small commercial.
	PG&E should get out of business, PG&E's program is better than SDG&E though. They [SDG&E] shouldn't dole the jobs out to contractors. They should not be selling projects, just offering $ to promote efficiency.
	Partner with electrical contractors.

9 SAMPLING METHODS

This section provides documentation of the customer and supply-side sampling methods employed for the study.

9.1 CUSTOMER RESEARCH METHODS

9.1.1 Customer Surveys

Sample Development

The objective in designing our sampling plan was to enhance our ability to make informed inferences pertaining to an entire population frame based on data collected from the sampled portion. The underlying basis of sampling principles is that we can devise a strategy to collect data from a small portion or sample of a population frame that will be statistically representative of the whole population.

The first step in developing a sample is to define or frame the population that we are trying to represent. In characterizing the population frame, we identify the group to which we extrapolate the results. Known characteristics of the population frame are used as proxy variables for designing the sample.

The second stage of the sample design is to develop an allocation scheme for a specified number of sample points. Optimal allocation of a sample is affected by number of elements, variability of observations, and cost of obtaining an observation.

Clarifying the survey goals can be enhanced by looking at the type of data to be collected and how the data are to be interpreted. Consideration of questions such as the following can help direct the design process.

- What are the target variables we are trying to predict?
- What variables are to be collected by the survey?
- What are these variables being compared to?
- How are these to be calculated?
- What assumptions are there with respect to the variables?

Objectives

Taking into account the project objectives of evaluating the market effects of commercial lighting programs, it is necessary to choose appropriate proxy variables for the targeted information. The sampling process will attempt to cover as large a portion of the lighting market as possible. Although it is useful to interview lighting distributors to characterize sales trends of lighting technologies, in order to assess the effect of programs on customer awareness and acceptance of efficient lighting it is necessary to talk with the actual end users. Sample development objectives include the following:

- Develop representative sample of lighting purchase decision makers.
- Provide a basis on which to estimate market shares of efficient equipment purchases, given that respondents would represent facilities that varied greatly in terms of size and fluorescent lighting equipment saturation.
- Minimize variance, given a fixed sample size.
- Provide an unbiased representation of customers in nonprogram areas.

Comparison of Sources

Given the objective of developing a representative sample of lighting purchase decision makers, a review of sources was undertaken to determine the usefulness of readily available (electronically on CD-ROM) directory-type databases, our assessment focused on three distinct sources:

- D&B MarketPlace 3.0
- PhoneDisc PowerFinder West 1997 (California Yellow Pages)
- 1992 Economic Census

Dun & Bradstreet offer a database, D&B MarketPlace, that contains current information on businesses including: name, location, number of employees, sales data, number of years in business, etc. The database is updated quarterly. This analysis focused on the current quarter, July-September, 1997. The D&B database contains information that is useful for defining the size of the lighting market as well as providing names of businesses to be included in the sample frame.

The PhoneDisc PowerFinder West (California Yellow Pages) database offers access to name, address, city, state, zip code, phone number, and SIC codes. Although there is no information as to the size of the lighting market, these data can be easily downloaded into a format that can be read directly into Excel, which is useful for drawing a sample.

The 1992 Economic Census contains information on the number of establishments, number of employees, and sales data. Depending on the required level of detail, the data is available for individual counties by four-digit SIC code by commodity line (eight-digit SIC code) within a given state. This source is useful for defining the size of the lighting market, but does not have data on individual businesses.

In addition to reviewing these electronic databases, there was an effort to surf the Web for other available databases. This effort did lead to the on-line Yahoo Yellow Pages and U.S. Census Bureau. Although these are interesting sites which offer useful information, this approach does not provide the detail or adaptability that is necessary.

Population Frame

Because of the convenience of Dun & Bradstreet's D&B MarketPlace for gathering information on businesses necessary for pulling a sample, we tested this source against the Commercial Energy Use Study (CEUS) that was done for SDG&E in 1992. This initial comparison was done to determine the feasibility of this approach as well as to check D&B's coverage. In looking at the following comparisons, it is important to remember that the D&B data potentially cover only a portion of SDG&E's service territory, as we only included San Diego based on 3-digit zip codes (919, 920, 921) in the analysis.

The D&B MarketPlace database contains a lot of information, such as number of employees, sales data, and number of years in business, but does not include information on energy consumption. In order to characterize the energy use attributable to each building type, we developed a factor of electric use per employee, using 1992 CBECS data for the Pacific region.

