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PG&E Energy Center Market Effects Study

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A project like this gives one an appreciation for the enormous complexity and value of an institution and the creativity and commitment that are needed to create and sustain an organization such as the PEC. It is our fervent hope that this report will help others appreciate the importance, value and impact of this institution.

Nick and John

May 1998

Executive Summary

The Pacific Gas & Electric Energy Center (PEC) provides educational programs, consulting services and building performance tools to professions and businesses making design and operational decisions for commercial buildings — architects, heating, ventilation and air conditioning (HVAC) engineers, electrical engineers, lighting designers, building owners, facility managers, and facility engineers. Its goal is to educate and train professionals in order to create a sustainable market for energy efficiency and energy efficient products. Its educational philosophy is to promote a systems (whole building) approach to design that optimizes owner value, user comfort, and energy efficiency.

This report describes the transformational effects that the PEC is having in the commercial building sector. The report was commissioned in June of 1997 by Pacific Gas & Electric (PG&E), with guidance from the California Demand Side Management Advisory Committee (CADMAC), to increase general understanding of market transformation and to learn how and to what extent education and service programs, such as those offered by the PEC, can transform the product and service markets for commercial buildings. This report is based on the analysis of participation data from the PEC and other sources such as Dun & Bradstreet, in-depth interviews with staff and key informants, and a survey of 216 PEC users.

This research answers seven important questions

1. What are the key market structures and who are the key actors in the commercial building products and services markets?
2. To what extent is the PEC reaching the actors in these markets?
3. When the PEC reaches these markets, is it able to effectively communicate its message to actors in ways that induce changes in behavior?
4. What are the most important factors that influence market actors to change their behaviors?
5. If market actors have changed their behaviors in response to the PEC, what have the effects been?
6. Are the changes in behavior and the impacts associated with the behaviors sustainable in the future?
7. What lessons for future market transformation studies can be learned from this research?

The PEC has reached its target audiences

From its 32,000 square foot facility located in the South of Market District of San Francisco, the PEC has provided more than 100,000 services to some 30,000 users since its inception in December 1991. *We conservatively estimate that the PEC has provided services to at least 30% to 40% of the building owners and managers in the immediate area of the Center and to the lighting equipment and service firms and engineering firms in Northern California.* We were unable to accurately quantify the degree of penetration of the architectural community. However, architects are among the most numerous users of the PEC.

The majority of PEC users in its key market segments — architects, lighting designers, and engineers — have used the PEC multiple times. Roughly 10% of users from these segments have five or more recorded uses of PEC services. Forty percent or more of these users attended the PEC events two or more times. Frequent users of PEC services are more mature professionals who have been in their current positions for some time and who are well established in their fields.

The PEC is influencing behavior

The PEC is responsible for significant changes in relevant market related behaviors. Lighting designers indicated the most change. Seventy-nine percent indicated that they were specifying more efficient equipment, and 44% said that this change was entirely due to the PEC. Approximately 58% said they were spending more time analyzing the quantity and quality of light, and 24% said that that behavior was almost entirely due to the PEC.

We found similar patterns of change for decision makers involved with architecture and HVAC systems. Roughly half the architectural decision makers interviewed said they were now using more daylighting and external shading devices on buildings, and roughly a quarter said that these behaviors were directly a result of their exposure to the PEC. About half of the HVAC decision makers said that they had changed their behaviors with respect to commissioning, and roughly ten percent said this behavior was entirely due to the PEC. People who were heliodon users, who were measurement tool borrowers, or who participated in building simulation workshops also indicated that they had changed behaviors as a result of these experiences.

We also assessed the relative importance of various factors, such as reliability, cost, information from the PEC, and Title 24, in decision making. *Among factors influencing decision making, reliability was ranked the highest, followed by cost factors, followed by demonstrations, and then information from sources such as the PEC. The most important finding is that people have different decision styles and these styles affect the information that they seek and use.* There are the "globally attentive" who consider a broad range of

factors, weighing information most. There are the "client oriented creatures of habit" who follow client dictates and rely on specifications and manufacturer catalogs. There are the "systems oriented investors" who focus mainly on the investment potential and who respond to rebates. Finally, there are those for whom first cost is the only issue. It is clear that the PEC will have the most impact with the first group and less impact with the others. If the PEC staff targets end users, they may influence the second group. If they rephrase their message, they may be able to reach the third group. They may have to wait until the market is transformed to reach the fourth group.

Users will continue to use behaviors learned as a result of exposure to PEC

Approximately half of the respondents said that once they had changed their behaviors, they continued to engage in all of those same behaviors. Another quarter said that they had continued most of the behaviors.

Changed behaviors are influencing many buildings

Eighty percent of the respondents said that the changes had influenced at least one commercial building. *More than 20% said that the changes in behavior had influenced 21 or more buildings.* An even higher percentage (32%) said that they felt the change would influence 21 or more buildings in the next two years. *Over forty percent of the respondents said that the new behaviors and changes in behavior were influencing most of the buildings with which they were dealing.*

The bottom line is that the PEC is transforming its target markets:

- The PEC is reaching its intended audience.
- Its message is causing behavioral change.
- The behavioral changes are leading to changes in commercial buildings.
- People indicate that they will continue the changes.

The PEC is transforming its target markets.

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Chapter 1. Introduction

The purpose of this report

This report describes the findings of an investigation of the Pacific Gas and Electric Energy Center's (PEC) success at influencing the use of design techniques, products, and services that will lead to a more energy efficient commercial building sector. The study identifies key market actors, the structure and operation of relevant product and service markets, and patterns of decision making among actors within the markets. It also describes the extent to which the PEC's activities have caused changes in market actor behaviors, market structures, decision making, and purchasing patterns for products and services that influence energy consumption.

The goals of the study were to:

- characterize the relevant markets and assess the extent to which the PEC caused changes in these markets and
- develop a set of recommendations regarding a methodology for tracking future changes in these markets as a result of the PEC's activities.

Research overview

An important concept underlying this report is *market transformation*. From a policy standpoint, market transformation is an intervention in a market for goods and services that is designed to change the structure and operation of the market to produce a desired result that can be sustained without substantial further intervention. In the present case, the intervention is the PEC's activities aimed at changing the market for energy-related goods and services for commercial buildings with a goal of increasing the energy efficiency of commercial buildings.

If a market is being transformed, new behaviors, products, and services should appear in the market and the adoption of the products and services by market actors should be evident. If a market is successfully transformed, the market will change so that new behaviors become more or less self-sustaining and/or even newer behaviors, products, or services evolve that meet the goal of the intervention. If efforts at transforming a market are not successful, large numbers of market actors do not adopt the changes and those who do are likely to revert to prior practice and behavior.

In this study, the market transformation literature, which is of recent origins and which may now consist of a hundred studies almost entirely focused on energy markets, is

supplemented with theories and concepts from a much older tradition, that of the *adoption and diffusion of innovation*. The adoption and diffusion of innovation literature is now nearly a hundred years old and is based on a scholarly literature of more than 4,000 published articles and books from more than a dozen disciplines. It is the basis for most of the market interventions that are undertaken outside the energy efficiency arena. It adds a significant depth and perspective to the market transformation literature.

This report describes the PEC, the structure of the target markets that the PEC is attempting to address, the extent to which the PEC is reaching its target markets, the degree to which actors in the target markets are responding to the messages from the PEC, and the extent to which the messages are making a difference in market behaviors. The basic finding from the study is that the PEC has been quite effective in reaching its intended audiences, in conveying its messages, and in getting market actors to change their behaviors in response to its messages. In addition, market actors indicate that they will continue to engage in their newly learned behaviors in the future.

An overview of the PEC

The PEC opened its doors at 851 Howard Street in downtown San Francisco in December 1991. Since then, approximately 30,000 individuals have participated in one or more PEC sponsored events. Because the PEC supports professional organizations that share its interests by making its facilities available to them, large numbers of additional people have attended events at the PEC hosted by other organizations.

The PEC's primary targets are professionals and businesses directly associated with building, renovating, operating and maintaining commercial buildings — including architects, engineers, designers, building owners, facilities managers, manufacturers, and distributors — located in the Pacific Gas and Electric (PG&E) service territory. In addition, the PEC has reached a large number of professionals who have responsibilities for commercial buildings in other segments of the commercial sector through referrals by PG&E utility representatives, through secondary referrals by the primary clients, and through social and professional networks. The impacts of the PEC extend well beyond the borders of the PG&E service territory. It has attracted literally thousands of professionals from across the United States and from around the world.

The goal of the PEC is to educate and train professionals in order to create a sustainable market for energy efficiency and energy efficient products. The PEC recognizes that in the long run, just selling energy efficiency may only minimally transform markets. Its educational philosophy is to promote a systems (whole building) approach that optimizes owner value, user comfort, and energy efficiency (Figure 1). PEC staff recognize that energy efficient practices and the use of energy efficient products are more likely to be sustained when there are multiple reasons for adopting them. In this philosophy, *optimization* is the key. It recognizes that the maximum solution for energy

efficiency may not always maximize owner value or customer comfort and may lead to the rejection of energy efficiency as a consideration in decision making. An optimal solution that includes energy efficiency allows decision-makers to achieve multiple goals. Fortunately, energy efficiency solutions are usually consonant with owner value and user comfort.

The PEC conveys this message through a broad array of activities. A primary way is through workshops and classes. During the fall and winter of 1996 and 1997, the PEC presented more than 85 workshops and classes. Workshops and classes address a wide variety of topics bearing on building energy efficiency. The topics include solar geometry and its relation to the siting of buildings, windows, and glazing; the use of architectural shading devices; lighting fundamentals; lighting design and daylighting; the use of daylighting controls and electric lighting; heating, ventilation and air conditioning (HVAC) systems design; building simulation models; building control systems and building communication networks to support controls; measurement tools and methods; and other topics. A constant emphasis in the workshops and classes is the interrelationship of these issues. The workshops and classes presented by the PEC usually include high quality student materials, demonstrations, frequent references to practical applications, case studies, and the hands-on exercises designed to firmly implant course concepts in the minds of participants and provide practical experience with the use of materials.

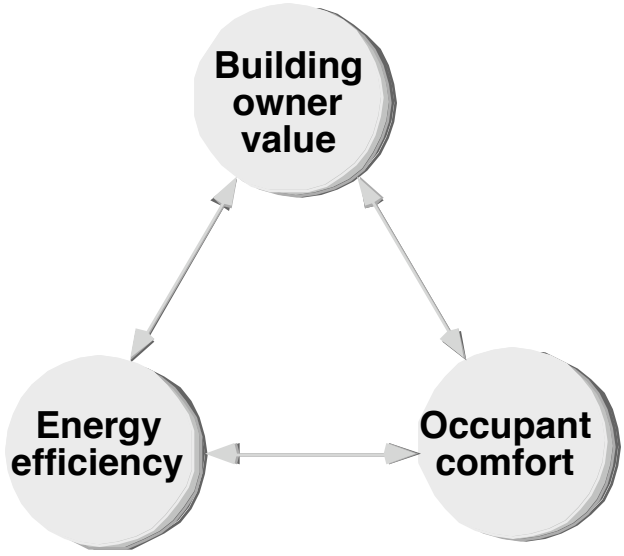


Figure 1. The core values in the PEC's educational philosophy

The PEC provides library services to its own staff and other PG&E staff as well as its targeted clients. The library contains professional reference materials related to core topics such lighting, HVAC design, architecture, and others. It also has a fairly substantial selection of manufacturer catalogs and general trade publications as well as journals and magazines. There are a variety of materials available through electronic media and users have access to commercial search services and the Internet.

The PEC also has a variety of tools that it makes available to users. The lighting classroom can be configured to demonstrate how different lighting technologies may influence illumination, glare, and color in different settings. The heliodon allows a user to study sun and shadow effects using a scale model of a building on an adjustable table with

a “sun” lamp. Users can also make use of daylight models to assess the effects of glazing, facade elements, and interior finishes on indoor environments. The PEC has full-scale mock-up rooms in which the ceiling height, lighting, glazing, shading devices, and interior finishes can be changed.

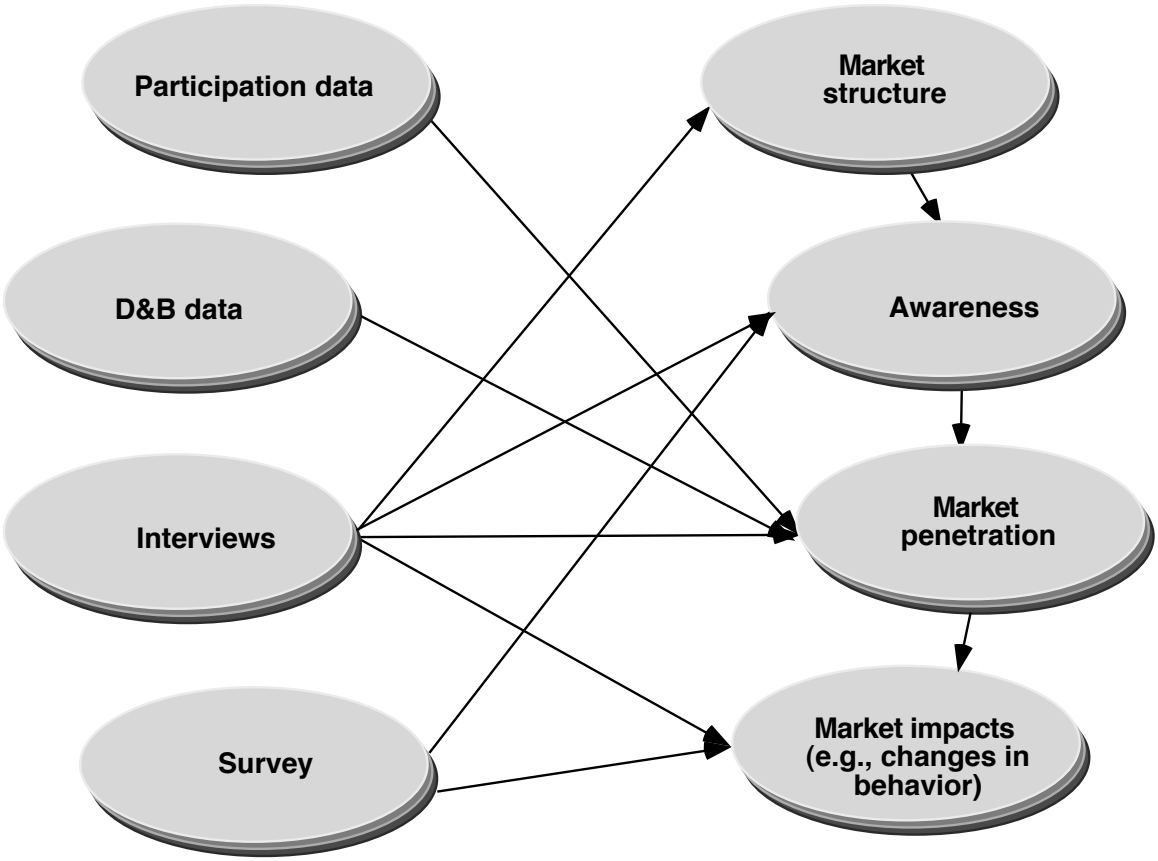
The PEC has a service for lending measurement devices to record such things as lighting levels, occupancy, temperature, power consumption, and meteorological data such as wind speed. The PEC helps clients to understand where and how to install these devices, how to design experiments to get desired results, and how to analyze data from the equipment.

In addition to the above, the staff frequently provide one-to-one consultation services which range from answering specific questions regarding technologies on the telephone to on-site sessions at the PEC involving the development of full blown client specific demonstrations.

The PEC facility is housed in a 32,000 square foot building that is itself a technology demonstration. The building, which was renovated especially for the Center, incorporates a variety of shading and light transmitting technologies. It has a near state-of-the-art HVAC system with a whole building control system. There is an area set aside near the entrance of the building to demonstrate energy efficiency principles and applications for the residential sector. The lighting classroom contains a variety of displays as well as a broad array of lighting technologies that can be individually controlled for purposes of demonstrations. There are very substantial displays of lamps, glazing, control systems, HVAC systems, and other items throughout the facility. There are several other rooms that serve as classrooms and meeting facilities. The ambiance and the quality of the displays and facilities communicate a message of quality and professionalism.

A brief overview of the research

Figure 2 is a schematic showing the data collection methods used in this research and their relationship to four key issues (market structure, awareness, market penetration, and market impacts) pertinent to assessing the influence of the PEC in the commercial building arena.



Source: TecMRKT Works, 1997

Figure 2. Overview of research methods and issues

Beginning with items on the right of the schematic and reading from top to bottom, the first purpose of the research is to describe *market structure*. Market structure is comprised of the key market actors and the relations among them. An example of a market structure might be the way in which commercial buildings are owned and managed. A building owner who controls a large amount of floor space may focus on financial issues. The owner's staff may include designers who deal with the physical features of the space. There may be a leasing staff, a facility manager who is responsible for managing the building, and an engineering staff, ranging in size from one to 25 people, who operate and maintain the building. For our purposes, it is important to know who the key actors may be and what influence they may have in the decision process. Without knowing something about the structure of the market, it is difficult to understand the impacts that the PEC is having.

A second issue addressed by the research is *awareness*. Before the PEC can influence the market, the actors in the target market must be aware of the PEC. Part of the research is aimed at understanding levels of awareness about the activities of the PEC among the targeted actors.

A third issue is *market penetration*. Here, there are two basic issues. The first is to determine which actors in which market segments the PEC is reaching. The second is to determine the extent to which actors in these segments are using PEC services and products.

Finally, it is important to know what changes in behavior or *market impacts* the PEC may be causing in terms of the products that PEC clients recommend and/or buy. And, if the Center is causing change, to assess whether the changes will be sustained in the future.

The four main data collection efforts that were used in this study are illustrated on the left side of the schematic. Participation data were obtained from a database maintained by the PEC that contains basic data about 30,000 individuals who have attended events at the PEC since its inception. Data about firms listed in the participation database were matched to Dun & Bradstreet (D&B) data in order to get an idea of the size, annual revenues, and industrial classifications of firms using the PEC. In addition, we conducted in-depth interviews with key market players and a 20- to 25-minute telephone survey with 216 people who have attended PEC events.

The interviews were used to identify key actors in the markets, the structure of the markets, and key decision-makers who influence energy efficiency decisions.

Market penetration was determined using participation data and D&B data along with interview results. PEC participation data were analyzed to understand who is using PEC services and to what extent. By linking participation data to D&B data, we gained an understanding of the size, position, and influence of the participants. The D&B data also allowed us to gain some appreciation for the degree of target market penetration. The participation and D&B data also helped us to understand who beyond the target audience is using the PEC.

Survey data along with interview data were used to assess the levels of awareness in the target audiences and in other sectors within the commercial market. Analysis of the interview and survey data provided insight into the characteristics of the participants and the market impacts of the program. The survey allowed us to measure changes in behaviors, to establish whether or not markets are changing, and to assess the degree to which the PEC may be responsible for those changes. Finally, the analysis of the survey information was the basis for determining the degree to which changes may be sustained in the future.

The organization of this report

Chapter 2 discusses the underlying conceptual and theoretical frameworks that informed this research. One objective of that chapter is to broaden the understanding of market transformation and to supplement the market transformation framework with conceptual

and theoretical understandings derived from the adoption and diffusion literature. A second purpose of Chapter 2 is to frame the major issues that were addressed through this study of the effects of the PEC on its target markets.

Chapter 3 describes the basic data collection methods used in this research.

Chapter 4 describes some of the key market structures that the Center is attempting to influence. We have been able to identify and organize material to provide a basic description of selected actors and markets.

Chapter 5 provides a more detailed description of the activities of the PEC. The purpose of this description is to provide a basis for understanding what the PEC is attempting to do with its programs as well as how it operates. Unlike a lighting rebate program which may have a narrowly defined set of goals and be promoting a fairly specific set of technologies, the PEC's program is quite broad in scope and its goals and objectives are difficult to describe in measurable terms. For instance, its goal is to promote energy efficient practices and behavior, but that is not necessarily the same as selling efficient technologies. It is important to identify some of the PEC's messages, the behaviors that it hopes to engender in response to its messages, and some practical measures of those behaviors.

The degree to which the PEC has penetrated its target markets is discussed in Chapter 6. The participants along with their degree of involvement with the PEC is described. The degree to which participants are key players in the target markets is discussed.

We then turn to the issue of whether the PEC has actually influenced behavior. Chapter 7 presents data showing the extent to which participants have changed relevant behaviors and the extent to which those changes in behaviors can be attributed to the PEC. The analysis clearly demonstrates that the PEC is influencing behavior.

The PEC is only one of many forces at work in the marketplace. Chapter 8 presents an assessment of the relative importance of a variety of forces that affect markets. What emerges from this chapter is that there are different groups of actors operating in the market who are influenced by different forces. One of these groups of actors actively seeks information from all sources and views the PEC as a primary source of that information. There are other groups within the market for whom technical information is much less important in decision making and therefore, for whom the products and services of the PEC are less important.

Chapter 9 describes the extent to which market actors who have been influenced by the PEC have acted in the market and the degree to which these actors are likely to take additional actions in the future.

Chapter 10 summarizes the lessons learned from this research for understanding and measuring market transformation.

Chapter 2. Market transformation and the adoption and diffusion of innovations

Introduction

Since the energy crisis of 1973, the goal of many organizations and companies has been to increase the market share for energy efficient products and services. The use of the term *market transformation* in the energy literature is of relatively recent origins. Papers with *market transformation* in their titles only began appearing with some regularity in 1993 and 1994 (Feldman, 1994, and Prahl and Schlegel, 1993).

Schlegel and Gordon (1996) suggest that market transformation initiatives are strategic efforts to induce lasting structural and behavioral change in the markets for products and services. The goal of market transformation is to produce new patterns of "business as usual" for all actors in a market place. More recently, Eto, Prahl and Schlegel (1996b) have defined market transformation as *a reduction in market barriers resulting from a market intervention as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced, or changed*.

The theme of market transformation emerged for a variety of reasons. One reason is the desire to increase the effectiveness of demand side management programs. At least through the end of the 1980s, demand-side management (DSM), driven by a resource acquisition focus, primarily targeted end users. In the late 1980s and early 1990s, large numbers of practitioners in the field began to recognize the need for partnerships and alliances with other market actors to amplify their efforts. This led to a closer examination of market structures, to recognition of the regional and national scale of markets, to a search for alternative points of intervention, and for ways to more broadly intervene in markets.

The discussion of competitive energy markets and deregulation that began in earnest after 1987 also helped to encourage the emergence of the market transformation theme. The use of economic incentives, particularly rebates that had been a mainstay of many demand side management programs, did not jibe well with the various visions of a competitive future. Strategic interventions in markets and with market actors other than end-users were considered as a way to reduce reliance on economic incentive mechanisms and as a way to more cost effectively achieve desired ends.

The move toward competitive markets in the mid-1990s also meant commoditization of energy at the wholesale level and now the retail level. In a commodities environment, regulation plays less of a role in motivating behavior and suppliers of energy goods and

services are increasingly motivated by the bottom line. In this new environment, alternative goals representing important public goods, such as reducing dependency on fossil fuels for national security reasons or reducing air pollution, become motivators for market actors only when they are aligned with other goals that positively influence the actor's bottom line. If addressing such goals does not positively influence the bottom line and important social goals go wanting, then, according to some, a public response is appropriate. This is why Eto et. al. (1996b) suggest that market transformation is a "central policy objective for future publicly funded energy efficiency programs in California." In the absence of corporate drivers, the public good aspects of energy efficiency become a public responsibility.

The market transformation model

Figure 3 presents a simplified model of market transformation. The basic model posits that market interventions are used to reduce market barriers in order to achieve desired market effects.

Figure 3. Simplified market transformation model

Market interventions are not new. Traditional market interventions have included utility DSM programs; standard setting efforts such as the Federal appliance standards and California's Title 24; the utility, state and Federally funded information programs of the late 1970s that gave way to the resource acquisition programs of the 1980s; and other public interventions such as low-income weatherization programs.

Eto et. al. (1996b) identified the typology of market barriers shown in Table 1. These barriers may prevent the movement of a concept, product, or technology into the market place. For example, an actor's lack of awareness of a technology or product is an obstacle to improving energy efficiency. A potential technology adopter may be aware of the technology or product but may lack important information that would lead to adoption of the technology. The potential adopter may have to expend resources to obtain that information and the expenditure of those resources is potentially a barrier to adopting the product. In the market transformation framework, someone interested in increasing energy efficiency might intervene in the market to increase the awareness of a product, to increase the availability of information, and / or to reduce the costs of locating product information.

We know from studies in the diffusion of innovation field that product reliability is often a barrier to adopting a new technology. In the terminology of market transformation, this

is *performance uncertainty*. An example of an intervention to overcome this barrier is to provide product reliability information in the form of a testimonial from a user.

Table 1. Examples of market barriers

Market Barriers
Information or search costs
Performance uncertainties
Asymmetric information and opportunism
Hassle or transaction costs
Hidden costs
Access to financing
Bounded rationality
Organization practices or custom
Misplaced or split incentives
Product or service unavailability
Externalities
Non-externality pricing
Inseparability of product features
Irreversibility

Source: Eto, et. al., 1996b

Eto, et. al. (1996b) see these barriers and interventions in the context of a market structure that includes a variety of actors, for instance, manufacturers, distributors, retailers, various intermediaries, and customers. The barriers, and thus the potential interventions, differ by actor.

Assuming that an intervention is effective, there will be *market effects*. Eto, et. al. (1996b) provide a table listing outcomes that are indicative of market interventions. The outcomes include such things as changes in service offerings, changes in design practices, and increases in the percentages of efficient products in the market. A key concern is whether the market effects are a transitory response to an intervention or whether the effects will be sustained.

Many of the studies that have been done have attempted to use sales as an indicator of market transformation. The assumption has been that market transformation efforts can be linked to changes in sales and changes in the patterns of sales. Early on, there was interest in defining distribution systems and tracking sales through the distribution systems (Van Liere, Vig and Feldman, 1992). However, obtaining sales data proved a less tractable problem than many thought (Meadows, Okstein, and Reed, 1995a; Meadows, Okstein, Reed, Szabo, and Can, 1995b; Van Liere, Winch, Standen, Feldman, and Brugger, 1993). Some sales data are available at the national level so national trends can be monitored but local and regional data are more difficult to obtain and interpret.

With increasing competitive pressures within the economy as a whole, these data may become less available. Further, for a variety of reasons, national sales data cannot be disaggregated to regional or service territory levels. This limits their usefulness for determining the effects of programs at regional, state, or service territory scales. The development of distributor level sales tracking systems have largely foundered on the ability to gain participation of adequate representations of distributors. The Wisconsin Motors Study (Meadows, et al., 1995c) and its successor study showed that distributors could and would provide estimates of changes in sales as opposed to actual sales data. Prahl and Pigg (Prahl and Pigg, 1997) have provided the clearest example of the use of

sales data in a commercial lighting study in the Wisconsin Electric Power Company service territory. However, it is not clear that that example can be copied in other locations. The prospects for using sales data as an outcome variable can be summarized as follows:

- Except at the national level, manufacturer sales data are not available and/or are not likely to be available so that an analysis of transformational effects at lesser geographic scales of interest are likely to be difficult.
- Sales data for specific models of products are difficult to obtain from distributors and wholesalers. Distributors are reluctant to divulge such data. Further, distributors' data systems are not designed to effectively track efficient products and services.
- Wholesalers and distributors can provide reasonable estimates of sales based on their understanding of their markets. Tracked over time these can indicate how markets are changing.

The limits of the current market transformation model

While the current market transformation model represents a substantial intellectual achievement, it needs to evolve from a typology to theory. The model focuses on barriers to transformation rather than the process of transformation. The model needs to move from identifying the friction points that may prevent the diffusion of products and services, to a model that describes transformation processes and can be used to both design and evaluate programs. For example, the model may identify reliability (performance uncertainty) as a barrier but also needs to provide understanding for how to deal with the barrier.

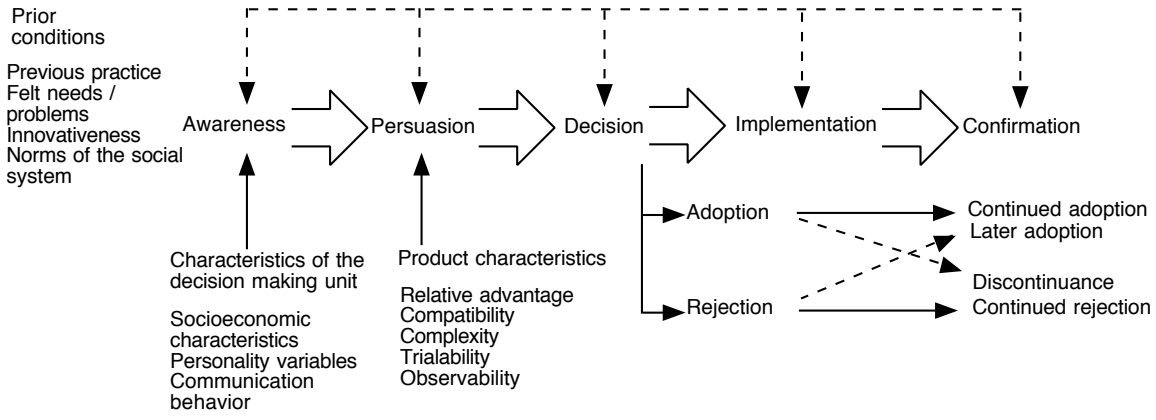
The model assumes a flow of information but it does not describe the structure and functioning of information flows. There is a substantial literature that relates the use of mass media channels and the use of professional and social networks to the effective movement of products in the market. The choice of information channels and the timing of their use are known to significantly influence the rapidity with which market transformation may occur. Market transformation efforts would be greatly enhanced by attention to these details.

The perceived characteristics of the product or innovation have much to do with whether and how rapidly an innovation is adopted and markets transformed. The market transformation model only partially speaks to this issue through the identification of barriers such as *performance uncertainty*.

Finally, the market transformation literature does not yet deal with characteristics of those doing the adopting. Transformation occurs in stages and the importance of the barriers change with the stage. As we shall see, there are well established personal characteristics that are correlated with stage of adoption.

The adoption and diffusion of innovation model

Figure 4 illustrates a widely accepted model of the diffusion of innovations (Rogers, 1995). This model is based in a long research tradition and is much more of a process oriented model than the current market transformation model. The model defines a process by which market actors adopt a new innovation. Actors must become aware of the innovation. Once awareness of an innovation is established, a market actor can at any point enter a persuasion stage during which the actor seeks and processes information in order to decide whether to adopt the innovation. The timing of the active portion of this stage is highly dependent on the individual and the context in which the individual is operating. At several points in time, the market actor may make a decision not to adopt, to postpone adoption, to continue the search for information, or to adopt the new innovation. This persuasion stage is followed by an implementation stage in which the actor enacts the decision. Finally, actors reevaluate or confirm their decisions to adopt and/or their implementation of the decision. The result may be either continuance or discontinuance of the adoption.



Source: Rogers, 1995.

Figure 4. Model of innovation diffusion

The time frames for adopting an innovation can be compressed or fairly lengthy. For example, awareness of an innovation may precede the decision to adopt by months and years. Rogers (1995) has data showing awareness preceding the adoption of hybrid seed corn by about 1.7 years for early adopters and by as much as 3.1 years for later adopters. Further, the decision to adopt and the implementation of the decision may be separate acts and may be separated in time (Reed, Erickson, Ford and Hall, 1996).

Factors influencing the rate of diffusion of an innovation

There are a variety of factors that influence the rate of adoption of innovations that have a strong similarity to market barriers. The rate of adoption of a product or innovation is

determined by the nature of the social system, by the channels used to communicate about the innovation, by the attributes of the product or innovation, by the type of innovation decision, and by the extent of promotional efforts.

The adoption of new innovations does not occur in a vacuum. Prior practice, for instance, the availability of specifications from previous jobs, may weigh heavily in determining whether or not to adopt an innovation. In the lingo of market transformation, this is a form of bounded rationality. Norms within a social system, such as union practices or local codes, also influence adoption decisions. This is undoubtedly what Eto, et. al. had in mind when they identified organizational practices or customs as a market barriers.

A careful reading of the diffusion of innovation literature makes it clear that market barriers are not just "out there" but may be triggered by the innovation. The nature or perceived nature of a product or service contributes to whether and how quickly it is adopted. The literature identifies five key attributes of products or services (innovations): relative advantage (for example, initial cost), compatibility (with existing culture and practice), complexity, trialability, and observability. Of these, relative advantage and observability are known to be the most important.

Relative advantage is the degree to which technologies, products or services, are perceived to be better than similar products and services. The literature identifies key dimensions of relative advantage to include "degree of economic profitability, low initial cost, a decrease in discomfort, social prestige, savings in time and effort, and immediacy of the reward" (Rogers, 1995). Scholars have found that economic profitability may explain considerably less than half of the variance associated with relative advantage.

Energy efficient products often have characteristics that place them at a relative disadvantage in relation to other products. Whereas products that are adopted rapidly often have low initial cost, energy efficiency products often have high initial costs. Life cycle costs, a frequent justification for purchasing energy products, focus on long-term rather than the short-term rewards that are characteristic of products that have relative advantage. Increasing access to financing, does not necessarily address a need for a short term focus on rewards.

The main point is that barriers to adoption may be inherent in the product. The barrier may be as much one of performance certainties as performance uncertainties. Attention to product evaluation issues is an essential ingredient in any analysis of market transformation programs.

We would especially emphasize methods and approaches that employ value added services (for example, owner value and customer comfort) as a strategy for success (Wight, 1996). If the characteristics of a product or innovation do not meet customer needs, then it is unlikely that the market will be transformed. Too often, it seems we are dealing with products and services searching for a market rather than creating a product or

service to meet the needs of a market. Our basic point is that we need to look more closely at the value of products and services in markets before we attempt to understand if the market for the products and services is being transformed.

Without going into a lengthy discussion of decision types, we would point out that the decision literature defines three types: optional, collective and authority. "Optional" defines the situation in which the decision is largely a personal one. The "collective" decision involves a group. The remaining decision type is the decision driven by authority – for example, a purchasing rule, that dictates decisions be based on first cost, or a regulatory standard, such as Title 24, that mandates the adoption of more efficient designs and technologies. The dynamics of a collective decision are very different than those for an individual.

Finally, communication channels significantly influence adoption and the rate of adoption. The diffusion literature identifies two basic channels of communication, broadcast and interpersonal. A broadcast channel is a one-to-many communication path, a prime example is mass media. Interpersonal channels involve one-to-one communication, the message spreading like a contagion. Innovators and early adopters use broadcast channels, but the literature is clear, the transformation of the market does not kick in until the interpersonal channels really begin to work. This means that professional and social networks are a key to the process.

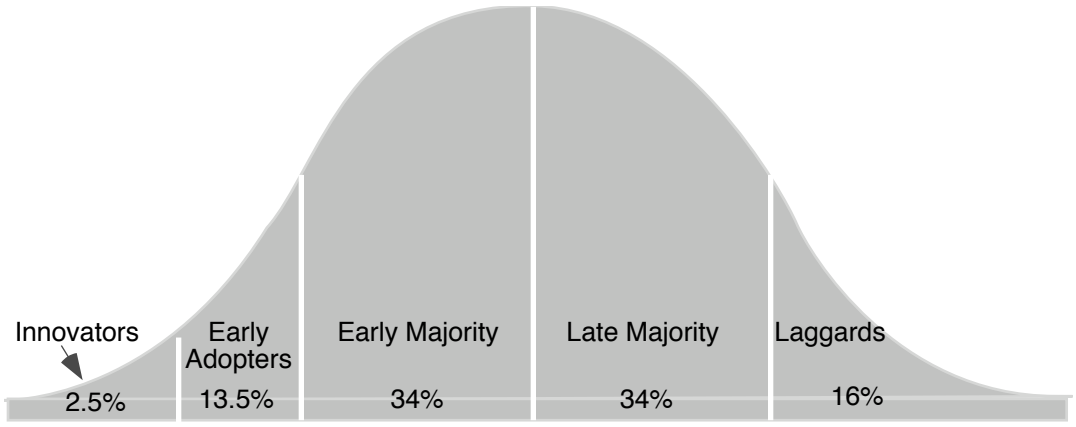
Types of adopters

Market transformation really represents a series of decisions by individuals and firms. The decision to adopt has to be made by each actor in the market, at least until the point at which actors have no alternatives but to adopt (e.g., the market is fully transformed). However, people and organizations differ in the speed with which they will accept innovations. Adopters are generally categorized into one of five groups: innovators, early adopters, the early majority, the late majority, and laggards (Figure 5).

The literature points out (Moore, 1993) that there are significant differences among the adopter groups and that these differences have important implications. *Innovators* are a very small group and they pursue technology aggressively. They purchase and use new technologies out of pure interest in technology. *Early adopters* appreciate the potential benefits of technology and will utilize technology when they see that its benefits match their own needs and desires. Both the innovators and early adopters learn about and make decisions about technology based on information received through broadcast channels.

The *early majority* has an interest in technology but is driven by practicality. They will wait and see if a technology delivers on its promises. Also, they want to reference others of the early majority, not just innovators and early adopters, before they buy. Thus,

getting the early majority on board requires a different level of effort than attracting the innovators and early adopters. This is the point at which the interpersonal communication channels really take on importance. This is the point where many ideas and products fail. If ideas and products attract the early majority you get "take-off" (Rogers) or as another Moore calls it "a crossing of the chasm." In other words, the market is being transformed and the market for the product becoming self-sustaining.



Source: Rogers

Figure 5. Categories of adopters

The late adopters differ from the early majority in one major respect. They are not comfortable with technology and will wait until a product has become the standard before purchasing. The laggards simply do not want to have anything to do with new technology and do not consider it. The laggards may adopt only when there is no alternative.

Methodological issues in measuring market transformation

A difficulty that the market transformation and the diffusion of innovation traditions share is the problem of measuring change. To accurately assess the effects of market interventions, time series data are needed. Because time series data frequently are not available at the time that we want to assess market effects, there is a tendency to rely on cross sectional analysis of "single shot" surveys. There are significant problems with attempting to make inferences about change based on cross-sectional analyses of data. This criticism has been widely discussed in the diffusion of innovation literature (Rogers) for more than 20 years.

The issue is often described as one of how accurately people can recall the past and whether recall can be relied upon for the analysis of change. This is really an over

simplification of the problem. Recall may be a problem but there are well understood techniques that can be used to minimize recall problems in surveys. More importantly, cross-sectional analysis relies on discovering differences in segments of populations and then interpreting those to explain change. That is very different than recording changes between points in time and then correlating change to change.

The best approaches for analyzing market transformation and the diffusion of innovation rely on field experiments that include the collection of primary and secondary *time series* data for targeted and comparison areas. By tracking market interventions and comparing these to changes between market and comparison areas over time, one can establish causal links between the interventions and the effects.

The issue is not one of whether surveys, sales data, or other types of data are the most appropriate method for studying change. Rather, it is whether these types of data are gathered and used in powerful experimental designs that allow one to determine if it is the market intervention or a rival explanation that produced a change in the market. Figure 6 illustrates such a design. This design calls for a series of relevant measurements through time in a target and a comparison area, and measurements of program interventions. The differences between the measures at different points in time are the measures of change. Program interventions and other influences can be compared to changes in the market measures in the target and comparison areas to assess the overall effects of the interventions.

In the long term we need to design market transformation efforts and the assessment of market transformation efforts to allow longitudinal assessment and analysis of the effects of the intervention. The current study is an attempt to retroactively establish the effects of an intervention. Because there are few, if any, systematic time series measurements from the past, it is not possible to conduct the analysis based on a rigorous experimental design. As much as we might like, we are forced to live within the limitations of cross-sectional analysis.

The cross section alternative requires that we carefully design surveys and interviews and wherever possible buttress the survey data with existing data from other sources to assess effects. The keys are to use well-designed surveys and to triangulate the results in as many ways as possible.

For example, in this project we are attempting to assess complex behaviors and effects that can occur independently of one another. Therefore, it is important to ask multiple questions about a range of specific behaviors rather than one or two questions about general behaviors. Also, it is important to design questions that focus on specific behaviors rather than more general behaviors or opinions. People are usually able to more accurately recall specific behaviors than general behaviors and opinions. It is also important to use well-trained interviewers and survey takers.