Figure 9-1
Number of Businesses

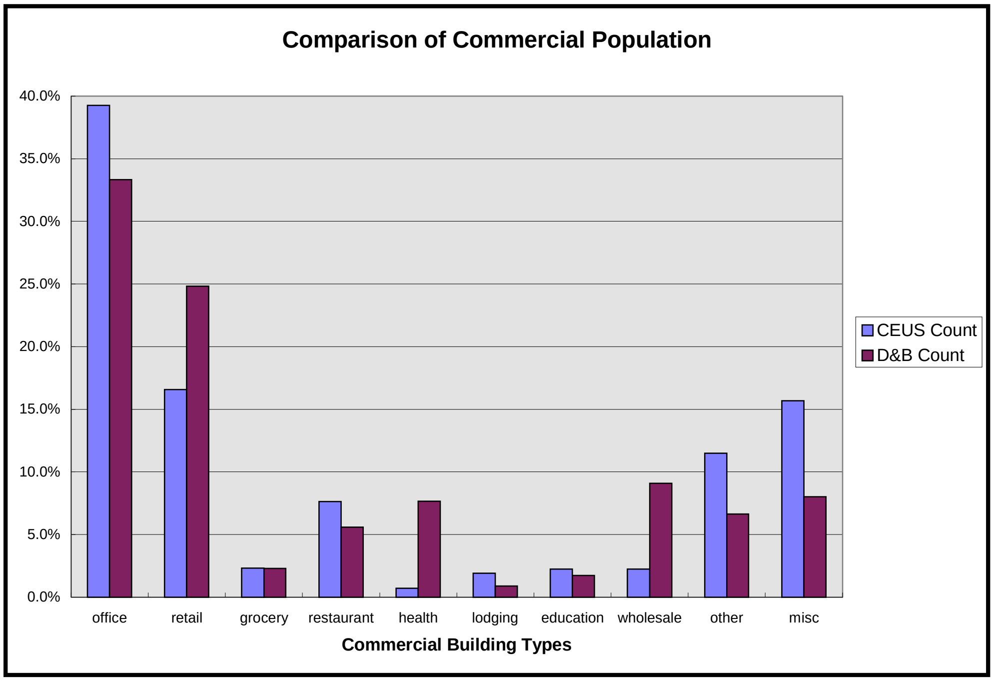


Figure 9-2
Building Energy Consumption

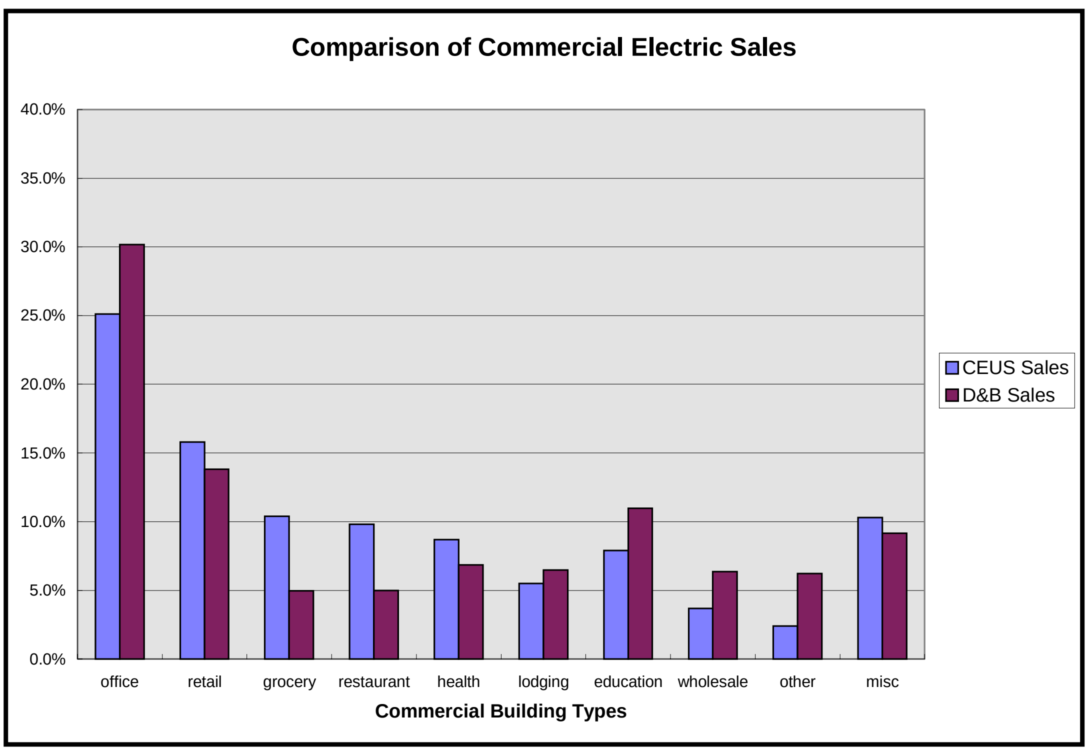


Table 9-1
Summary

	Both		PG&E		SDG&E	
	Number of Businesses	Number of Employees	Number of Businesses	Number of Employees	Number of Businesses	Number of Employees
Office	110,913	1,256,600	81,348	941,092	29,565	315,508
Retail	77,001	476,945	54,997	341,424	22,004	135,521
Grocery	8,511	119,176	6,481	96,554	2,030	22,622
Restaurant	18,990	192,525	14,030	134,797	4,960	57,728
Health	24,960	298,542	18,188	210,758	6,772	87,784
Lodging	2,513	66,593	1,730	39,888	783	26,705
Education	5,807	242,686	4,278	164,448	1,529	78,238
Wholesale	31,648	299,370	23,589	235,230	8,059	64,140
Other	21,242	220,420	15,364	173,686	5,878	46,734
Misc.	25,335	283,422	18,231	214,550	7,104	68,872
Total	326,920	3,456,279	238,236	2,552,427	88,684	903,852

In addition to the above comparisons, we chose to work with the D&B MarketPlace database for the following reasons.

- Reasonably complete listing of commercial *establishments.* This was the closest proxy for decision makers. We had learned through previous work that a sizable portion of decision makers were tenants who did not pay utility bills directly and would not be represented in utility customer lists.
- Each establishment was characterized by primary SIC code. This allowed mapping of all customers to building types customarily used in market studies and load research pertaining to commercial customers.
- Each establishment was characterized by size variables: number of employees and sales.