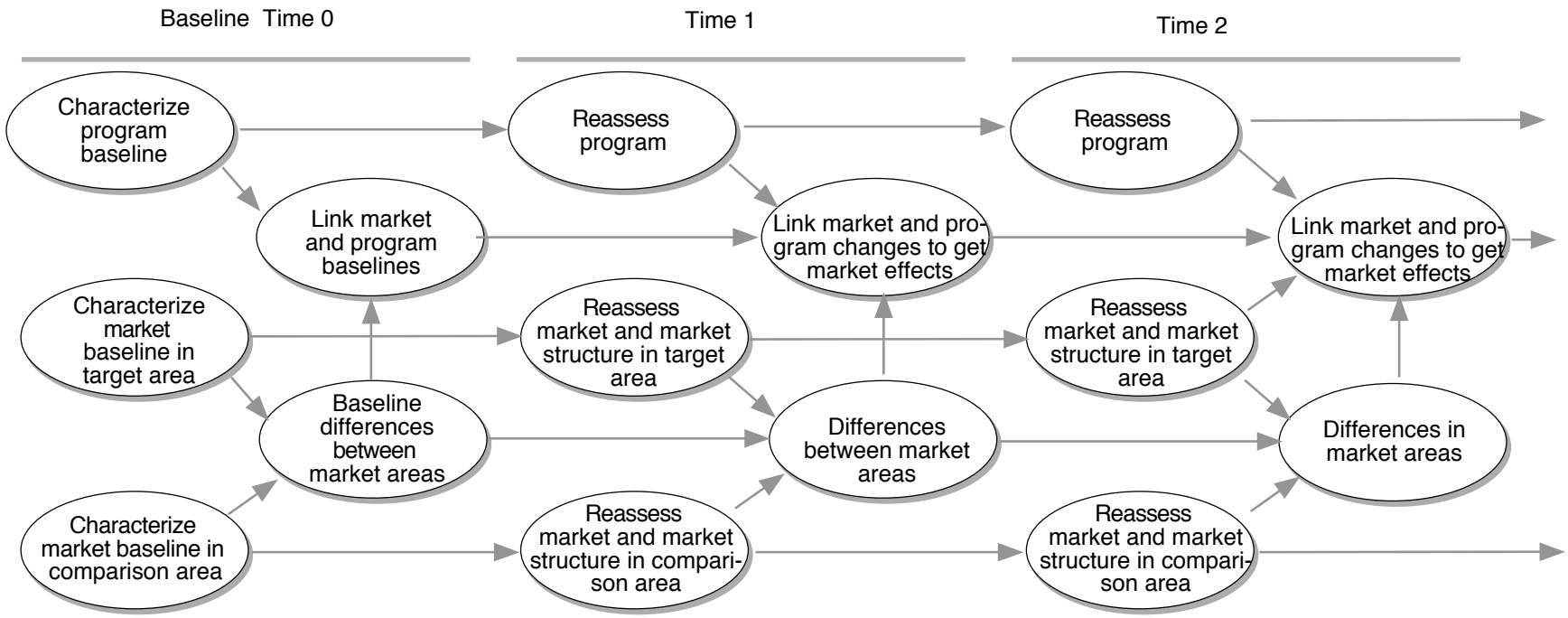


Figure 6. Ideal design for analyzing market transformation

Finally, it is important to look for multiple indicators of effects in a variety of places. If no indications of effects can be found, that is good evidence that the interventions have not been successful. If there are broad indicators of a variety of different effects, that is good evidence that the interventions are working. Unfortunately, alternative explanations are not necessarily ruled out.

In the short term, studies such as this one are useful for the initial assessment of effects. In the long haul, programs and policies need to be built upon a solid foundation of good time series data.

A framework for evaluating the market transformational effects of the PEC

By drawing on these frameworks we can develop a strategy to assess whether the PEC is transforming its target markets. The basic strategy is to lay out a sequence of steps or stages that are consistent with the way innovations are diffused (markets transformed) and then to determine whether the PEC's target audiences have reached or passed through these steps or stages. If we can demonstrate that they have, then we can effectively argue that market transformation is occurring or has occurred. Essentially, we need to answer six basic questions:

1. *What are the key commercial building products and services markets?* We need to be able to understand the markets structure and players well enough to be assured that the PEC is reaching its key audiences.

2. *To what extent is the PEC reaching its key markets?* If the PEC is not reaching its markets, then it cannot be transforming them. If the PEC has reached only a small percentage of actors in a market, then the transformation process probably has not taken on a life of its own. It is important to demonstrate that the PEC has reached its markets and that actors in these markets believe that the PEC is a credible and useful source of information. A measure of the degree to which clients believe the PEC is a credible and useful source of information is repeated use of PEC products and services by market actors.

3. *When the PEC has reached its markets, has it been able to effectively communicate its messages and induce market actors to change their behaviors?* Here, two things need to be demonstrated. First, it is important to demonstrate that actors are changing relevant behaviors. Secondly, it needs to be demonstrated that at least some of the change in behavior can be attributed to the PEC, and not entirely to some other factor, such as a change in standards like Title 24.

4. If we find that market actors have changed their behaviors, then we need to ask, *what is the impact of these behavioral changes in terms of the market?* Market actors may

engage in new behaviors, but those behaviors may or may not influence the market. There needs to be a demonstrable link between changes in behaviors and buildings. In other words, are the behaviors actually resulting in changes to the design of buildings? It is also possible that changes may be influencing some, but not all, buildings. Is the number of buildings being influenced substantial? Does this represent a substantial part of professionals' practice?

5. *Will the changes in behavior and the impacts associated with the changed behaviors continue in the future?* The diffusion literature is quite clear that market actors are constantly evaluating and reevaluating their behaviors. Actors may discontinue their use of an innovation, they may continue its use, or they may move to an alternative concept, idea, or product.

6. Finally, we may want to ask, *what are the most important factors that influence market actors to change their behaviors?* Different groups of market actors may respond differently to different inputs to the decision process. Are there differences in market actors? What criteria do the different groups of actors use?

Chapter 3. Sources of Data

Introduction

The data for this research came from five sources: one-to-one interviews, PEC participation data, professional society membership lists, Dun and Bradstreet data, and a telephone survey. The goal of the interviews was to create a framework for understanding the PEC, its programs, and the markets it serves. PEC participation data provided a basis for understanding the participants and their characteristics. Membership lists for professional societies and associations were used to determine how effectively the PEC was reaching members of these societies. Dun and Bradstreet data were used to determine characteristics of businesses represented by PEC participants. The participant survey was used to obtain data about the effects of the PEC on the participants.

One-to-one interviews

In-depth interviews with key informants were conducted during three one-week periods in July, October, and November of 1997. The interviews had two main purposes. The first was to obtain descriptive data about PEC programs and to gain a qualitative understanding of what the informants think the impacts of the programs are. The second purpose was to identify market structures associated with the various market segments and to understand how the PEC relates to the players in the various segments.

Prior to the first interviews in July, TecMRKT Works constructed a generic interview protocol (Appendix D) which identified the topics to be pursued and detailed questions for each topic. During the first round of interviews, which were primarily with PEC staff, the interviewers selected topics that were appropriate to the person being interviewed from the generic protocol. In the subsequent rounds of interviews, more specific protocols were developed that were focused on the market segment and discipline of the person being interviewed – for example, architecture, engineering, lighting design, building owner, or facility engineering.

Interviews with the PEC staff were coordinated through the Director of the PEC, Mr. Jim Chace. All current staff and contract support staff were interviewed. Most of the staff interviews took place at the PEC although a few were conducted at other locations. The interviews with key informants from different market segments took place mostly at the informants' places of business although a few were conducted at the PEC and a few were completed by telephone.

During the interviews, PEC staff members were asked to name individuals who they thought could provide insight into the structure of markets as well as the impacts that the PEC is having on markets. Independently of this, TecMRKT Works staff identified representatives of the American Institute of Architects (AIA), the Illumination Engineering Society (IES), Local 39, the Building Owners and Managers Association (BOMA) and the International Facilities Mangers Association who could provide recommendations about persons who could serve as key informants. In each instance, these contact persons provided several names. TecMRKT Works attempted to contact most of these persons. During the interviews with key informants, the informants were asked to identify persons who they thought could provide detailed information about the markets that they served and the Center. This resulted in the identification of additional informants.

An attempt was made to get the broadest representation possible among the potential informants. Representation was sought from larger and smaller firms, from firms that were reputed to be leaders as well as more in the mainstream of their discipline, and firms and organizations from the public and private sectors. The research team made a concerted effort to identify informants who might provide alternative views of the PEC and the markets that the PEC serves. More than half of the interviews were with people who were identified as potential informants by someone other than a PEC staff person. There were some among the informants who saw the PEC as a competitor and some who knew the PEC by reputation but who have not used its services. Given the limitations on the number of interviews that could be conducted, we believe that the mix of perspectives and experience with the PEC was appropriate to the needs of the study.

A call was placed to each informant chosen for an interview. If the informant was not reached on the initial call, a message was left with someone in the informant's office or on the informant's voice mail. Follow-up calls were placed after a day or two if the informant did not return the call. As a group, the informants were extraordinarily receptive to being interviewed. Once the goal of the project was explained to the informants, most agreed to an interview immediately. Several people who received voice mail messages returned calls and agreed to participate with almost no further explanation. Several people made extraordinary efforts to adjust their schedules to fit in interviews. In a few cases, the people we contacted suggested that we speak with a different person in their firms. There were a few people we were unable to interview because of scheduling conflicts but we had no refusals.

All non-staff informants were sent a fax confirming the time of their interview and a preliminary list of questions (Appendix D). Upon arriving at the interview, the interviewer explained the purpose of the interview and answered any questions the informant had about the interview. Informants were asked if the interview could be recorded except in a few circumstances where recording was not possible for technical reasons. Two TecMRKT Works staff members were present for the PEC staff

interviews completed in July. During those interviews, one person conducted the interview and the other took extensive notes. For the remainder of the interviews, there was one interviewer present. During these interviews, the interviewer made notes.

A total of 38 interviews were completed. A list of those who were interviewed can be found in Appendix F.

PEC participation data

The PEC has maintained data on participation in PEC activities since its inception in December 1991. Although the data were originally kept in other formats, most of the data are now in ACCESS databases. From December 1991 through the early part of 1996, PEC staff maintained a fairly complete and comprehensive record of participation at the Center. The database contained names, addresses, company affiliation, occupation, event information, and other information.

In 1996, because of resource issues, the PEC began placing less emphasis on keeping attendance information. During the last half of the year, workshop and class attendance records were maintained in spreadsheets and staff maintained their own lists of services that they rendered outside of the workshop settings. At the beginning of 1997, historical attendance data, with the exception of the data for the fall of 1996, were shifted to a new ACCESS™ database and the classroom and workshop attendance data for 1997 were being entered and organized in a new format.

There is also information about the use of other PEC services, such as the library and the tool lending library. The librarian(s) have tracked requests for library service manually and through the use of electronic spreadsheets. These records contain only counts of direct requests by category of requester. The library counts do not include counts of people who may have used the library but who did not request assistance from the librarian(s). The database for the tool lending library was initially maintained in Filemaker Pro™ but is now in ACCESS™. It tracks users, projects, and equipment and is probably the database with the most consistent information.

There is a very substantial, although not entirely consistent, record of participation from the early days of the PEC to the present. In comparison to other program tracking efforts about which we are knowledgeable, the records from the PEC are remarkably complete.

There are some gaps and problems that limit our ability to use the participation data in this project. Recent data in the participation database includes mostly people who have attended workshops and classes. The records for people participating in other activities are less complete. In addition, staff advised us that people who participate in events do not always register, and because of resource issues, less effort has been made in recent years to ensure that all attendees are registered.

The participation databases were really designed to allow the PEC to maintain contact with participants and to provide basic counts for use of services. Data in these databases are more difficult to use for research. For instance, there are often multiple renderings and different spellings of company names. This is not usually a problem if one is generating mailing lists but it does create problems if one desires to count all individuals from the same company who have attended the PEC. From a market perspective, we may want to know something about the differences among people from the same company who may be attending the PEC. There is no way to know, for example, whether an individual is working for the AT&T retail division or the AT&T communications division. Also, there is considerable variation in whether participants provided a company mailing address or a personal mailing address.

We attempted to remedy some of the data consistency problems to allow for a more in-depth analysis of the data. However, a thorough cleaning of the data is outside the scope of this project. We were not able to resolve many of the company name address problems to our satisfaction.

There were also a number of inconsistencies in assignment of occupation and other classifications. As a result, care needs to be taken in interpreting the data in absolute numerical terms. In most cases, the numbers we report based on the participation data will underestimate the level of activities simply because of the number of cases with missing data. In a few cases, the numbers may *significantly* underestimate activity. The data are more wisely used to discern trends and to make relative comparisons.

Data from professional societies

As a way of assessing the effectiveness of the PEC in reaching its target audiences, we attempted to obtain membership lists of key professional organizations so that we could match them with participation records from the PEC. We were able to obtain complete lists from two groups, the Building Owners and Managers Association (BOMA) and the Illumination Engineering Society (IES), and what appears to be a fairly complete listing of members of the American Institute of Architects (AIA).

The BOMA list was obtained from their World Wide Web site. The information was limited to the name of the member, the member's telephone and fax numbers, the member's company name, and an indicator of whether the member was an owner/facility manager or a vendor of services. The San Francisco Chapter has a total of 478 members, of which 246 are building owners or managers and the remaining 232 represent accounting, architecture, legal, construction, and maintenance firms which service building owners. Several of the building owner managers were representatives of the same firm, so the actual number of property owning firms was 175.

Although the IES generally does not release its membership list, we were able to obtain a list for the purposes of this research. That membership list indicates that there are approximately 309 members of IES in the local chapter. The list we obtained had names and addresses.

Many architects who are members of AIA, are listed by firm in the Construction Database found on the World Wide Web. This database is structured so that various selection criteria can be used to limit the number of firms that are identified during a search. Examples of such criteria are location and specialties — for example, commercial buildings. We used the selection capability to identify all architectural firms specializing in commercial buildings with an address in Northern California (a Zip Code beginning with 94 or 95). Using these criteria, we identified a total of 419 firms and 1,098 architects. The list excludes architects with specialties other than commercial buildings, architects who are not members of AIA, and architects who may have chosen not to be listed. The list also excludes architects who work for private firms that specialize in other products and services, government agencies or architects who are on the faculties of universities.

We had expected the number of architects to be somewhat higher based on other information. However, during the interviews an informed member of the PEC staff said that it was very difficult to get lists of architects. He pointed out that many architects are not members of AIA. Firms often have one or two individuals who are AIA members while other members of the same firm who are architects may not be members. He concluded that the AIA listings provide only a partial list of architects. Our experience with this list appears to be consistent with that observation. Ultimately, we found that attempting to identify architects was our most difficult challenge.

Dun and Bradstreet Data

Because there was no firmographic data beyond company name and address in the PEC participation files, we attempted to match company names from participation files with Dun and Bradstreet (D&B) data. There are two potential benefits of doing this. First, matching permits us to attach SIC codes to firms in the participation file, and this allows us to classify types of business for purposes of analysis. Secondly, D&B files contain information about the size of firms, the number of employees, annual revenues, and other information. Successfully linking the D&B data to the participant data allows us to conduct additional analyses to better understand the characteristics of firms that the PEC is reaching.

About two-thirds (~19,700) of the records in the participant database (~30,000 records) had company names. From this, we generated a list of all companies and organizations that have used the PEC and have addresses in Northern California (Zip Codes beginning with 94 and 95). After cleaning the PEC participant database and eliminating as many

duplicates as possible, we ended with a list of 5,586 firms with Northern California addresses who had employees who had used the PEC. Keeping in mind that there were many participants for whom we did not have company affiliation, this is a low estimate of the number of firms in Northern California which have had employees that used the PEC. Some of these firms have multiple locations.

We sent this list to Dun & Bradstreet for matching. For each match we asked for standard SIC codes, company parentage, revenue for recent years, number of employees, square footage, and other information. Dun & Bradstreet was able to match 3,466 of the 5,586 records for a match rate of about 62%. About 300 of these had multiple locations in Northern California. We were then able to relate D&B information back to firms in the participation database with single locations.

Telephone survey

The last major source of data was a telephone survey of PEC participants conducted in November 1997. The survey was designed to last 20 to 25 minutes. A copy of the survey questionnaire is provided in Appendix E.

Respondents were asked about the PEC services they had used and the frequency with which they used the services. They were also asked which topics presented by the PEC were of most interest to them. There was a section about the respondents' reasons for participating in PEC events.

In addition, respondents were asked a series of questions to determine if the respondents influence decisions about HVAC systems, lighting designs, and/or architectural features of buildings. For each area where they had influence, respondents were asked if they had attended any PEC events related to that decision-making area. If they had, they were asked a series of questions about their behaviors in that decision-making area and whether those behaviors had changed between the period before they attended the events at the PEC and the present. Finally, they were asked to assess the extent to which any changes they reported resulted from their participation in PEC activities.

The questions were designed in this way to help overcome some of the limitations inherent in using a "single shot" survey to assess change. Because there is an enormous range of content in the PEC's offerings, the sets of questions were designed to tap a broad range of behaviors. Second, the questions ask about specific behaviors as opposed to respondents' opinions about what they may have learned at the PEC. People are usually able to more accurately recall past behaviors than opinions. For instance, people are usually able to more accurately recall when they first used a new technique or procedure than when they first formed or changed their opinion. Also when questions are more specific, respondents' understandings of the questions and the resulting responses to them are likely to be more consistent across respondents.

The survey also contained questions for people who had used the heliodon, borrowed measurement equipment, attended sessions on building simulations, or had one-to-one consultations with staff. These questions focused on whether experiences with the PEC may have caused changes to professional practice.

Finally, respondents who indicated that their practices had changed were asked a series of questions designed to determine what impact those changes might be having in the market. In particular, respondents were asked how many buildings might have been influenced by changes in practice resulting from PEC activities.

The survey also contained questions on use of workshop materials, how respondents learned about PEC events, professional networking, and factors that influence decision making about products and services in the market. There was a standard section for demographics and firmographics.

A sample of 1,258 records was drawn from among PEC participants who had attended at least one PEC sponsored event after January 1995. This cut-off date was chosen to balance problems related to remembering details of their PEC related experiences against the need to include respondents who had had time to actually implement what they had learned at the PEC.

Based on our examination of attendance records, we knew there were significant differences in the degree to which various professions were represented in the population. We attempted to stratify the sample in order to ensure a substantial representation of each of the major target groups: architects, engineers, designers, tool users, etc. The attempt to stratify the sample was only partially successful because many of those in the participant database did not have occupational classifications. When no occupational classification was available, a participant was placed in a general pool from which we drew a random sample.

Respondents were contacted by telephone during regular business hours. They were told the purpose of the call and asked to participate. Because of the large number of voice mail machines being used by businesses, interviewers were asked to leave a message on the first contact, and subsequently to attempt to reach each respondent directly. When requested, interviewers made arrangements to conduct the survey outside of business hours.

Of the original sample of 1258 participants, 474 sample points (38%) were unusable because the respondent could not be located, the telephone number was disconnected, the telephone number was incorrect, the number was a fax or modem line or the person was ineligible to participate.

A total of 216 interviews were completed from the 322 respondents with whom we able to establish contact and explain the survey. There were 104 refusals. The completion

rate for individuals with whom contact was established and to whom the purpose of the survey was explained was 67%. Almost all of the individuals (104) who declined to take the survey did so when told it would take 20 to 25 minutes to complete. Two people terminated the call during the interview.

For the remaining 464 sample points, 19 percent were situations in which no contact was established. For an additional 55% of this group, we were unable to get past answering devices after repeated attempts. For the remaining 26 percent, attempts to complete callbacks went unresolved. As many as fourteen attempts were made to reach individuals in the sample frame. A sample disposition table (Table 40) can be found in the Methodological Notes in Appendix A.

Chapter 4. Defining the target markets — The commercial building sector and associated professionals and professional organizations

Introduction

The life cycle of buildings can be conceived as a funnel (Figure 7) with six stages. The vertical axis of the funnel represents opportunities to influence decisions that affect the value of the building for the owner, the comfort of the occupants, and the energy efficiency of the building. As one progresses from schematic stage to completion of the structure the opportunities to influence decisions diminish rapidly. The opportunity to influence increases when the building is being rehabilitated only to diminish again once the renewal is completed.

In the schematic stage decisions about the orientation of the building, the materials to be used in the shell, the potential for using shading devices, the sizes of windows, and the choice of glazing all impact the efficiency of the building and the comfort of the occupants. Once these decisions are made, they establish the parameters, such as ambient light and solar gain, within which other building systems, such as lighting and HVAC systems, must operate.

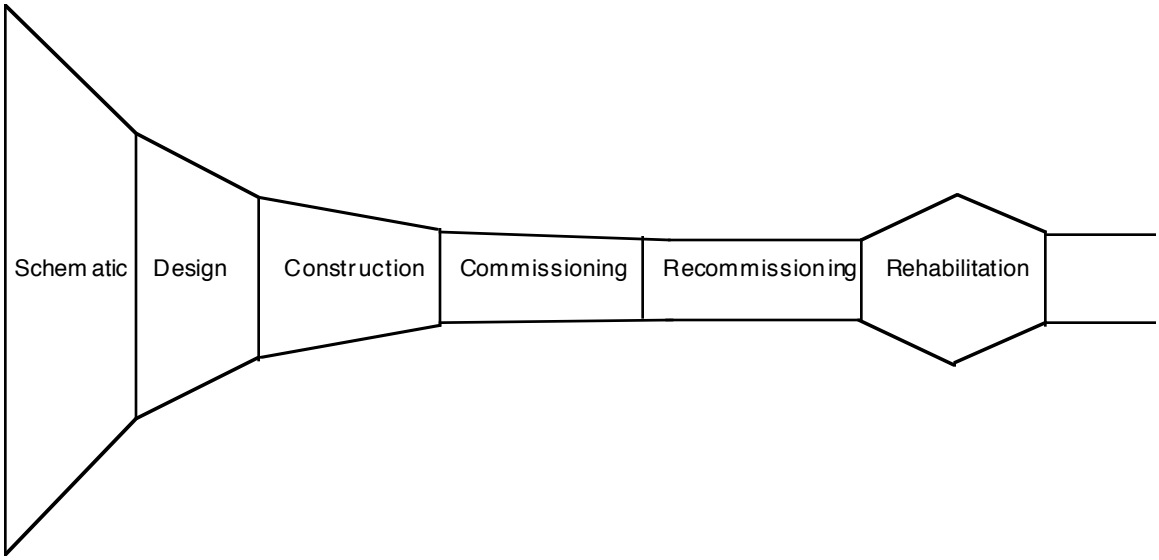


Figure 7. Schematic for the range of decisions in a traditional architect driven design model

As decisions are made about the type of HVAC system, the choice of components, and the organization of the system, other opportunities are foreclosed. The same is true of choices about the use of controls, downlighting, and efficient lamps. In the construction phase choices about construction techniques and methods and the quality of construction foreclose additional opportunities. At the commissioning stage, the choice of operating strategies and the adjustment of controls determine if the building will be used optimally. Maintaining and adjusting the operating strategies over time represent opportunities to maintain value, efficiency and comfort. Buildings do need renewal and when that happens, the opportunities to influence energy efficiency increase.

This chapter is about the market actors who have opportunities to influence the decisions at each of these stages and about the context in which the actors operate. Who is influential and the level of influence differ by stage and by situation. This chapter discusses who the key actors may be in terms of the way that new construction is organized. It discusses who the important actors are during a building's operational phase. It also attempts to address who the influential actors may be when buildings are renewed. Hopefully, this discussion will provide some insight into who the key PEC target audiences may be and lay the ground work for establishing whether the PEC is reaching and transforming its target markets.

Three models of decision making in new construction

During the course of the research, we identified general models that describe patterns for organizing new construction. The three models are the traditional architect driven *plan/design/build* model; the *design/build* model which has overtaken certain parts of the new construction market and is making inroads into other parts; and a third model, the *collaborative model,* which is an emergent approach. The actors and their relative influence in decision making vary from model to model.

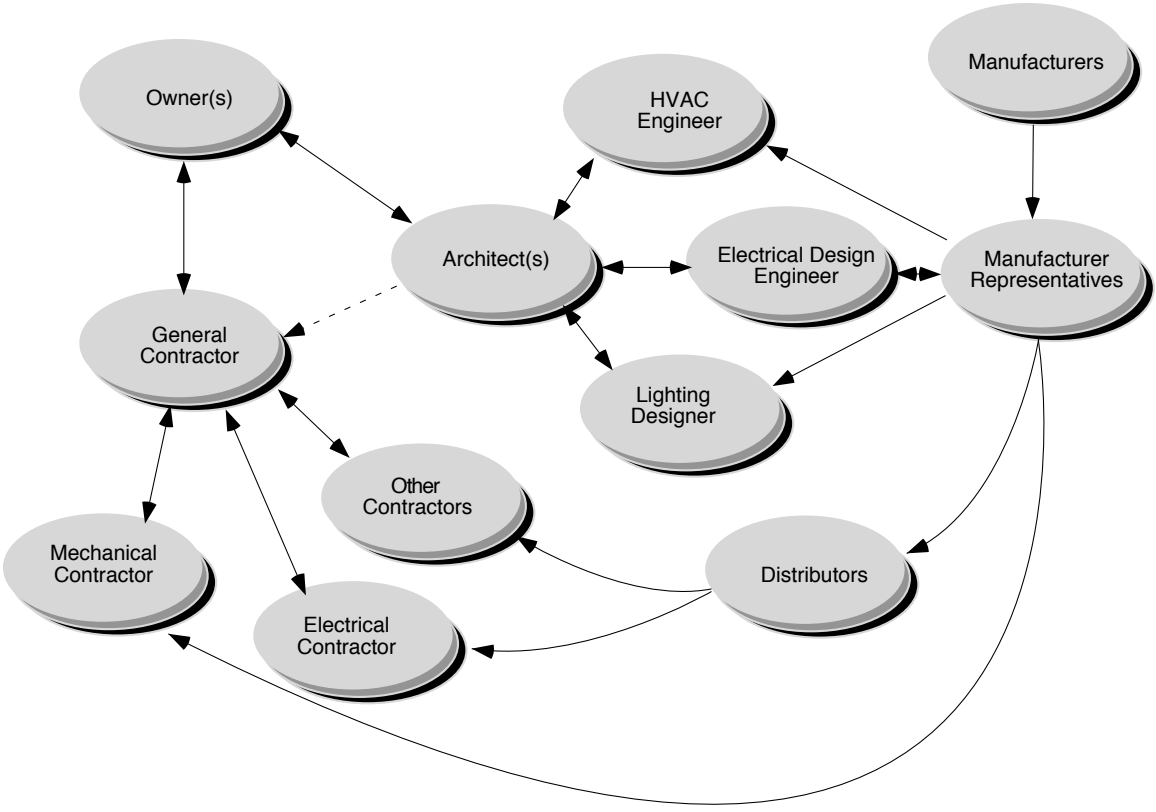
One implication of this is that the PEC's target audience varies by model. A second implication is that the target audiences may be slowly shifting. If the traditional model is being supplanted by the design/build and the collaborative models, that means that the PEC should increasingly be tailoring its efforts to the growth segments of the market.

Because this research wasn't really designed to estimate the size of these market segments we don't have a very good understanding of their relative penetration in the market place. Based on comments from some of the interviews we estimate that the traditional approach is still more than half of the market, design build is perhaps a quarter to the third of the market, and the collaborative approach is a small piece of the remainder. At best, these are rough estimates which simply prove inaccurate when good data are available.

The traditional architect driven plan/design/build model

Figure 8 illustrates the traditional architect driven model. In this model the owner engages the services of an architect usually through a competitive solicitation or competition. The architect is responsible for developing the schematic and managing the development of the detailed plans and specifications. Depending on the size of the firm, the architect will either use internal expertise or engage outside consultants to develop the detailed designs and specifications for the HVAC systems, electrical distribution systems and electrical components, safety and security systems, etc.

With drawings and specifications in hand, the owner solicits bids from contractors to construct the building. The bid process may call for bids from general contractor teams including the mechanical and electrical subcontractors and others or the general, mechanical and electrical contracts may be let separately.



Source: TecMRKT Works. 1997

Figure 8. General model of the actors in a traditionally designed building

One of the theoretical advantages of the traditional plan/design/build model is that design issues are worked out in advance and presumably the solutions are integrated. In reality,

the level of the integration of the solution is highly dependent on the ability of the architect to manage the work team and the degree to which the general contractor is able to manage the construction team. The level of integration can range from full partnership in the design process to fairly independent work by each consultant. Well-coordinated teams are likely to produce buildings that are more efficient, provide customers with value and provide greater user comfort than are teams that function less well together. The level of integration is partially a matter of the owner's willingness to pay for the services and partially a function of the choice of actors, the actors' communications skills, and the functioning of the team leaders.

The number of actors will vary. For instance, the lighting designer may be a member of the architectural firm, may be a consultant as shown here, or may work for an electrical design engineering firm. There can be several variations on this.

In the traditional plan/design/ build, the key decision-makers are the owner, the architect(s) and the consultant designers. It is these actors who make the key decisions about footprint, orientation, facade, equipment, etc. The general contractor and others play much less of a role in efficiency, comfort, and owner value issues.

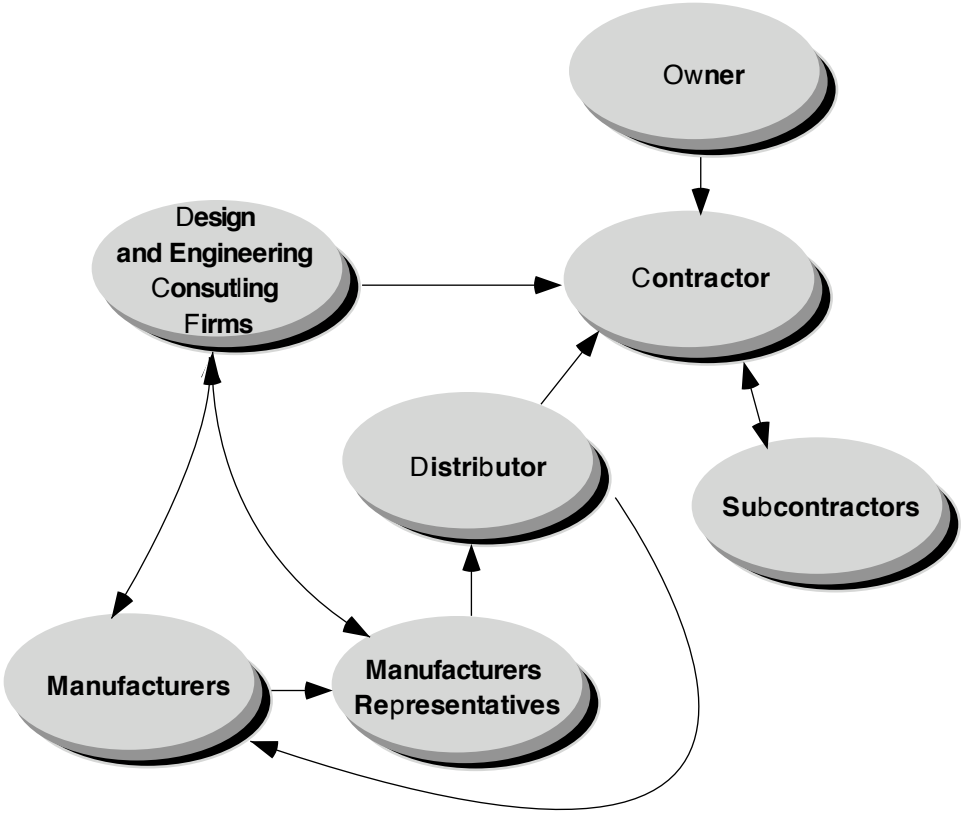
The design/build model

Over the last 15 to 20 years an increasingly greater proportion of new construction activity has been organized using the *design/build* model (Figure 9). A key advantage of the design/build model is speed. In the traditional approach, the architect completes plans before dirt is moved and concrete poured. Design/ build is contractor driven. Design and construction are completed on parallel tracks with an attendant savings of elapsed time. Later stages are being designed as earlier stages are being put into place. Design/build relies heavily on the contractor's experience and knowledge. The goal of the contractor is to construct the facility as quickly as possible.

In the Bay Area, the use of the design/build concept has been fueled by the growth of the semiconductor, computer, and biotechnology industries. The firms in these very competitive industries need to deliver new products to the market in a matter of months which means that they must be able to assemble groups of people and establish them in a work environment as quickly as possible. The design/build process facilitates this.

The design/build approach has been heavily used in areas south of San Francisco, and it is now being used in major structures, for instance, a major new hotel and a commercial office structure in Downtown San Francisco. During the interviews key informants told us that the proportion of projects using the design/build approach is growing, and they variously estimated the number of existing projects in the range of 25 to 50%. From a market transformation perspective, it is important to understand that this model accounts

for an increasing share of the market and that key actors in this model differ from those in the traditional approach.



Source: TecMRKT Works, 1997

Figure 9. Design/build model

Either the contractor builds a shell on speculation or the owner contracts directly with the contractor for completion of the building. The contractor either has internal staff who do the layout and set the specifications or the contractor obtains those services from outside firms. The contractor's employees and the outside design firms may rely on distributors and the distributor's manufacturer representatives for product knowledge. A lot of the work is formula driven and the level of analysis and integration may not be very high.

The people we interviewed who are knowledgeable about design/build activities told us that the primary concern of the contractor is to complete the building. Concern about the efficient use of energy and user comfort is more likely to be driven by the owner or the owner's representatives and tends to stem from two issues.

The first issue is that owners in highly competitive industries are cost sensitive and they want buildings that can be maintained as inexpensively as possible. To the extent that the

energy to operate a building is an important cost factor in their operations, owners will seek buildings that are efficient.

A second issue that is especially important for owners in high technology industries is employee productivity and the retention of valued employees. In some industries, compensation has reached levels where employees focus on amenities and the environments where they put in the long hours required to earn the salaries. Several of those we interviewed observed that building owners are increasingly sensitive to employee issues. They are seeking building environments that minimize problems, such as the glare associated with CRT screens, and designs that give individuals control over at least some aspects of their physical environment, such as the ability to control the lighting in their work areas.

From the perspective of the owners, the productivity issue is probably the more important of the two. From a market transformation perspective, it is productivity (owner value) that sells efficiency. Efficiency is simply the icing on the cake.

In the design/build environment, it is the owners — or their representatives in the person of the property manager or facility managers or design staff of the firm — that are the key decision-makers. Generally, the contractor responds to their requirements. The contractor is also a key decision-maker. The contractor can be motivated to build more efficient buildings if the efficient designs give the contractor an advantage in the market place.

The collaborative process model

There is a perception that buildings built from traditional and design/build models suffer integration and quality problems. Integration and quality problems are perceived to stem from the fragmentation of responsibility, design processes that are more serial than parallel, and inadequate communication between disciplines during design and construction. It has been widely recognized that “bad” buildings result from the lack of teamwork and integration of product by designers and builders.

In the traditional model there is potential for conflict among the design consultants and the architect as well as between the architect, the general contractor, and the subcontractors. In a design/build environment, there is potential for conflict between design consultants and the general contractor.

The conflicts often arise when individual systems requirements are not communicated fully and clearly enough at the various stages of the design process and the disciplinary teams then design systems that meet some but not necessarily all of the requirements. For example, the architect and space planners may not communicate information about the utilization of space and the mechanical engineer may not communicate the physical space requirements for HVAC components or air flow. The result can be conflict

couched in disciplinary values. The architect will defend the aesthetic. The space planner defends the organization and efficiency of the space. And, the engineer puts forward arguments about the thermal comfort of users and indoor air quality.

The crux of the issue has to do the amount of additional design work required to resolve the conflict. The margins in contracts are not large and the profits in design and construction can be quickly dissipated if too much redesign is required. The resulting solution is likely to be based on minimizing and spreading the costs among the involved parties rather than one that provides optimal functionality, comfort, aesthetics and efficiency.

The collaborative process model has been developed as a way of addressing integration and quality issues. In the collaborative process model, owners engage the services of a team representing the range of disciplines needed to construct a new building — architects, design consultants, and contractors — rather than separately engaging the actors. The members of teams have long term agreements to work with one another on projects and to bid as a team.

The collaborative process involves building teams that work well together, that stress performance, that work together to build performance, and that utilize common communication and planning tools to make the design and construction process function smoothly. Collaborative process teams differ from partnering arrangements which may be merely agreements to work together with little focus on interpersonal dynamics and design tools that allow the partners to work together more productively and efficiently.

Collaborative teams try to minimize the conflicts described in the previous paragraphs by encouraging high levels of communication among the members of the team and by utilizing common tools, such as 3d rendering, that can lead to early identification and resolution of problems. Also, collaborative teams emphasize the development of a team culture that focuses on good buildings and emphasizes their common understandings of and approaches to building problems.

From the perspective of transforming the energy market, collaborative teams are potentially an ideal mechanism. Their focus is systemic and their goals are oriented to achieving an “optimal combination of cost, quality, function, scope and time” to meet the needs of clients. This is very similar to the goal of the PEC.

It is interesting to note that the energy commissioning and re-commissioning literature discuss the need for integration among disciplines but provides little practical guidance as to how that integration can occur. The collaborative process is an attempt to define methods for creating higher levels of integration.

It is not yet clear how dynamic this movement may be and whether it will effectively displace the more traditional or design/build approaches. From the perspective of a PEC, the actors in this market represent a potentially strategic target.

Decision making about existing buildings

The previous section described structures, market actors and decision making for new construction. In this section, we briefly tackle those same issues for existing buildings. We start with investment strategies because investment strategies play an important role in determining response to efforts to transform markets.

Investment strategies

Building owners have different investment strategies. The importance of investment strategies is that they establish a framework within which decisions about buildings and changes to buildings are made. Investment strategies are largely the province of high level managers, and managers tend to focus on them to the exclusion of the myriad of other details such as energy efficiency. A request to make alterations to a building will be considered along with other investment options. If optional uses of the funds will beget higher returns, the money is likely to be invested in the optional uses.

The types of investments that may be considered will depend on investment strategy. In a buy and hold strategy, the investor's focus is on buying buildings and holding them with a goal of realizing both capital gains and income from rentals and leases. An alternative strategy may be capital gains oriented. A firm may purchase a building that is partially leased and in need of refurbishing, refurbish the building, lease it, and then sell the building realizing the capital gains. A third strategy is to minimize total investment while seeking as much revenue as possible.

Strategies appear to be associated with firms. Firms structure and organize themselves to make the most of the strategies that they have chosen. Based on the interviews, firms appear to follow strategies over fairly long periods of time. Strategies are probably driven more by the preferences of owners and managers, tax laws, and the expertise of the firm than by economic cycles.

Alternative investment strategies have different consequences for energy efficiency improvements. In a buy and hold strategy, the owner may be looking for ways to add perceived value for people leasing space in buildings especially to the extent that that can increase the return on space. Such a strategy also requires high occupancy rates and the ability to attract or retain customers. In this strategy high performance lighting may be a way of attracting and retaining someone on a lease. A firm with a buy and hold strategy may be willing to consider efficiency investments with somewhat longer paybacks. Whatever the paybacks, they have to compete with paybacks for other types of

investments. If there are investments that yield 30% annually, energy efficiency projects will have to show the same kinds of returns.

In a capital gains oriented strategy, owners may only be willing to consider investments that have a payback that is less than the period they intend to own a building. One of our informants cited the example of a firm that intended to buy and sell a building in three years. From their perspective, this meant that any investments in efficiency had to pay back in this time frame. Finally, revenue oriented firms may only be interested in those investments that clearly enhance revenue streams.

There are least two key points with respect to investment strategies and the transformation of energy efficiency markets. First, the owners, as represented by the investment managers, are interested mostly in return on investment. Large building owners have staff to whom they delegate the details such as calculating return on investments for such things as energy efficiency projects. Managers pick and choose among the alternatives. Detailed information about energy efficiency information targeted to investment managers is likely to go unread. On the other hand, targeting managers with information that favorably compares energy efficiency investments to other investments may get their attention. There is an information market place and the users of information are more likely to attend to information that meets their needs.

Secondly, property owners have general investment strategies. These strategies set the parameters within which investments are made. The investment strategies encompass a much broader set of issues than energy efficiency. There are many opportunities to invest money in buildings. Among other things, one can upgrade a lobby, increase the speed of the elevators, buy improved maintenance equipment, upgrade space for a tenant, invest in energy efficiency, or buy another building. Each item represents an opportunity and a return on investment. If an important criterion is a 35% return on investment, opportunities that don't meet the criterion are likely to go unfunded.

As currently structured, it is unlikely that energy related market transformation efforts will impact the broader investment strategies. What market transformation efforts can impact is what is included in the calculation and how the return on investment calculation is done for energy products and services. For instance, if productivity and energy savings are included in the calculation rather than just energy savings, an efficiency upgrade may be more likely to pass the investment test. The PEC can increase the likelihood that an investment will be made if it can show the investment will payback.

Decision making about existing buildings

Decision structures and key actors vary across different types of building ownership. It is useful to review two or three different types of ownership in order to understand who the important actors are.

Large firms which own and operate large commercial buildings

There are a substantial number of firms that own and manage a very large amount of commercial lease space in Northern California. Although some of these firms are regional, many own and manage property in other parts of the country as well. Figure 10 illustrates the way in which a very large property-owning firm might be structured.