The actual population frame for each of the three survey regions was defined based on location and SIC code. The original intention was to survey 300 respondents within each region. Where the program area was represented by two regions, the nonprogram area was taken as a single region. For the nonprogram area, 11 states were identified as having had little or no DSM activity in regard to commercial lighting. The Dun & Bradstreet MarketPlace database specified as follows constitutes the sample frame for the end-user surveys.

- PG&E -> The program area for PG&E was specified to include zip codes of 93001-93003, 93007, 93015, 93101, 93103, 93105, 93110, 93111, 93130, 93160, 93501, 93505, 93510, 93515, 93516, 93518, 93523, 93555, 93561, 93581, 932-934, and 936-960. (Note: The 3-digit designations include all 5-digit zip-codes beginning with those digits.)

- SDG&E -> The program area for SDG&E was specified to include zip codes of 919-921, 92624, 92629, 92653, 92656, 92657, 92672, 92675, 92677, 92679, and 92691.
- Nonprogram -> The nonprogram area was specified to include the states of Arkansas, Kansas, Louisiana, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, Pennsylvania, South Carolina, and Texas.

For each of the locations indicated above, each commercial 2-digit SIC code (40 - 97) was mapped into one of 10 building types:

Sector	SIC Codes
Office	47-49, 60-65, 67, 73, 81, 83, 86, 89, 91-97
Retail	52, 53, 55-57, 59, 72, 76
Grocery	54
Restaurant	58
Health	80
Lodging	70
Education	82
Wholesale	42, 50, 51
Other	40, 41, 43-46, 75, 78, 79, 84
Miscellaneous	87

Each building type was divided into three strata (small, medium, and large) so that approximately one-third of the lighting energy was contained in each stratum. The lighting usage was developed as lighting use per employee times the number of employees. The lighting factors were calculated by analyzing 1992 CBECS data of mean lighting use per employee. The program area factors were developed for Pacific division temperature zone 4, whereas the nonprogram area factors were developed using the entire CBECS database.