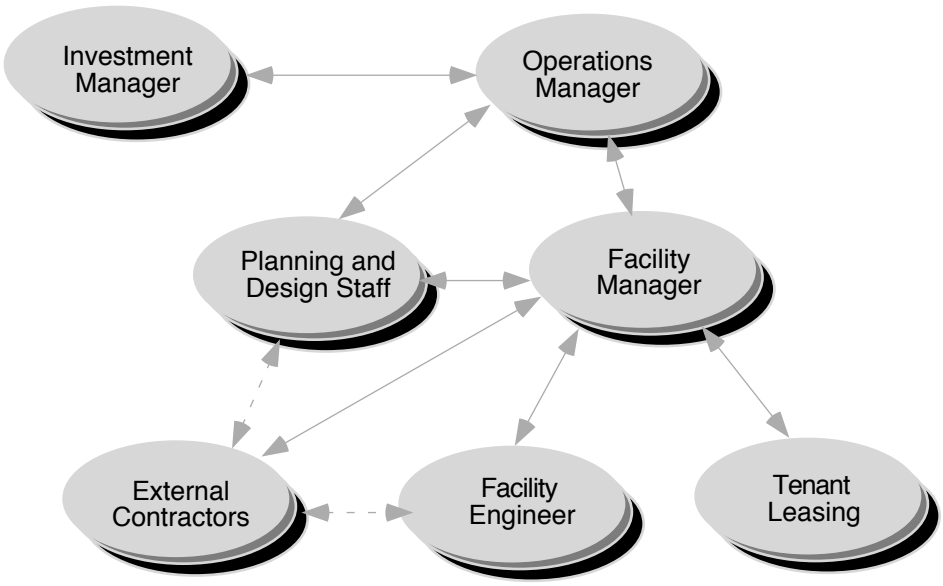


Figure 10. Market actors for a large building owner

In such firms, the investment managers make decisions about investments and investment strategies. The operations manager is responsible for managing the properties that make up the firm's portfolio. For such a firm, each building or building complex would have a facility manager responsible for leasing and operation of the building. The facility manager will have a small staff that may include one or more leasing agents responsible for keeping the space filled and managing tenant affairs. The facility engineer is responsible for the operation and maintenance of the building. A large building might have a Chief Engineer, an Assistant Chief Engineer, and as many as 25 journeyman engineers.

When it is determined that changes are to be made to a building, the corporate planning and design staff is called upon to develop recommendations and do the design work. Depending on the size of the staff and the amount of work, planning and design may be done in-house or through a consultant. Typically, outside contractors are used for projects that go beyond general maintenance.

In this situation there are several actors who influence decision making. Within limits, tenants can dictate the layout of the space and any special requirements that they might have such as improved lighting design. Several of our interviewees indicated that currently many tenants entering spaces are asking for lighting that minimizes glare on

CRT screens. The costs of changes initiated by a tenant are usually recovered through the lease.

A facility manager is responsible for the cost of operations of a building and may make a case to management for investment in the building to reduce maintenance and operating costs, to improve leasing prospects, or to replace equipment nearing the end of its lifetime. Such requests for changes usually originate with leasing agents or the facility engineer.

The corporate design staff probably has the most influence over design and equipment selection whenever there are changes in the building. The building engineer also has significant influence by virtue of the engineer's knowledge of the building. One facility engineer told us that because of exposure to information about glazing films at the PEC, he was able, with the help of a design contractor, to demonstrate that glazing film would meet payback criteria, and was able to get it installed. Facility engineers work closely with outside consultants in developing recommendations and defining the scope of work. The influence of contractors is usually minimal unless they are also providing design services.

From a market transformation perspective, the corporate design staff and the facility engineers for large property owners are the key actors. What they can do is limited by investment criteria and budgets established by upper level managers including the investment managers and corporate operations manager. The building and planning staff, the facility manager, and the facility engineer are aware of the criteria and plan projects accordingly.

In our one-to-one interviews, we found that upper level managers in large property owning firms did not have a great awareness of the PEC but that members of their corporate planning staffs were quite aware of the PEC and made use of it services. In order to get greater awareness and involvement from upper level management, the PEC probably needs programs that focus specifically on investment issues.

Smaller firms which own and manage commercial property

Smaller firms that own and manage commercial property typically have less elaborate management structures. An owner and staff may work directly with facility managers to operate buildings. Operators working in this scale do not have planning and design staff but may have an individual who deals with technical and operational issues. This individual works with consultants or may work directly with contractors to deal with physical issues in buildings. The choice of whether to work with a consultant and then a contractor or directly with the contractor is partially a function of the scope of the project being considered.

In planning changes to a building, there will be a much heavier reliance on consultants or contractors who can provide design assistance. The facilities engineer may play a more prominent role in determining what is done and working directly with the contractor.

The owner will establish the investment criteria. From a market transformation perspective. the key actors are the technical operations manager, the facilities engineer, and the consultant/contractors.

Property management firms

There are a number of large property management firms in the San Francisco area. Property management firms manage and operate buildings on behalf of owners for a fee. Owners typically seek bids for property management services. Because of the frequent conflict, there is not an inconsequential amount of turnover in property managers.

The property management firm is responsible for leasing as well as the maintenance and operation of the property. Property management firms typically have one or more managers responsible for the physical operations of the buildings they manage. As with other large buildings there is a building engineering staff.

Changes to buildings may be made in response to requests by tenants or prospective tenants to make buildings more attractive, to change the costs of operation, or to meet maintenance and replacement needs. Tenant requested upgrades are factored into the tenant's lease cost. The general maintenance and operation of the building is handled through a budgeting process. The owners may become more directly involved in decisions concerning large-scale investments related to building upgrades. The owner sets the parameters within which alterations may be made to a building. The property management firm is responsible for recommendations and for managing the process.

Depending on what is to be done to a building, an operations manager may write bid specifications or engage consultants to establish such specifications. Building engineers will have substantial input into this process. The property management firm will then place the specifications for bid.

From a market transformation perspective, the operations manager, the building engineer, the consultants, and/or the contractors are key actors who influence what is done.

Owner-users

For large firms, which own there own buildings, there is usually a property manager responsible for acquisition and sale of properties. In addition, there is typically a manager with staff who is responsible for physical facilities. Depending on the size of the company, this person may be a professional architect or engineer or a manager who has these professionals on staff. The manager of physical facilities is responsible for upgrades to the facilities and for the maintenance and operation of facilities. Typically

the facilities manager's operation is a budget driven process. There is always pressure to reduce costs. Requests for capital for upgrades typically compete with other investments that the company makes, for example, upgrades to computer equipment.

Depending on the size of the firm, the facilities staff may do design work internally or subcontract work to consultants. The key market actors are the manager of physical facilities and that person's staff. The corporate property manager will be the key actor when an acquisition is taking place.

Building management firms

There are a growing number of firms that provide building maintenance. These firms contract their services to commercial property owners and firms with their own buildings. One of the market niches that they fill is to service buildings which do not need a full time maintenance staff. These firms provide services ranging from maintenance and operation design and construction management in building. The design staffs of these firms are key actors in the market.

Other key actors and associations

There are a variety of organizations and associations related to the commercial buildings market. These include the American Institute of Architects (AIA), the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE), the Association of Energy Engineers (AEE), the Building Owners and Managers Association, the Illumination Engineering Society (IES), The Lighting Forum, the International Facilities Managers Association (IFMA), and the Stationary Engineers Operating Local (Local 39).

AIA is the professional association for the architects. It has an active chapter in San Francisco and has jointly organized programs with the PEC. It actively encourages continuing education among its members and recognizes PEC events for purposes of continuing education credit. Membership in AIA is not universal among architects but most larger firms will have several members. AIA members may be found in academic institutions, government, public institutions, and in a wide variety of businesses.

ASHRAE has a very active local chapter. One of the main activities of the national organization has been standard setting. PEC staff members have played an important role in standard setting as well as in providing leadership to the local chapter. The local chapter regularly uses the PEC for its meetings.

BOMA is a business association representing the interests of large commercial property owners. Its membership includes managers from many of the large commercial property owning firms as well as managers of firms that provide products and services to those firms. Recently BOMA members have banded together to purchase power when the

retail power market opens. As of November of 1997, it appeared that there would be a commodities contract for power covering BOMA members who elect to be a party to the contract and that the contract would include provisions permitting individual members to purchase other energy services from the same vendor. This contract may substantially influence how members of BOMA interact with the PEC in the future. The PEC may have a diminished role for those members who elect to obtain their energy services through the provider contract.

The Illumination Engineering Society is an organization for lighting professionals. It regularly uses the PEC for its programs. It has an education program of its own and makes use of PEC classrooms to teach its courses. The IES has a diverse membership ranging from those who are most interested in the aesthetics of lighting to those who come from electrical engineering backgrounds. There is a subgroup called The Lighting Forum that includes people interested in many of the aesthetic issues.

The IFMA is an organization of facilities managers who manage property for firms and organizations.

Local 39 is the union local for facilities engineers. They represent about 15,000 stationary operating engineers in Northern California and Nevada. They have a newly expanded training facility under development in San Francisco. This training facility provides the bulk of the classroom training that apprentice building engineers receive. This is an extremely important venue for communicating energy efficiency concepts and techniques to building engineers and it should be viewed by the PEC as an important ally and partner.

At the present time, a small but significant number of Local 39 members use the services of the Center. Many of these participants represent some of the largest office structures in the downtown area. As was pointed out above, building engineers are often in a position to recommend important alterations to buildings. Knowledge of what is available and what can be done is important. For example, one building engineer reported that because he had learned about glazing films at the PEC, he was able to get an engineering contractor who was evaluating his building to include glazing film on the list of upgrades. When it was evaluated the film met the payback criteria. A particularly important area for collaboration with the Local 39 Training Center is commissioning and maintenance.

Summary and conclusions

This chapter describes some of the market structures and key market actors that the PEC must influence if the commercial building markets are to be transformed. In the new building construction market there are at least three major ways in which construction is organized, the traditional plan/design/build model, the design/build model, and the collaborative process model. In the traditional model, the architects and designers along

with the owner tend to be the key actors. They are the targets of influence that the PEC must reach. In the design/build model the "owner", usually a property manager or general facilities manager, is the key to influencing building design. Without the influence of the owner, the contractor generally will complete the building as quickly as possible to the contractor's specifications. As we shall see in chapter six, it appears that the PEC is reaching facilities managers who may be purchasing or leasing design/build properties. When it focuses on design/build contractors, the message that the PEC needs to be communicating is that customers want quality buildings and that quality design sells.

The collaborative process is an emergent model. We believe that it will become an increasingly important model as problems with buildings continue to emerge and as the way building industry is organized changes. A possible trend is that the larger firms in the building industry will become more multi-disciplinary and less fragmented.

Underlying the collaborative process model is a holistic approach to construction that is conceptually compatible with the PEC's approach to good buildings. It is not clear how the PEC may impact or be impacted by the collaborative approach. Because collaborative teams already approach problems from a holistic perspective, they may have less need for the types of information available through the PEC or may obtain the information in other ways. Clearly, the PEC needs to know about the collaborativist movement and may want to find ways to partner or align itself with it.

For existing buildings, who makes the decisions about design and construction is dependent on patterns of ownership and management. In large commercial property companies, there may be professional design staff that influence design decisions or that supervise the work of consultants. Facility engineers with their intimate knowledge of the buildings may play a significant role in decision making. Decision-making takes place within the limits of investment criteria and strategies. From the perspective of trying to influence the market, the PEC is not likely to change building owners' broad investment strategies. What the PEC may be able to influence is what is included in the calculations for return on investment and how the calculations are done. This could result in a shifting of priorities on the part of building owners.

Some owners hire property management companies to manage their buildings. Property management firms have technical staff who are responsible for design and construction work. They may do the design and specification work or they may contract it to consultants. They may also hire contractors with design capability. Property management firms must be able to sell the value of efficiency to the owners.

Some building owners may use maintenance contractors who provide design and construction management services. Here, the maintenance contractors must be the target of the PEC's efforts if changes are to take place.

The structure and functioning of the buildings market is much more complex than can be described in this brief characterization. From a marketing standpoint, a much more thorough study or set of studies that identify the characteristics of the various market segments would be useful. For instance, there are probably other models that describe the organization of building construction. Undoubtedly, there are investment strategies beyond those described here. Research that would more fully describe how these work and provide a quantitative assessment of their prevalence in the market would allow for the targeting of appropriate messages to the right audiences.

Chapter 5. The PG&E Energy Center and its programs

Introduction

The purpose of this chapter is to provide a more detailed view of the PEC and its programs. This description provides essential context that will help readers to understand and interpret the findings presented later in this report.

The PEC facility

The PEC is a 32,000 square foot facility located in a remodeled older building in the South of Market Street Area in San Francisco. The three levels of the building and its roof are used intensively in all aspects of the program. The building is itself a technology showcase. For example, there are interior lighting controls, motorized exterior blinds, vanes to reflect or direct light through a sky light, a computerized building monitoring system, etc.

Upon entering the facility and greeting the receptionist, one's eye is immediately drawn to an opening to the lower level through which one sees the Energy Resource Center (library). One's attention is also drawn to a residential energy efficiency display. This is a model of a residential building that has examples of applications of insulation, vents, and wiring. There are examples of efficient lighting products, an efficient refrigerator, and a new and efficient front loading (horizontal axis) clothes washer and dryer. There are interactive elements to the display that allow one to learn about the sun, shading, and building orientation and architecture. An infrared sensor and display helps to convey concepts of heat. A variety of attractive energy related graphics are found on the walls behind the display.

As one moves toward the back of the building, one passes the lighting classroom on the right. The lighting classroom is designed to facilitate lighting education. The walls of the classroom contain interactive displays illustrating fundamental lighting concepts such as the relationship between lumens, candela, and foot-candles and the relationship between illuminance and distance from a light source and displays that demonstrate the basic operating principles of incandescent, fluorescent, and high intensity discharge (HID) light sources. The room is also designed to allow users to experience the differences between direct lighting, indirect lighting, and direct/indirect lighting for interior spaces. There are luminaires that allow the demonstration and comparison of alternatives to incandescent downlighting. There is a space designed to illustrate the basic principles of lighting design and another set of spaces designed to demonstrate the color properties of light sources.

The first level also contains a large conference/classroom facility and two smaller meeting rooms. One of these contains a skylight system with vanes that can be used to block or reflect light.

The second level has additional space for meetings and classes, a space for model building, the tool lending library, and workspace for staff. There is a specialized classroom used to demonstrate the various mechanical elements of HVAC systems. A large area in the center of the second floor is open and is used to house displays. There are mounted displays of lighting products, control systems, HVAC systems, wall sconces, etc. There is also a glazing display area.

In the back of the second floor are two mock-up rooms that can be configured to demonstrate the effects of a lighting system. The rooms are ten by fourteen feet with movable ceilings that can be adjusted between seven and ten feet in height. South facing windows with exterior blinds can be adjusted to modify or eliminate daylight. The PEC provides the space and an electrician to do the installation of lighting equipment. Users provide specifications, materials, and fixtures to be installed.

The second floor also houses an area where users can mount constructed scale models of rooms so that they can be viewed in order to make a qualitative assessment of indoor environments as they may be affected by glazing, facade elements, and interior finishes. Scale models are mounted against a clear window and viewed from the inside.

The heliodon, an important user tool, is located in a portion of the second floor space. The heliodon is a machine with a tabletop that can be tilted and rotated about different axes and an electric light source to represent the sun. A model of a building attached to the table top, oriented to true north, and adjusted for latitude, can be tilted and rotated to simulate the effects of the sun by time of day and time of year. One can observe how the sun may penetrate a building based on the orientation of the building, window positioning and sizing, the presence of architectural shading devices, and the location of other landscape elements. The heliodon allows a user to test design concepts to see the details of a building's envelope and form to best respond to solar conditions.

The administrative offices are located at the front of the building on the second floor. Staff offices are located in the middle of the building and to one side. Also, staff use some of the space associated with the mock-up rooms and the model building area.

Access is available to the roof that is often used for class exercises.

Description of key program elements and contents

Educational components

The PEC offers numerous educational programs. In 1996 there were 55 educational programs listed on the calendar. There were 34 offerings in the first six months of 1997. In the fall of 1996 there were 24 workshops, attendance at which ranged from 12 to 75, with an average of 35.

The 1996 calendar listed programs in six broad categories, architectural programs, lighting programs, HVAC programs, measurement tools, simulation tool programs, environmental programs, and design programs. The programs ranged from presentations of specific examples of design, for example, Charles Davis's talk on *The Monterey Bay Aquarium's New Outer Bay Wing*, to rather more esoteric topics such as networks to tie together building components and manage building information. Appendix C is a list of courses that were offered in the first six months of 1997.

Some of the programs are jointly sponsored with groups such as the American Institute of Architects (AIA), while others are organized entirely by the PEC. Workshops and classes are typically organized and taught by staff or adjunct staff. They may utilize experts with relevant knowledge and experience. An example of the latter is *Advanced Data Collection Session: Tools and Techniques for Field Assessment of Pumps and Fans*, a program presented by Verne Martin of Flowcare.

Programs range in length from two hours to more than a day. The previously mentioned program on pumps and fans was broken into six topics: fundamentals of pump and fan systems; project screening — identifying good system optimization candidates; optimization study methodology; data acquisition and field performance testing; case studies; MotorMaster Plus demonstration; and wrap up. There are prepared handouts for most of the workshops.

The PEC attempts to make classes engaging through the use of demonstrations and exercises. For instance, a recent class on horizon shading presented three methods for estimating the timing and quantity of shading provided by objects, such as other structures, that may surround a potential new structure. The course concluded with a rooftop exercise asking the students to go to the PEC's rooftop and evaluate one of six locations for a solar collector using each of the three methods.

The Energy Resource Center

The lower level of the PEC contains a reference library. This library has a wide variety of materials including books and reference works, proceedings of conferences and research papers, documents from the California Energy Commission and the Electric Power Research Institute, manufacturer catalogs, product and video tapes, a good selection of

relevant professional journals and trade publications, and a growing collection on renewable energy.

The reference library also has computer equipment, software, and a growing collection of databases and reference materials on CD-ROM. Users may come to the Energy Resource Center to try a wide variety of building analysis software. There are programs for daylighting analysis, electric lighting analysis, life cycle costing analysis, whole building simulations, etc. Staff assistance is available.

The Energy Resource Center is connected to the Internet and the staff is prepared to assist clients in searching for materials on the World Wide Web as well as selected databases to which the Resource Center has access. In recent years the library has been staffed by a full-time librarian who assists patrons in locating materials in the library or through other sources. The librarian has a broad professional network that includes libraries that may be maintained by related firms in the area as well as other specialized libraries that deal with similar issues.

Tool lending

True to its original plans, the PEC has developed a measurement tool lending library. The tool loan program appears to be an increasingly popular service. Based on data collected October 1997 in the PEC's tool lending database, the tool lending program made loans measurement instruments to 521 projects. Eighty-five percent of the loans were to outside clients. The remaining fifteen percent were for internal use, class demonstrations, loans for dissertation studies, etc. Examples of these projects are chiller performance studies, lighting illuminance studies, load profiles, and faulty equipment identification.

The tool library contains a wide range of instruments, including data loggers, temperature probes, pyranometers, luminance meters, humidity loggers, and voltage loggers, to identify just a few.

The PEC also provides training and technical support for the use of measurement tools. For instance, application notes provide general information on data collection, information on using equipment, and suggestions for specific data applications. The PEC also offers automated spreadsheets to help with analysis. There are workshops designed to give hands-on experience. Users can get project specific advice in person, by telephone, or by e-mail.

Consultation

On request, the PEC staff provides consultation in their areas of expertise. Consultations range from brief telephone calls to formal scheduled sessions. Questions focus on the characteristics of specific technologies or may deal with alternative technologies appropriate to particular functions or application.

The staff often arranges for demonstrations in relation to a consultation. For instance, a department store might be interested in evaluating more efficient lamp technology. The goal is to show clothing to the best advantage while improving lighting efficiency. The PEC might arrange for store personnel to bring a rack of clothing to be displayed under alternative lamp technologies, and staff would discuss the characteristics of each technology. Store personnel would use their knowledge of customer perceptions to determine which lamp technology might be most effective in their retail setting.

Staff and users frequently discuss the models of buildings that users bring for evaluation on the heliodon. Staff may have suggestions for design alternatives or for dealing with issues discovered during a session.

These are just two examples of consultation. The possibilities are almost endless. In many consultative situations the staff walks a fine line. They do not recommend specific technologies although they help the user to clarify requirements and assist the user in understanding the characteristics of technologies that might meet the user's needs. Of necessity, the staff avoids entering into consultations in the same way as a professional of record for a project might do.

Meeting services

Talk to any user of the PEC and that user will almost certainly talk about the quality and comfort of the PEC's facilities. The PEC has become a hub for meetings for affiliated organizations. Meeting rooms are well equipped and comfortable. The PEC is centrally located in the Bay Area and public transportation is readily available.

On a recent day when an interviewer was in town, all meeting rooms in the PEC were in use. In May, June and July 1997, months when meetings may be less frequent, there were 55 affiliate meetings at the PEC. These meetings ranged from California Public Utilities Commission subcommittee meetings to a Building Ecology Forum and a Photovoltaics Seminar.

As part of its outreach, the PEC makes its meeting space available to affiliate organizations such as the Illumination Engineering Society (IES) and American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) without charge. Food service is available. One purpose in making the space available is to support affiliate organizations. For example, the IES has made considerable use of the space. During the one-to-one interviews more than one member commented that it has helped to strengthen the organization. Such meetings generate target audience traffic which allows the PEC to showcase its programs and services and allows exposure to staff. One IES member commented that when he attended a recent meeting he had seen a new HID lamp that he had heard much about but had not had a chance to observe. Most people attending affiliate meetings can share similar experiences. It is not unusual to observe staff conversing informally with those attending affiliate meetings.

Outreach

In the first year or two after the PEC opened, there was a concerted effort to draw members of the target audiences to the PEC. There were a large number of events. New exhibits were mounted every six months as a way of attracting people. There was a constant flow of announcements and mailings. This was a very effective way of introducing the target audiences to the PEC.

Resource constraints have limited outreach efforts somewhat in recent years. The PEC now distributes a semi-annual calendar and sends faxes and mailings to firms for internal distribution. Both staff and users agree that there were advantages to the more direct mailings of earlier years. The PEC also provides calendar information to newsletters of affiliated organizations. The PEC promotes its own products and services at its own events.

An important part of the outreach has been for staff to participate in local professional organizations. Each staff person is responsible for relating to one or more professional organizations. For example, one staff member has been very active in ASHRAE, serving on national standards committees and serving as an officer of the local chapter. The librarian has been active with local librarians who staff specialized libraries like the one at the PEC. Other members have been active in AIA and IES. These linkages are important as a way for the PEC to maintain its visibility in the larger community. They also make the PEC more accessible to those organizations and they lead to opportunities for cooperative ventures.

Concepts, products and services the Center is attempting to introduce to the market

In order to evaluate whether the PEC is transforming its target markets, we have to clearly identify the goal and the messages that the PEC is attempting to convey. Only then can we measure whether market actors have received and acted on those messages.

In the introduction to this document we briefly described the goal of the PEC as promoting a systems (whole building) approach that optimizes owner value, user comfort, and energy efficiency. This goal implies that each building is evaluated on its merits and the most appropriate solution tailored for the situation. This philosophy recognizes that there are competing values, that values other than energy efficiency may be perceived by clients as most important. In the end, these values may take precedence in decision making.

A good example of optimizing values is the retail lighting scenario. In its lighting classroom, the PEC can demonstrate the various lighting technologies for retailers. It is up to retailers to choose the technology that best fits their needs. Retailers are not likely

to install lighting that creates a competitive disadvantage. Retailers are likely to choose technologies that create value in terms of the display of goods or decreased costs while maintaining the value of the display of goods. When owner value comes into play, the choice may be the most efficient technology, a technology that leads to a small efficiency improvement, or even a decision to use a less efficient technology. Happily, owner value and energy efficiency usually coincide so that the choice is usually an efficient one. In many instances, an efficient choice is the owners valued choice. Efficiency is a side benefit.

Part of the PEC's message is to encourage the adoption of efficient technology that makes sense economically. But the PEC's larger message is really a message about systems. What the PEC is attempting to do is to encourage clients to tailor and integrate technology in ways that capture savings beyond those that might be achieved by installing efficient components. For example, one might change the facade of a building to incorporate shading devices, change the building's orientation or footprint, attend to window design, use glazing that allows more light to pass. These measures might result in the use of more materials in the facade but allow glazing with higher transmittance factors and the installation of a smaller HVAC system and much less use of energy.

In retrofit situations, one-for-one replacement may not provide the most efficient solution and may not even guarantee a reduction in energy use. For instance, there are documented cases where the replacement of an existing chiller with an efficient chiller of the appropriate size had no measurable effect on energy consumption or led to small increases in consumption. This is because chillers run at some part of their maximum capacity most of the time. If the characteristic of the replacement chiller is not well matched to the point where a chiller runs most of the time, the result can be a loss of the potential savings gained by installing the more efficient machine. More significant savings might be had by replacing a larger chiller with a series of staged chillers allowing the individual chillers to be operated at their most efficient point or to use variable speed drives that allow load matching. The goal is to create the most efficient solution that meets the client's needs not necessarily to install the most efficient equipment. In process systems, simply replacing electric motors with more efficient motors may save a few percent but optimizing the system may increase savings to 30 or 40%.

One of the PEC's important messages to its clients is that by doing more analysis of all kinds, by using more sophisticated tools, and by considering different combinations and arrangements of equipment, efficiency, value, and comfort can be provided beyond that which would come from using efficient components. In order to assess the transforming effects of the PEC, we may want to know if PEC clients are consistently using more efficient equipment. However, sales of efficient equipment cannot account for improved efficiency resulting from not having to use equipment or from more carefully matching equipment. The largest proportion of the effects from the PEC's efforts stem from efficiency improvements based on collecting data and analyzing, integrating, and

organizing systems. To measure the integrative effects as opposed to the results of installing more efficient equipment, we need to discover if PEC users are engaging in the behaviors that lead to integrating components and building systems into more efficient wholes.

Table 2 lists behaviors that might be indicative of PEC clients having adopted the PEC's message. The list is suggestive rather than exhaustive. By measuring the degree to which clients are engaging in these behaviors we can understand whether the PEC is indeed transforming the market.

Table 2. Possible changes in behavior for professionals from various disciplines exposed to the PEC

Architects might be:	Lighting designers might be:	HVAC engineers might be:
• Paying greater attention to sun and shadow effects and doing more analysis to understand these. • Considering shading devices more and increasing how often they are used. • Spending more time considering impacts of windows and types of glazings on thermal loads and interior lighting. • Increasing transmittance of glazings in combination with shading. • Admitting more daylight with reduced thermal loads. • Paying more attention to integrating the shell, lighting and mechanical systems, and making greater use of control systems. • Spending more time on these issues with clients. • Finding ways to complete these types of analyses in productive ways that will keep their services affordable.	• Paying greater attention to and specifying more efficient lighting components. • Doing more analysis to understand the quantity of illumination, quality, and color of lighting to make spaces visually comfortable and attractive and relating this to task requirements. • Spending more time specifying components. • Collecting and analyzing more site specific data. • Specifying more indirect lighting. • Using wall wash in combination with task lighting to reduce the number of general lighting fixtures or the amount of illumination associated with them. • Designing lighting schemes which reduce or eliminate glare while using less energy. • Using computer models to understand the visual effects of daylight entering the structure and integrating controls that coordinate daylight and electric light. • Integrating lighting controls with more general building controls. • Considering the impacts of the lighting scheme on other building components. • Paying attention to commissioning. • Using a broader range of fixtures to achieve their ends.	• Making more use of monitored data in pre-retrofit designs. • Trying to convince customers of the benefits of more sophisticated and extensive analysis during the design phase. • Working more closely with other design professionals to evaluate the interactions between HVAC and other building systems and components. • Doing more whole building simulation. • Giving more attention to load frequency distributions and choosing combinations of equipment sizes to increase flexibility in meeting loads. • Specifying variable frequency drives. • Paying greater attention to commissioning and recommissioning issues. • Making use of post installation monitoring to fine tune the operation of the system. • Using more sophisticated control strategies. • Including life cycle cost analysis in their repertoire.

Chapter 6: The PEC's penetration of its markets

Introduction

If the PEC has not reached its markets, then it is difficult to argue that it has transformed them. In this chapter, we explore the extent to which the PEC has penetrated its target markets. We start by describing participation in the PEC's activities. We then turn to the more difficult issue of trying to determine the proportions of its target markets the PEC has reached. A related issue is the degree to which people in the market have participated in PEC activities. Has the participation been minimal or has it been fairly extensive?

These issues are not as easily addressed as one might hope. There are significant problems, mostly related to the availability of good quality data, that make determining the size of target populations and participation in programs difficult. Because of this, we have pursued these issues using multiple methods in the hope that we would be able to obtain some level of convergence in the answers.

Participation in PEC activities

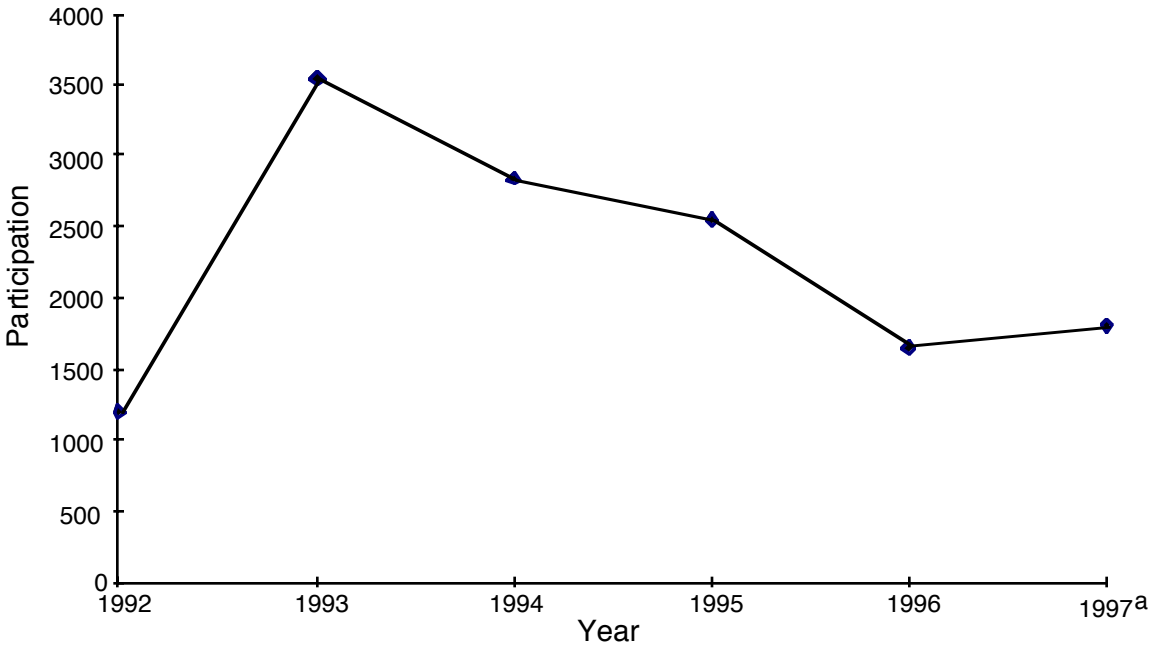
The PEC has a very broad set of program offerings. In addition, there are a variety of forms of participation: attendance at workshops and events, library use, tool lending, and heliodon use. In order to give some idea of the extent of the program and its use, we discuss participation in workshops and other events, library use, and tool use.

Workshop and class participation

Since 1991, more than 30,000 individuals have registered and been recorded in the PEC participation database. Many of these 30,000 individuals received multiple services and the total volume of services easily exceeds 100,000 instances (workshops, classes, heliodon use, consultations, tours, etc.). More than 80% of the people who have used the PEC's services live and work in Northern California, mostly in the immediate San Francisco, Oakland, and Berkeley areas. Registrants from outside the PEC's service area include many individuals from utilities, laboratories, and companies from throughout the United States as well a substantial number of international visitors. Many people, who have visited the PEC facilities to attend meetings of other organizations, are not listed in the participation database.

Figure 11 shows annual attendance at one type of event, educational workshops and classes, since 1992. The numbers are for PEC sponsored workshops and classes and

exclude attendance at meetings or classes held by professional associations such as ASHRAE or IES at the PEC. Also, the numbers in Figure 11 do not include the use of library services (see below), attendance at open houses, attendance at general lectures, borrowing of measurement tools, use of the heliodon, or consultations with staff. An individual who attended several classes is included in the count *each* time he or she attended. However, that individual shows up just once in the registration database. Individuals may have several instances in which they have used other PEC services.



[a] January through September

Source: PEC participation databases

Figure 11. Attendance at educational workshops and classes by year

Peak workshop attendance occurred in 1993, when 3,500 persons attended educational events. Subsequently, attendance declined until 1997, when participation began rising again. The actual 1997 attendance is considerably higher than is shown in the graph because it does not include the last three months of the year. It will likely be at or above the 1995 figure.

There are several possible reasons for the decline in attendance after 1993. It is probable that some of the 1993 attendance was driven by curiosity and interest in what was still a new facility. Also, in the early years of the PEC, individual events were promoted with direct mailings, a practice that has not been continued. Furthermore, displays and exhibits were being revised and mounted on a semi-annual schedule which undoubtedly raised the level of interest in the PEC. Also, there were very real differences in the economy between then and 1997 that have probably impacted attendance. In 1992 and 1993

building activity was lower than at present. In our interviews with key informants, several people suggested that because of the recent economic upturn there has been less time for attendance at PEC events. This may be particularly true of individuals from smaller firms. The economic upturn may have reduced attendance by individuals with a less immediate need for the information presented in the programs. Finally, fewer resources have been devoted to tracking participation in the most recent years, especially 1996, and this may have resulted in slightly lower attendance figures.

The PEC's marketing efforts

To more fully understand how effectively the PEC has reached its target audiences, we need to understand the methods the PEC has used to reach potential clients and the effectiveness of those methods. Because of budget constraints in recent years, promotion of PEC events has been limited mostly to mailings of semi-annual calendars of events, faxes and mailings to selected organizations and individuals, and announcements placed in the newsletters of partner organizations such as ASHRAE and IES.

The survey data (Table 3) confirm that the calendar has been the most frequent source of information used by participants, followed by mailings from the Center. There appears to be a split verdict on professional newsletters as a source of information. Many people

Table 3. Most frequent sources of information about PEC events

Source	Never/ almost never	Sometimes	Frequently	DK/NA
Calendar of events from the PEC	7	23	70	0
Mailing from PEC	18	35	46	1
Information obtained through professional/ trade association newsletter or mailing	44	31	25	
Attendance at events at PEC	30	50	20	0
Information from a colleague within your own firm	39	43	16	1
Information received from colleague outside firm	51	39	9	0
Discussion with PEC staff	61	30	9	
Recommendation of a PG&E employee	62	29	9	
Fax received from PEC	68	23	9	0
PEC Home Page	76	17	7	0
Notice posted on bulletin board in office	79	14	6	1
E-mail	88	7	4	0
Internal electronic bulletin board	94	4	1	1

Source: Participant survey; n=216

say they use them frequently, and many say they never use them. We suspect that this is because some associations regularly include PEC information in their newsletters and others do not. Also, some participants are not members of associations and would not get information through those channels.

During the one-on-one interviews with key informants, the interviewer frequently noticed that calendars posted on bulletin boards, refrigerators, and outside office doors. However, Table 3 shows that notices posted on bulletin boards are very near the bottom of the list of participant information sources. There are several possible meanings for this finding. The low ratings for posted notices could mean that most respondents received calendars directly and therefore did not pay attention to posted calendars. It could mean that some of those who get their information from the "Calendar of events from the PEC" include people who got the information from a posted notice, and it could be that people don't read posted notices. We suspect that some combination of the first and third explanations is the most reasonable.

Personal contact, such as attendance at other PEC events and information received from colleagues inside and outside the firm, are also important sources of information about PEC events.

Electronic sources of information fall near the bottom of the list. In the future, electronic communications may be an important source of information, but the current evidence suggests that many participants do not yet receive or actively seek information about the PEC through electronic media.

During the interviews, there were a number of unsolicited comments regarding the need for more direct contact with members of the target audiences. Several people lamented the demise of event related mailings that were a centerpiece of communication efforts in the early years. They pointed out that without reminders, they often miss events of interest unless they copy information from the PEC calendars to their personal calendars. Several people suggested that direct mailings be re-instituted. The PEC staff also said they felt that direct contact methods produced better results.

There are three additional points that pertain to how effectively the PEC is reaching its target audiences. During the interviews several people confirmed PEC staff views that the PEC is too "PEC focused" and needs to have more events outside the building to better reach target audiences. Several people suggested that the PEC should offer luncheon programs especially at large firms. The PEC staff uniformly agreed that this form of outreach is needed but not possible with current resources.

The PEC is doing well at generating awareness but not quite as well at communicating information about its products and services. During the interviews, we discovered that many of the key players within the professional communities were highly aware of the PEC and *generally* aware of activities but often didn't know very much about the specific

services available from the PEC. For example, several people did not know about or had just heard about the tool lending library. Several informants suggested the need for new services that the PEC is already offering. There appears to be an information gap about the available PEC services among more mature professionals who are managers and/or those who do not use PEC services often. Closing this gap might increase demand for PEC services.

The old saw "location, location, location" certainly has relevance for the PEC. The PEC is said to be located within a mile or two of most of the major architectural firms in the Bay Area. If one looks at attendance patterns, use of the PEC falls off rapidly with distance. Several of the key informants outside the city say that they personally do not use the PEC as much as they might, or not at all, because of distance. Informants repeatedly told us that there is a negative correlation between the distance of PG&E customer representatives from the PEC and the use of the PEC by those representatives. One or two of the key informants indicated that they take clients to see installations closer to where they do business rather than use the PEC because of the distance and inconvenience in getting to the PEC. One informant flatly declared the need for a satellite center in the South Bay Area. There probably is no better location than the current one, but to reach target markets that are not being reached, the PEC may need to devise ways to deliver extended services.

The PEC is currently involved in a major undertaking to make many of its resources available through the World Wide Web. This may help to overcome the distance problem by making access to content more convenient. However, it may still leave a distance gap with respect to the hands-on experience. As we shall see later, the hands-on nature of the PEC experience is highly valued by PEC clients. A significant part of the PEC's success is the first-hand experience with the enabling technologies that are built into the classrooms and the building. It may not be possible to match the dramatic demonstration effects achieved within the building when using media such as the World Wide Web.

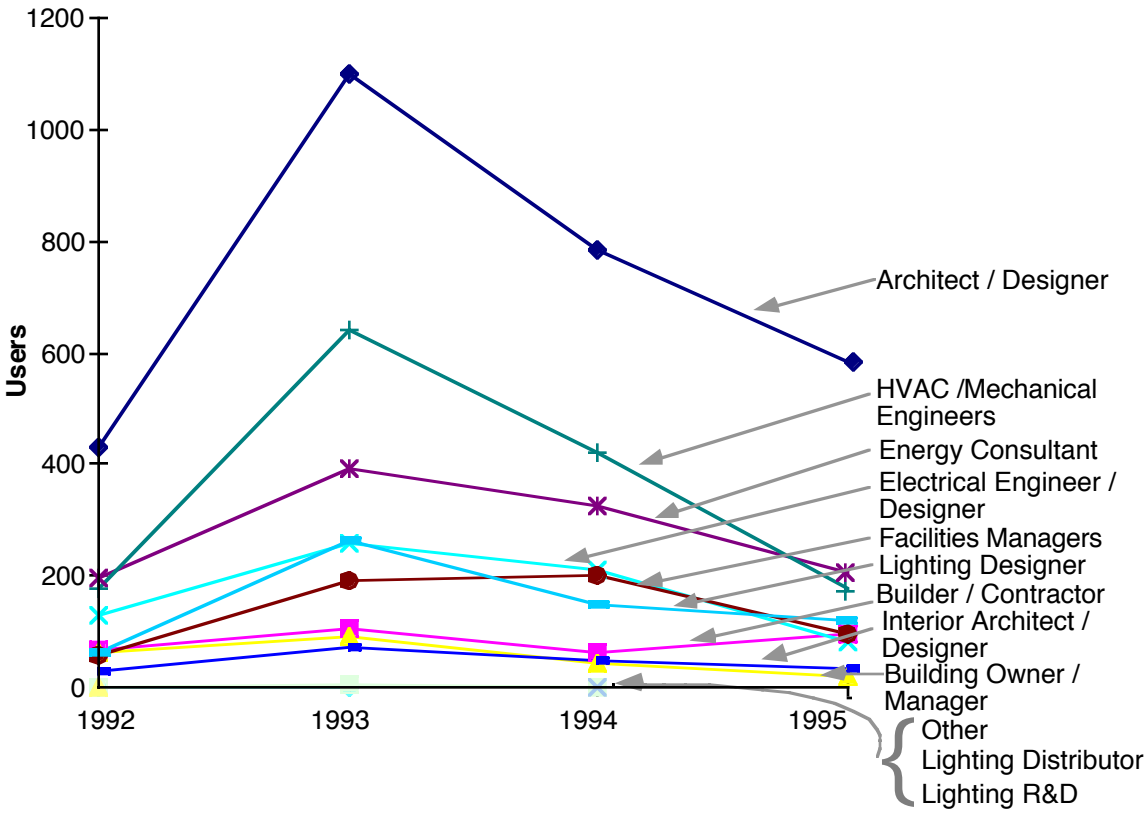
There are several conclusions to be drawn from this material. The PEC is successfully reaching its target audiences. Although effective, neither the staff or key informants perceive current marketing methods to be as effective as the more intensive direct mail efforts in earlier years. This may partially explain the decline in attendance in recent years.