Table 9-2
Number of Businesses

	Office	Retail	Grocery	Restaurant	Health	Lodging	Educ.	Wholesale	Other	Misc.
PG&E										
small	138,755	86,861	11,256	13,747	32,305	3,512	5,770	32,898	26,235	27,932
med.	8,181	23,463	790	2,141	1,650	240	1,749	6,773	3,537	3,698
large	648	1,452	345	1,138	127	51	118	1,108	270	109
SDG&E										
small	29,684	18,438	1,898	2,628	6,971	588	1,234	7,352	5,207	7,047
med.	1,714	4,985	167	488	357	39	156	1,242	729	917
large	52	356	55	328	12	15	12	170	53	26
Nonprog										
small	585,236	410,877	57,653	61,940	115,767	14,430	26,454	158,123	128,222	84,022
med.	35,677	124,571	4,651	11,241	6,553	1,085	10,980	38,542	17,389	4,770
large	2,824	7,860	1,746	5,638	740	191	709	2,274	1,269	451

Allocation of Sample

There are a number of ways of allocating sample points for a discrete variable which are often based on a proportional distribution. For this analysis, the sample was allocated proportional to lighting usage within each building type. The number of sample points in each stratum were calculated as:

$$n_i = n \times \frac{lighting\ energy_i}{\sum_i lighting\ energy_i} \qquad \text{(proportion to proxy variable)}$$

In order to achieve the desired sample numbers within each stratum, 10 times the desired number (up to the maximum available) was drawn from the D&B database. The large overdraw was done to allow for misclassifications and refusals.

Table 9-3
Sample Design

	Office	Retail	Grocery	Restaurant	Health	Lodging	Educ.	Wholesale	Other	Misc.
PG&E										
small	23	19	3	4	6	5	10	10	7	7
med.	20	23	2	2	6	4	17	12	7	9
large	23	18	5	3	7	5	12	13	9	9
SDG&E										
small	22	19	2	3	6	6	23	10	6	8
med.	22	22	3	2	7	7	17	9	7	11
large	18	19	2	4	6	10	6	8	6	8
Nonprog										
small	19	15	4	3	6	6	8	17	8	7
med.	16	19	3	2	7	6	15	28	8	6
large	19	16	4	3	8	6	11	19	8	7

As mentioned above, in drawing observations for sampling from the D&B database for the telephone surveys, each cell is oversampled to account for expected response rates. The number of observations that were available for the sample are shown in the following table.

Table 9-4
Available for Surveying

	Office	Retail	Grocery	Restaurant	Health	Lodging	Educ.	Wholesale	Other	Misc.
PG&E										
small	230	190	30	40	60	50	100	100	70	70
med.	200	230	20	20	60	40	170	120	70	90
large	230	180	50	30	70	51	118	130	90	90
SDG&E										
small	220	190	20	30	60	60	230	100	60	80
med.	220	220	30	20	70	39	156	90	70	110
large	52	190	20	40	12	15	12	80	53	26
Nonprog										
small	280	200	40	50	90	60	80	280	80	90
med.	190	230	30	20	70	60	210	310	80	70
large	280	160	70	30	80	60	110	200	80	100

Although the intent of the project was to complete 300 surveys for each of the three survey areas, there were a number of cells that were short due to lack of sample and problems arising from reaching fewer customers than expected. There were 579 surveys completed in the program area (303 PG&E and 276 SDG&E) and 287 completed in the nonprogram area.

Table 9-5
Sample Achieved

	Office	Retail	Grocery	Restaurant	Health	Lodging	Educ.	Wholesale	Other	Misc.
PG&E										
small	23	19	3	5	5	5	10	10	7	5
med.	20	23	2	2	6	4	17	12	7	9
large	23	19	6	3	7	5	13	13	11	9
SDG&E										
small	22	17	2	3	4	7	23	7	6	8
med.	22	22	3	2	7	7	17	9	7	11
large	9	19	2	4	6	5	3	8	6	8
Nonprog										
small	16	15	4	3	4	6	9	14	8	5
med.	16	19	3	2	7	6	11	28	8	5
large	19	16	3	3	8	6	11	19	8	5

It took 5,574 observations to achieve the 579 completed program area surveys and 3,690 observations to reach the 287 nonprogram respondents.

9.2 SUPPLY-SIDE SAMPLING METHODS

The purpose of this section is to identify the sampling process used to interview supply-side actors, for both in-depth interviews and the distributor interviews conducted by the survey house. Additionally, this section identifies the sources used in creating the sample frame and assesses their implications on the results.