General awareness of the PEC as a facility and place is high. This high level of awareness is not always matched by a similarly high level of awareness of the PEC's products and services, especially among the more senior members of target communities and people who are not regular users of the PEC's services. There is a desire for more off-site outreach both on the part of PEC staff and its target audiences as well.

Characteristics of participants

Using data for 1992 to 1995, we were able to examine participation in workshops and classes by profession Figure 12. The reader should keep in mind that workshops and classes are just one service that the PEC offers and that these curves represent the use of multiple services by the same individuals. In the early years of the tracking system, PEC personnel assigned participants to a professional classification based on information furnished by the participants. The classifications appear to be reasonably accurate. There is some inconsistency in the totals between Figure 11 and Figure 12 because of the availability of occupational codes.

Numerically, the most frequent participants in workshops and classes between 1992 and 1995 were architects/designers. They were followed by HVAC and mechanical engineers, energy consultants, electrical engineers/designers, and lighting designers. If the categories of electrical engineers/designers and lighting designers are aggregated, a not unreasonable

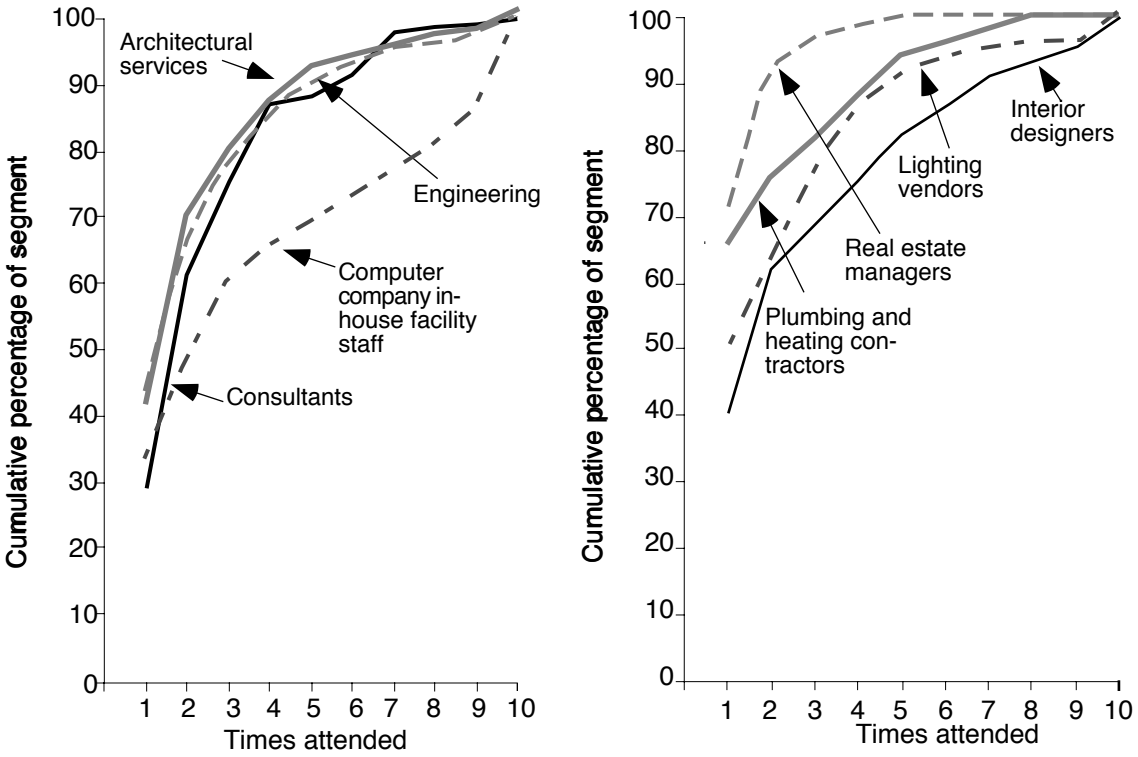


Source: PEC participation databases

Figure 12. Participation by year and occupation

combination, the combined group has greater numbers of participants than do energy consultants. The decline in participation after 1993 occurred most heavily among architects and HVAC engineers. There was also a slight up-tick in participation among builders and contractors near the end of this period.

The numbers in Figure 11 and Figure 12 represent attendance. An obvious question is whether these numbers represent many users participating once and/or a smaller number of discrete individuals participating in several events. In order to examine this, we linked the participation databases to the D&B databases to try to more thoroughly classify the firms whose employees use the PEC. We then generated lists of employees from all firms falling into targeted classifications and attempted to count the number of times individuals attended PEC functions. While we encountered numerous data problems in constructing the information, we believe that the cumulative attendance distributions presented in Figure 13 are representative of how individuals in the different target audiences use the PEC.



Note: Data presented in two graphs for greater visual clarity.

Source: PEC participation data and D&B data

Figure 13. Attendance by professional affiliation

More than half of the facility managers used the PEC two or more times. Forty percent of consultants used the PEC more than once. About 38 percent of lighting designers and 30 percent of architects and engineers used the PEC more than once. Forty percent of lighting distributors and sales people used the PEC more than once and 25 percent of the

people from plumbing and HVAC contractors and 8 percent of the real estate managers used the PEC more than once.

The most striking finding is the attendance patterns for the facility managers from computer companies. About thirty percent of the computer company facility managers attended the PEC five or more times. The next closest group was the interior designers. Ten percent or fewer of the persons from the remaining professions attended five or more times. The reader may recall from the discussion of the design/build concept that facility managers are in a position to influence design/build contractors. At a minimum these data suggest that facilities managers are obtaining the information that is needed to influence contractors. The level of interest by the interior designers may be partially a function of the number of programs offered in their areas of interest and the heavy use of the PEC facility by the IES which may encourage attendance at PEC events.

Overall, we conclude that between 40% and 50% of local users came once, 30% came two to five times, and 10% came more than five times. The fact that substantial percentages of PEC clients are returning indicates that they believe they are getting value.

Experience of the average PEC participant

The survey data can be used to get a better idea of participant demographics. Because the sample was stratified, data from the survey is not necessarily representative of the population of participants as a whole. In fact, Table 4 shows that more than 60% of the survey respondents had attended the PEC five or more times, which, when compared to Figure 13, means that survey respondents appear to have had more PEC experience than other participants.

Table 4. Frequency of use of the PEC

Number of times	Percent attending
1	12
2	13
3	6
4	7
5 -10	31
10 +	30
Total	99

Source: Participant survey

About an eighth of survey respondents had less than a college education, a third were college graduates, a fifth had course work above the college level, and 35% had a master's degree or above. Those with less than college degrees are typically technicians from design firms or operating engineers for buildings.

One might hypothesize that the PEC would tend to attract less experienced professionals who would be attempting to increase their knowledge. In fact, this does not appear to be the case. Based on the survey data, nearly 60% of respondents have eleven or more years of experience in their chosen fields and half have been in their current position six or more years (Table 5). These data suggest that mature professionals are finding value in the offerings of the PEC. The high

percentage of those with more than 20 years of experience also reflects attendance at PEC courses by a number of retirees.

Because the PEC offers such a broad range of services and information, it was not possible to explore in detail peoples' knowledge and skill levels before they attended the PEC. In an attempt to get some idea of the extent to which the PEC was providing completely new knowledge and skills as opposed to adding to knowledge and refining skills, we asked each survey respondent to pick the PEC event or a service that they found most beneficial. We asked them not to consider events that were sponsored by other organizations that were held at the PEC. The respondents were then asked to name or describe the event and tell us when the event occurred. We then asked them to answer two series of questions related to the event or service. The two series of questions were formulated around the stages of adoption. The idea was to see if we could get some idea as to whether people were at the awareness, information, decision, or implementation stage before and after attending the event or using the service that they considered most beneficial. This is not the same as determining their stage of adoption prior to their first use of the PEC.

Table 5. Participants' years of experience and years in current position

	Years in current position (percent)	Years doing this kind of work (percent)
5 or less	47	16
5 - 10	27	16
11 - 15	12	21
16 - 20	7	22
20+	3	22
DK/NA	2	3
N	216	216

Source: Participant survey

Figure 14 shows the results of analyzing these data in a tree format. At the top of the tree we see that 84 percent of the respondents had used concepts, skills and technologies that were the focus of the service prior to receiving what they considered to be a most beneficial service from the PEC. Moving down the tree we see that people who had used the skills or concepts prior to the service were statistically more likely to have sought information from publications and colleagues and that they were statistically more likely to have had some formal training in the area. Fifty-nine percent of the total sample had previously sought information and received training.

Notice that those who had not used the concepts, skills, or technologies prior to receiving what they considered a most beneficial service, were statistically less likely to have sought information and the views of colleagues and were also significantly less like to have had formal training in the area. About half of those who hadn't attempted to use the concepts, ideas, or technologies prior to the service had not sought information or had not had other formal training.

These data suggest that users who come to the PEC have already attempted to implement the skills and concepts. It would appear that a majority of users' purposes for attending the PEC are to hone and improve existing knowledge and skills rather than to learn completely new and previously unused skills and concepts.

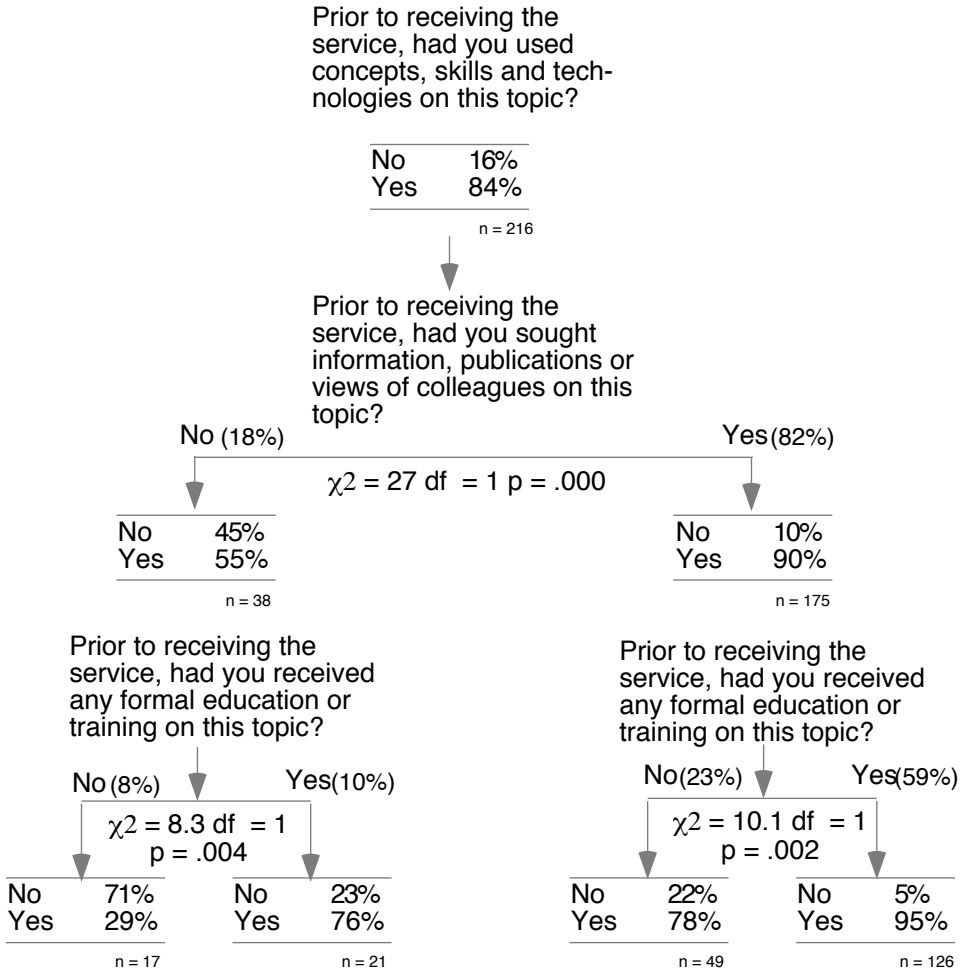
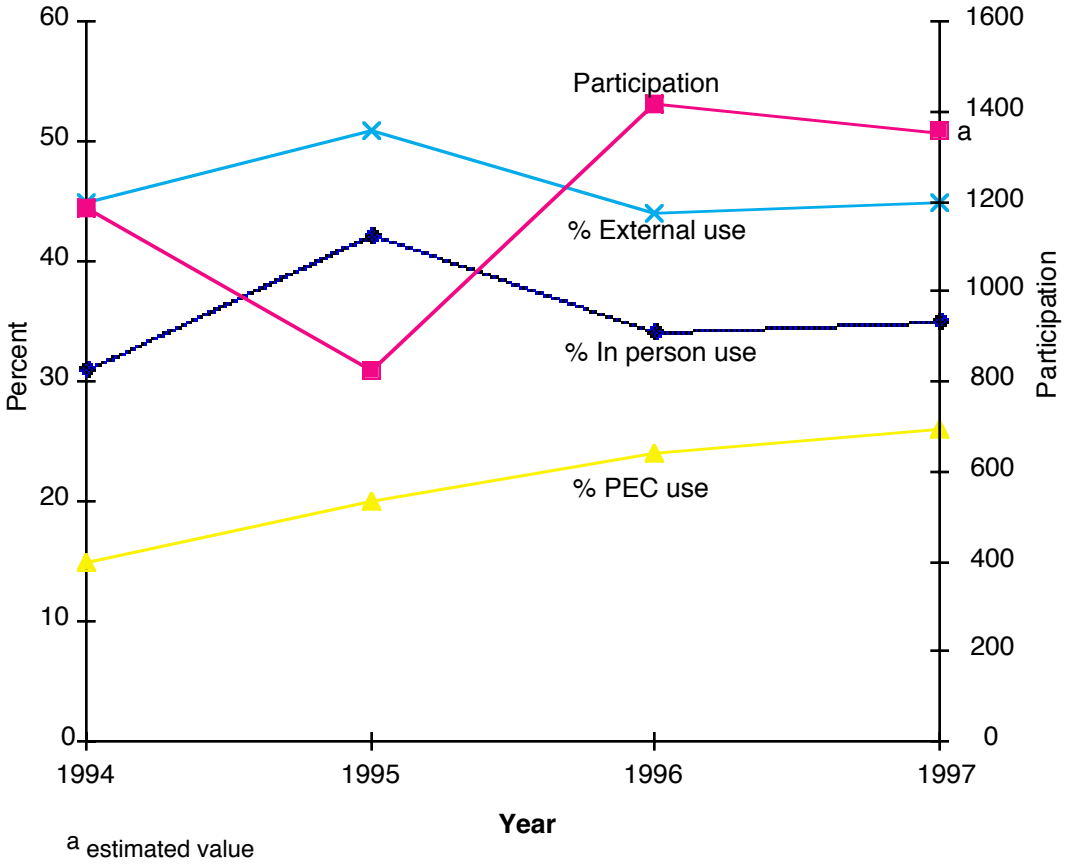


Figure 14. Participants use and exposure to concepts and technologies prior to the receiving a service

Library use

Figure 15 displays information about the absolute number of library users requesting services (right hand scale) and the percentage of users by affiliation (left hand scale). These numbers do not include persons who may use the library without requesting assistance. Many people told us that they stop in the library when they visit the PEC for other reasons.

The requests for library services appear to have been fairly constant over the years and perhaps are up slightly in the two most recent years. The value for 1997 participation is an estimate since complete data are not yet available.



Source: Librarian count; percents use the left scale and participation uses the right scale

Figure 15. Library use

In three of the last four years there have been more than 1,200 requests for information. The use of the library by the target audiences (people who are neither PEC nor PG&E employees) accounts for between 40 and 50% of those requesting library services. Use by PEC staff has been growing and was about 25% of total use in 1997. The library is a significant resource for the staff. Not shown is usage by other PG&E employees, which accounted for about 40% of the usage in 1994, but only 30% in 1997. This decline is probably related to reorganizations and changes within the field representative structure at PG&E. Also not shown in the graphic is the emergence of requests to the library over the Internet. The number of these requests is small but growing.

Based on information from the librarian and a variety of observers, the library tends to support smaller firms that do not have their own libraries more than the larger firms which may have libraries. However, the librarian also reports extensive cooperation with librarians in larger firms and cooperation with other specialized libraries in the community. While the library does have some resources that could be found elsewhere, it also has many unique resources that are difficult to locate and which provide a significant service. The open-ended comments in the survey indicate that PEC users view the library resource very favorably.

Participation in the tool loan program

The tool loan program appears to be an increasingly popular service. Based on information through October 1997 in the tool lending database, the tool lending program had made loans to 521 projects. Approximately 85% of these loans were for field projects, and the remainder were for internal use, class demonstrations, loans, dissertation studies, etc. The equipment is being used for projects ranging from evaluation of lighting systems to the performance of chillers. The range of companies making use of the equipment is quite broad.

Penetration of target market groups

The remaining issue is the degree to which the PEC has reached its target audiences and to what extent it has provided services to those audiences. We have already partially answered the second question in the previous section by describing the usage of the PEC by different market segments.

Because participation data are incomplete and not consistently entered, because it is difficult to determine the exact size of target populations, and because it is extraordinarily difficult to effectively match data from different sources, generating precise estimates of penetration is difficult. We have estimated penetration using different methods and then compared the answers to see if they converge to form a reasonably consistent picture.

We started by matching firms listed for people in the PEC participation database with D&B. About 66% of the participants had organizational affiliations in the PEC database which could be matched with D&B data. We also obtained estimates of the total number of firms in selected SIC classifications as a basis for estimating market penetration.

Table 6 identifies 13 target markets, the number of firms in those markets appearing in the PEC participation database, the number of firms that D&B has listed for those target markets in Northern California and the percentage of Northern California firms with PEC participants. In this case, we defined firms as being from Northern California if the first two digits of their zip codes were 94 or 95. In two instances, architects and energy consultants, we did not include the D&B counts because they are clearly misleading.

Table 6. PEC penetration of target markets based on Dun & Bradstreet data

Category	Number of firms in PEC and D&B data base	Number of firms D&B estimates in Northern California	Percentage Penetration
Architectural services	414	-	-
Engineering services	259	828	31
Interior designers (lighting)	182	437	42
Energy consultants	94	-	-
Real estate managers	85	1362	6
Electrical contractors	85	428	20
Lighting equipment vendors	75	196	38
Plumbing contractors	58	510	11
Non-residential building operators	47	411	11
Single family construction	43	1167	4
Commercial construction	35	453	8
Developers	24	280	9
Apartment building operators	15	549	3

Source: Participation database and D&B match files

By looking at the raw counts in the last column of Table 6, we can see the PEC has served architectural service firms most often, engineering service firms next most often, interior designers next, followed by energy consultants. The reader should keep in mind that these are undercounts because of matching problems. However, this ordering of the data is quite consistent with that in Figure 12, especially if the lighting designer and interior designer groups in that figure are combined.

If we look at the percentages of penetration in Table 6, we see that the PEC has reached 40% or nearly 40% of the firms in the interior designer and lighting equipment vendor segments, and more than 30% in the engineering services sector. It is likely that these percentages are low. The reader should also keep in mind that we are defining the market shed as Northern California and that participation falls with distance. If we were dealing with firms in the vicinity of the PEC, the percentages would probably be well above 50%. Having direct contact with at least 30% of firms in a market segment with a market shed this large is a substantial accomplishment.

It is one thing to reach a sizable proportion of firms, but it is also important to know whether the PEC is reaching the most important firms. One fairly consistent finding from market studies is that 20% of the firms typically do 80% of the business. If the PEC is

reaching the larger firms, its impact in the overall market will be more significant than if it is only reaching smaller firms. It was clear from the interviews that smaller firms were making heavy use of the PEC. The question is whether the staff of larger firms are also using the PEC.