9.2.1 Sampling Approach

Initial Approach

The initial sampling approach for the large sample distributor survey, described in the August 1997 Final Research Plan, proposed the use of Dun & Bradstreet's MarketPlace database. The database contains over 10 million business sites and represents an acceptable universe from which to draw the sample. Consequently, this approach would generate probability-based estimates that reflect program and nonprogram area populations. The approach requires an a priori segmentation that must be mapped to SIC codes, and to account for the variation in sales volume by company, the sample must also be stratified.

In addition to the phone-house distributor survey, the initial samples for in-depth interviews of distributors, designers, and installers were drawn from MarketPlace. Appropriate SIC codes were identified for each segment and businesses were randomly selected.

Problems Encountered

As the in-depth interviewing process progressed, two significant problems arose as a result of the classification system used in the MarketPlace database.

1. *Low interview-to-phone call ratio*. The businesses identified in the MarketPlace sample were often not involved in the commercial lighting market, particularly those that had the requisite SIC codes listed as secondary. Initially, the share of successful interviews was less than 5 percent of the total calls. Adjustments were made to the MarketPlace sample, such as screening by business name and refining SIC codes, but the interviewing process remained highly inefficient.
2. *Over and under sampling of subsegments*. The SIC code classification of businesses in MarketPlace does not accommodate the a priori segmentation of supply-side groups. For example, in most cases identifying the type of distributor (e.g. lighting supply, electrical supply, industrial supply) is not possible from the information provided by MarketPlace.

Revised Approach

In the revised approach to sample selection, we created a dynamic sample that grew as more information was gathered throughout the research process. Rather than relying upon the samples drawn from MarketPlace, we drew from a variety of sources in an attempt to improve the share of telephone calls that resulted in in-depth interviews, as well as ensure a diverse population of interviews. In general, the sources of sample data, described in more detail in the section below, provided more information on the type of business than was available in MarketPlace.

It should be noted that the sample for the phone-house survey was drawn after all of the in-depth distributor interviews were completed. The sample, therefore, reflects the knowledge gained from numerous in-depth interviews. For example, the phone-house survey includes a diverse number of business models based on prior interviews, including single-site lighting supply stores, branches of large electrical wholesalers, manufacturers' representatives and integrated distributor-designer-installer firms. Most likely, this diversity could not be attained through using the two or three primary 8-digit SIC codes that identify market actors in a particular lighting segment.

Rationale

There are several advantages to adopting the revised sampling approach.

- *Refine segmentation*. As expressed elsewhere in this document, the segmentation of supply-side actors is critical to understanding the research questions at hand. Consequently, the sample frame should reflect the diversity of business models that exist in the California lighting market. Using a dynamic sampling process permits the flexibility to select interview candidates who are identified through the learning process, and consequently may fall under new or refined segments. Moreover, the information provided in prior interviews can be refined and clarified in future ones.

- *Interview referrals*. Incorporating referrals into the sample improves the call success rate, and perhaps more importantly, improves the quality of the interview. Often the referrals were individuals with many years of experience, having had the opportunity to participate in the market during the study period.
- *Improve interview-to-phone call ratio.* Relative to the MarketPlace sample, the revised sampling approach improved the available information on market actors, and thereby reduced the number of wrong numbers and wrong business types. By improving the interview-to-phone call ratio, the research period was significantly reduced.

A disadvantage of using the revised approach for the large-scale distributor survey is that the estimates are no longer probability-based. This is mitigated to some degree due to limitations in the ability of MarketPlace data to reflect the true population[1]. Nonetheless, using the second approach does not allow us to make statistical inferences about the distributor population, as proposed in the research plan.

Recommendation

Since data on supply-side actors are diffuse and limited, a great deal of effort was involved in defining the sample frame for the in-depth supply-side interviews. Sponsors and California energy-efficiency policy-makers should consider further investigation into the limitations of current supply-side actor population data, and the cost and value of developing new frames to aid in future research and tracking of supply-side market effects.

9.2.2 Sources Used

The supply-side sample frames reflect a wide variety of sources that fall under one of five categories. The categories are listed below with a brief description.

Referrals. In many of the interviews, respondents provided the names and organizations of individuals they thought could contribute to our research. Generally, referrals were almost always added to the sample frame and given priority during the data collection process.

Sponsors. A number of databases and supplier lists were made available by the project sponsors and were included in the sample frame. The primary sponsor sources, besides referrals, are identified below.

- SDG&E eligible equipment list, July 24, 1997 [Manufacturer].
- SDG&E eligible contractor & distributor list, July 11, 1997 [Contractor & Distributor].
- PG&E Energy Center spreadsheet [Designer].
- PG&E California architect spreadsheet [Designer].

[1] See Final Research Plan, August 1997, pg. 3-1.

- PG&E (EERC) lighting vendor spreadsheet [All segments].

Associations & Trade Press. Using various mediums, supply-side associations were relied upon to populate the sample frame. Through association directories, publications, and interviews, this source was an important component in defining the sample frame, particularly for designers and distributors. The associations and trade journals relied upon most heavily for defining the sample frame were:

- International Association of Lighting Designers.
- Illuminating and Engineering Society of North America.
- National Electrical Contractors Association.
- Electrical Wholesaling Magazine.
- CEE News.

Internet. The Internet contributed significantly to identifying the sample. Numerous Web sites provide contact information for all segments in the supply chain. Of particular value were the home pages of several large distributors that provided office locations and contacts for all California locations. Other important sources include:

- Internet yellow pages.
- Company home pages.
- Industry & association directories.

Yellow Pages. The yellow pages were used within each of the sponsor service territories to identify distributors, electrical contractors, and design professionals.

In addition to the categories described above, several members of the XENERGY team have extensive experience in the lighting industry and used contacts and industry knowledge to populate the sample frame. Not all of the above sources were used for each supply-side segment; Table 9-7 below identifies the sources used for each segment type.

Table 9-6
Sources Used for Supply-Side Interviews by Market Actor

Supply Side Actor	Referrals	Sponsors[1]	Associations	Internet	Yellow pages
Distributors	✔	*S*	✔	✔	✔
Designers	✔	*P*	✔	✔	✔
Installers	✔	*S*	✔	✔	✔
Manufacturers	✔	*S*			
Government & Others	✔				

[1]S - San Diego Gas & Electric; P - Pacific Gas & Electric

9.2.3 Sample Coverage

In the process of creating the sample frame for distributors, designers, and installers, approximately 2,000 potential interview candidates were identified. Of the 2,000 businesses identified, a significant share (perhaps 25 percent[2]) are not involved in the commercial lighting market. The remaining 1,500 commercial lighting market actors represent a significant share of the total population. Although the entire universe of program area distributors, designers and installers is not known, we estimate that roughly 75 to 85 percent of the distributor and designer population was captured in the sample frame. Given the large number of electrical contractors and the difficulty of identifying the numerous, small independent firms, we estimate that the installer frame captured a smaller share of the program population, perhaps 50 percent. With respect to certain subsegments, we estimate that close to 100 percent of the population was identified in the sample frame. In particular, almost all lighting design firms, energy service companies, and lighting maintenance firms were identified.

Table 9-8 below displays approximations of the size of the sample frame used in identifying supply-side interview candidates. The estimates are for business locations and not for unique business entities. Not surprisingly, in using a multitude of sources, many firms were identified through more than one source. Since there was overlap in the identification process and the estimates below are “ball park” figures, the total sample size is not the sum of the types of sources.

[2] Since not all 2,000 businesses were contacted, this is a rough approximation based on those companies that were contacted.

Table 9-7
Approximate Size of the Sample Frame

(Number of Distributors, Designers and Installers)

Source	Segment Type	PG&E	SDG&E	Total
Sponsor Sources	All	1,200	50	1,250
IALD	Designers	--	--	50
IESNA	Designers	--	--	120
Referrals	All	75	50	125
Internet	All	200	100	115
Yellow Pages	All	300	30	330
Total Sample	All	1,800	200	2,000

Of the 2,000 program area candidates (distributors, designers and installers) in the sample approximately 600 were contacted, and 106 were interviewed by the XENERGY team. We estimate that over 1,500 telephone calls were made in our efforts to attain the 106 program area interviews.

The final breakdown of interviews completed is provided in the table below.

Table 9-8
Summary of Supply-Side, Government, and Expert Interviews Conducted

Supplier Type	Program	Nonprogram	Both	Total
Distributors - In depth	18	--		18
Distributors - Phone-house	60	30		90
Designers	57	25		82
Installers	30	8		38
Manufacturers	--	--	20	20
Government & Others	--	--	25	25
Total	165	63	45	273

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