Table 7 shows, for selected market sectors, the size of firms that have used the PEC. The preponderance of users is from smaller firms, which is what one would expect, since more firms are small rather than large. Nonetheless, the data show that the PEC is reaching larger firms as well. For example, 14% of the architectural firms using the PEC have 20 or more employees. Three percent of the architectural firms (12 firms) using the PEC have between 100 and 499 employees in the Bay Area. These are sizable firms.

Table 7. Percent of firms using the PEC by number of employees for selected target markets

Target sector	Percent of firms with number of employees								Total number of firms
	<10	10 - 19	20 - 29	30 - 49	50 - 100	100 - 499	500 +	No data	
Architects	66	16	5	3	3	3	0	3	421
Engineers	43	17	8	7	3	4	1	17	269
Interior designers	81	7	3	2		1	1	6	185
Consultants	66	5	3	4	6	2		13	95
Developers	46	8			8	17		21	24
Real estate managers	41	6	6	5	2	9		31	87
Apartment building operators	40	7				27		27	15
Non-residential building operators	30	9	4	9	9	4	4	32	47
Lighting	24	14	14	14	1			32	71
Electrical contractors	48	9	7	8	8	9	1	9	87
Plumbing / HVAC contractors	34	14	5	7	16	10	2	12	58
Commercial construction	31	14		6	26	6		17	35

Source: D&B data and participation database

The sectors identified in Table 6 and Table 7 are the PEC's target markets. There are probably three firms from outside the primary target markets that have used the PEC's services for every two firms within the target markets. The firms in this secondary market represent the "end users". Examples might be facility managers from high technology firms who are interested in quality environments and keeping costs low or retail space managers who are interested in lighting design issues. The largest percentage

of these participants come from the services sector, which includes hotels, restaurants, business services, health services, and social services. The next largest group is from the retail trades followed by manufacturing. The distribution of these firms is shown in Table 8.

Table 9 shows that while a third of these firms had fewer than 10 employees, larger firms are represented as well. Approximately eight percent of the firms had between 100 and 499 employees and eight percent had more than 500 employees. It is important to note that the PEC is serving audiences other than the target audiences, particularly audiences from the services sector.

Table 8. Distribution of PEC participant firms from non-target markets based on Dun and Bradstreet Data

Sector	Percent
Agriculture, forestry and fisheries	1
Mining	-
Construction	5
Manufacturing	10
Transportation, communications and utilities	5
Wholesale trade	8
Retail trade	12
Finance, insurance and real estate	6
Services	43
Public administration	7

Source: D&B data and participation database

A different way to attack the problem of market penetration is to compare PEC participation with membership rolls of professional organizations and societies. Obviously, not all professionals are members of professional organizations and professional organization membership may only represent a fraction, usually a sizable one, of all practitioners. Thus, counts of professional membership will under estimate the total number of professionals. The under counting may be offset somewhat by the fact that members of professional organizations are often among the most influential professionals within the target segment.

We approached this problem in two ways. The first method was to compare the names from association lists with PEC participation records to see if the individuals listed as members of an association actually participated in PEC activities and events. Based on discussions with different professionals, we anticipated that upper level managers in firms would be more likely to have professional association affiliations than would lower level personnel. We also anticipated that managerial level personnel in firms might be less apt to attend functions at the PEC than line personnel. A direct comparison of names with membership might lead to low counts.

Table 9. Percent of firms using the PEC by number of employees for non-target markets

Target sector	Percent of firms with number of employees								Total number of firms
	<10	10 - 19	20 - 29	30 - 49	50 - 100	100 - 499	500 +	No data	
Agriculture, forestry & fishing	52	4	12	8	0	12	0	12	25
Mining	50	0	0	0	0	0	0	50	2
Construction	47	15	8	6	6	3	2	11	97
Manufacturing	18	7	7	4	7	9	15	32	191
Transportation, communication & utilities	10	5	1	2	6	7	18	52	108
Wholesale trade	44	12	2	5	2	3	1	31	161
Retail trade	46	7	3	3	4	4	5	28	226
Finance, insurance & real estate	31	6	3	3	1	7	14	35	124
Services	37	8	5	4	4	9	6	27	811
Public administration	2	1	1	1	5	14	18	60	131
Non-classifiable establishments									0

Source: D&B data and participation database

In light of this, we decided that we should compare the names of firms represented in professional association lists to the names of firms in the PEC's records. This allowed us to get an idea of the extent to which firms of members were using the Center.

Finally, for individuals who were identified as participants, we counted the number of times they attended events in order to get a measure of exposure.

We had hoped to be able to use this technique for the AIA, the IES, and the BOMA. However, problems with matching and counting the data prevented us from using the AIA membership lists.

Illumination Engineering Society

As an association, IES has made significant use of PEC facilities. The association frequently holds meetings at the Center and uses PEC classrooms for their training courses. When we analyzed participation of this group, we disregarded participation in association activities held at the PEC and focused only on specific activities offered by the PEC.

The local chapter of the IES currently has a roster of 309 members. When we compared the names on the roster with the list of PEC participants, we found that 28% (86) of the members had participated in PEC events one or more times. About three-quarters of these individuals participated in more than one PEC event with the remainder participating just once. A fairly substantial number of IES members have participated in five or more PEC events. The penetration rates are quite consistent with the penetration rates in Table 6 for lighting related firms.

We also analyzed the participation of people from IES member firms who were not IES members. There were an additional 318 PEC participants from firms represented by IES members. This is a large number relative to the number of IES members and the number of firms represented in IES. Perhaps this is to be expected because lighting designers often are employed in architectural firms, manufacturers' representatives, lighting design firms, lighting distributors, etc. Thus, when we look at additional participants from IES member firms we are capturing a much broader spectrum of firms than lighting firms and a much broader set of disciplines.

The extent of participation in PEC activities by IES members is greater than participation of non-member counterparts in their firms. Slightly more than half of the 318 participants attended the PEC more than once. Even though the group is much larger, the number of individuals in this group who participated five or more times in PEC activities was about the same as for IES members.

Building Owners and Managers Association

As we reported earlier, 246 of the 478 members of BOMA were identified as owners or managers of companies. The 246 individual members represented 184 companies. When the names of these individuals were compared with the record of participation at the PEC, we found that 37% (90) of the individuals had participated in one or more events. Of these 90 individuals, slightly more than half had attended just one event.

When we compared the names of firms of BOMA members who were owner managers to the PEC participation file, we found that an additional 192 individuals from the firms of owner manager BOMA members had participated in PEC events. It is not surprising that there were more participants from owner manager firms than there were BOMA participants. In many instances members of BOMA are senior managers who direct people on their planning staffs (see the previous chapter describing this market segment) or employ facility managers or engineers who are participants in PEC events. These people have a direct interest in the information provided by the PEC. The owners and managers often rely on these subordinates to provide them with the technical information they need within the constraints of their investment strategies.

The other half of BOMA membership is comprised of individuals from firms that provide services to BOMA members such as maintenance, electrical services, etc. Only fourteen

of the 232 individual BOMA members representing these firms had participated in PEC events. Sixty-five percent of those had attended only one event. This is not necessarily surprising because many of the services this group provides are unrelated to energy efficiency. However, we found that 192 other individuals from those 232 firms had attended PEC events. Because many of those people are from firms such as electrical contractors or maintenance firms, they have a direct interest in what the PEC has to offer. Approximately 43% of those individuals had attended more than one event and 21% had attended three or more Center events.

Based on this analysis, we conclude that the PEC reached about 40% of the owner managers in BOMA. More importantly, the PEC has reached the designers, planners, facility managers, and facility engineers who work for these owners. These findings are consistent with what we learned from building owner managers during the course of the interviews.

Summary and conclusions

Approximately 30,000 people have attended one or more events at the PEC since its doors opened in December 1991. The total attendance at educational activities has ranged from 1,200 to 3,500 participants per year. The peak year was 1993. Attendance has declined since then, although it appears that it will increase in 1997 in relation to previous years. The groups making the largest use of educational opportunities have been architects, mechanical and HVAC engineers, and those in the lighting professions. Depending on the profession, 10% to 50% of those coming to the PEC attend more than once. Between five and ten percent of participants attended five or more events. The heaviest users appear to be more mature professionals with substantial experience and a fair amount of longevity in their current positions. In terms of the three or four most important target market segments, the PEC has had at least one representative from 30% to 40% of the firms in Northern California. The PEC seems to have reached nearly 40% of building owner managers and a large number of the employees of owner managers. Based on what we know about the diffusion of innovations, these numbers suggest that the PEC is reaching beyond the innovator and early adopter to the early majority.

Chapter 7. Impacts of PEC programs on the commercial building sector

Introduction

In Chapter 6 we demonstrated that the PEC is reaching its intended audiences. In order to transform the market, the PEC must take the next step and deliver its message to its audiences in ways that convince them to accept the message and to adopt new behaviors. The purpose of this chapter is to determine how effective the PEC has been in inducing behavioral change.

A key problem is how to measure changes in behavior. One possibility is to use a proxy such as sales of efficient equipment. However, purchase decisions may only indirectly capture what the PEC is attempting to achieve. The PEC's message is to encourage clients to use a systems oriented approach to buildings that optimizes owner value, occupant comfort, and energy efficiency. If the message is effective and is heeded, the result may be to displace the direct sales of certain kinds of efficient equipment. For example, incorporating architectural shading devices into a building envelope might significantly reduce the need for specialized glazings that reduce transmittance but increase the use of other non-glazing materials. Thus, the sale of the specialized glazings might not increase rapidly and the sales of clear glass might remain constant or increase.

In order to understand the impact of the PEC, we need to examine behaviors that are consistent with a systems approach. For example, are users paying greater attention to the integration of systems? We also need to recognize that the behaviors to be assessed will differ across the disciplines represented in this study.

Basic method

For each discipline – architecture, lighting, HVAC, etc. – we attempted to define a set of behaviors that would result from a systems approach. In the survey, respondents were first asked if they influenced decision making in a given discipline, for example, HVAC systems. If they answered affirmatively, they were then read a list of behaviors that are consistent with a system-oriented approach. For each behavior, they were asked whether the behavior had changed *since before they participated in PEC events*.

Obviously, any number of factors can cause change. Two examples are the emergence of a new technology or changes in the pricing structure for equipment. When respondents said that their behavior had changed, we asked whether their change in behavior was partially, wholly, or not at all related to their participation in PEC activities.

This approach has several advantages. It focuses on behaviors rather than intentions to behave. As we pointed out earlier, the focus on behavior helps to reduce recall problems. Further, because we asked about a fairly broad range of behaviors in relation to the disciplines, the responses allowed us to assess the extent to which different behaviors are being adopted. Finally, this approach allows us to determine whether the PEC influenced the change in behavior.

The impact of the PEC on building design behaviors

Fifty-one of the respondents, about 25% of the sample, said that they make or influence decisions about building design and that they had attended PEC workshops or events related to design issues. Many of these respondents indicated that their design practices have changed since they first participated in PEC events.

If we consider the behaviors listed in Table 10, nearly 70% of respondents said they were spending more time discussing building integration issues with clients than they did before their participation in PEC activities. Slightly more than half said they have increased the amount of effort devoted to analyzing integration issues and to using daylighting in structures. Slightly fewer than half said they are making more use of external shading devices and installing lighting controls in conjunction with the use of daylighting. Between a quarter and a third said that they are paying more attention to building commissioning issues, using more site specific data, and using building controls to integrate systems. A few said they are making greater use of computer models to understand the visual or thermal effects of light entering a building.

Some of these changes are attributable to the PEC. Table 11 displays the percentages of respondents who indicated that changes in their practice were partially or wholly attributable to their attendance at PEC events. So that we could understand the overall impact of these changes relative to each other, we used the number of people who indicated that they were decision makers (51) as the basis for the percentages rather than the number of people who changed their behavior. This allows a direct comparison of the percentages among the different items in the table.

Half or more of the respondents reported that the PEC was partially or entirely the reason for their decisions to change. As might be expected in a world where systems efficiency messages are emanating from a variety of sources, respondents most often reported that the PEC was a partial motivator of change, rather than the motivator of change. The exception to this pattern was the use of controls in conjunction with daylighting. In this instance, a modestly higher percentage of respondents reported that the PEC was a main factor rather than a partial factor in inducing this change. There were instances – for example, changes in the use of external shading devices, commissioning,

and the amount of effort devoted to analyzing costs – where a few respondents reported that the PEC was not at all a factor in changing their behavior.

Table 10. Changing behaviors of decision makers who influence building design

Behavior	Percent			
	Less	About the same	More	DK/NA
Amount of discussion with clients about the interactions among different building systems such as building orientation, shell construction, shading devices, windows and glazing, mechanical systems and lighting		31	69	
Amount of effort devoted to analyzing the initial and long term costs associated with the trade-offs among building orientation, shell design, shading devices, windows and glazings, mechanical systems and lighting	2	45	53	
Use of daylighting		49	51	
Use of external shading devices	2	51	45	2
Use of controls in conjunction with electric lights and daylight to reduce energy consumption and increase visual comfort	2	55	41	2
Attention to commissioning of building systems and controls		63	31	6
Use of measured site specific environmental data in design decisions		73	28	
Use of integrated controls to integrate systems		69	26	6
Use of physical or computer models to understand the thermal and visual effects of daylight entering a structure		80	16	4

Source: Participant survey, n = 51

Table 11. The PEC as a factor in changes in design behaviors

Behavior	Percent		
	Not a reason	Partial reason	Main reason
Amount of discussion with clients about the interactions among different building systems such as building orientation, shell construction, shading devices, windows and glazing, mechanical systems and lighting		37	31
Amount of effort devoted to analyzing the initial and long term costs associated with the trade-offs among building orientation, shell design, shading devices, windows and glazings, mechanical systems and lighting	4	27	24
Use of daylighting	2	24	25
Use of controls in conjunction with electric lights and daylight to reduce energy consumption and increase visual comfort	2	16	25
Use of external shading devices	6	20	22
Use of measured site specific environmental data in design decisions		12	16
Attention to commissioning of building systems and controls	4	14	14
Use of integrated controls to integrate systems		12	14
Use of physical or computer models to understand the thermal and visual effects of daylight entering a structure		10	6

Source: Participant survey, n = 51

The impact of the PEC in the lighting design area

Just under 50% of the respondents in our survey (107) indicated that they influence decisions about lighting and had attended lighting related classes at the PEC. Table 12 lists lighting related behaviors that might be influenced by the PEC and shows the percentages of respondents indicating that their behaviors have either remained the same or changed since attending the PEC. The largest change is that nearly 80% of the respondents report that they are now specifying more efficient lighting equipment and almost 70% say that they are using energy efficiency as a criteria in selecting equipment. These are significant changes in behavior.

Table 12. Percentages of respondents reporting changing or continuing lighting related behaviors

Behavior	Percent			
	Less	About the same	More	DK/NA
Specification and use of more efficient lamps, ballasts, reflectors		20	79	1
Use of energy efficiency as a decision criteria when selecting equipment		30	68	2
Use of analysis to determine the quantity of illumination, quality, and color of lighting to make space visually comfortable and attractive		34	63	4
Attention to the interactions between lighting systems and other building systems		44	54	2
Attempting to enhance productivity through the careful integration of daylighting, quality lighting, and task lighting		49	47	5
The use of daylighting in conjunction with controls for electric lights	2	52	44	2
The integration of lighting controls with other building control systems		63	33	5
Use of life cycle cost or other discounted cash flow methods in decision making	2	64	31	4
Attention to the commissioning and fine tuning of controls	1	61	31	7
Use of measurement equipment to evaluate lighting performance	1	65	29	5
Use of computerized tools to evaluate lighting performance and equipment efficiency options	4	70	21	6

Source: Participant survey, n = 107 for all questions

Respondents (63%) also indicated that they were doing more analysis to determine the quantity and quality of illumination and color of lighting to make space more visually comfortable and attractive. And, just under half (47%) indicate that they are paying more attention to productivity issues associated with a well lighted workspace. It is worthy of note that changes in behaviors associated with increasing comfort and productivity are high in the list and not very far behind efficiency. These themes are an important part of the PEC's messages.

Around half the respondents reported increased attention to the integration of lighting with other building systems and the increased use of controls in relation to daylighting.

Somewhat fewer respondents report changes in behavior related to commissioning issues (31%), the use of discounted cash flow methods (31%), the use of measurement tools (29%), and computer tools (21%) to evaluate lighting performance and equipment efficiency options. We might have expected to see more change in the area of computer tools since there are a number of tools that have recently become available. This is an area where more change might be expected in the future. The data from the interviews seems to indicate that there may be a cost barrier for smaller firms and that the larger firms may be using such tools.

As with the architectural design changes, we asked individuals who said their behaviors had changed with respect to lighting design, whether the change could be attributed in part or whole to the PEC. Their responses are shown in Table 13.

Table 13. Effect of PEC on adoption of lighting behaviors

Behavior	Percent		
	Not a reason	Partial reason	Main reason
Specification and use of more efficient lamps, ballasts, reflectors	0	35	44
Use of analysis to determine the quantity of illumination, quality, and color of lighting to make space visually comfortable and attractive	5	26	32
Use of energy efficiency as a decision criteria when selecting equipment	3	36	30
Attention to the interactions between lighting systems and other building systems	0	31	22
Attempting to enhance productivity through the careful integration of daylighting, quality lighting, and task lighting	0	25	21
The use of daylighting in conjunction with controls for electric lights	2	27	17
Use of measurement equipment to evaluate lighting performance	4	11	15
Use of life cycle cost or other discounted cash flow methods in decision making	2	18	13
The integration of lighting controls with other building control systems	3	20	10
Attention to the commissioning and fine tuning of controls	3	19	10
Use of computerized tools to evaluate lighting performance and equipment efficiency options	6	11	7

Source: participant survey; n=107; percent is percent of lighting decision makers

Nearly all of the persons who had changed their behavior attributed at least some of the motivation for the change to the PEC. On any one behavioral item, no more than a half dozen respondents said that the PEC had no influence.

With the exception of three behaviors, more people were likely to say that the PEC was a partial reason than the only reason for a change in behavior. Those three items were the use of more efficient equipment, the use of analysis to determine the quality of illumination, and the use of measurement tools to evaluate lighting performance. Given the wide array of influences that could cause changed behaviors, it is not surprising that most people consider the PEC partially responsible for the adoption of new behaviors.

Based on these data, we conclude that nearly 80% of the lighting decision makers specified or used more efficient lighting equipment partially or wholly because of their exposure to the PEC. Some 66% used energy efficiency as a criterion when selecting equipment partially or wholly because of the PEC. Fifty-eight percent said that they were using more analysis to determine the quantity and quality of illumination, and 53% said that they were attending more to the interaction among building systems after their exposure to the PEC. Fewer than half indicated that they had adopted other ideas as a result of the PEC. From these data it is reasonable to conclude that the PEC is effecting change in lighting markets.

Impact of the PEC on HVAC system design

A similar analysis was completed for HVAC systems design. There were 72 survey respondents who indicated that they make decisions about HVAC systems and who have attended PEC HVAC related events (Table 14). Of these 72, up to half indicated that one or more specific decision making behaviors had changed in the interval since they had attended HVAC related events at the PEC.

Between 40% and 50% of the HVAC decision makers said that they were paying more attention to the integration of HVAC systems with other systems, using variable speed drives, paying more attention to commissioning and recommissioning, attempting to convince clients of the benefits of more sophisticated analyses, using monitored data in analyses, and using more sophisticated control strategies.

Somewhat smaller percentages of respondents reported using more whole building simulations, load shifting strategies, and combinations of equipment to better meet part and full loads. As in the previous analyses, we evaluated the degree to which the PEC was responsible in part or whole for these changes (Table 15). Once again, the percentage base of the table is the total number of HVAC decision makers rather than those who reported that they had changed their behaviors.

Table 14. Percentage of persons making decisions about HVAC systems indicating the same or different behaviors after attending the PEC

Behavior	Percent			
	Less	About the same	More	DK/NA
Attention to the interactions between the HVAC system and other building systems and components in the design phase	3	47	49	1
Use of variable speed drives in HVAC applications		47	47	6
Attention and effort to commissioning and recommissioning	3	49	46	3
Efforts to convince customers of the benefits of a more sophisticated and extensive analysis during design		53	46	1
Use of monitored data in pre-retrofit designs		58	39	3
Use of more sophisticated control strategies such as condenser water reset to optimize instantaneous performance across climate and load conditions		56	39	6
Use of monitored data for post installation performance analysis		65	32	3
Use of sophisticated computerized analysis tools for systems such as cooling towers	3	64	29	4
Use of whole building simulations such as DOE-2	3	61	29	7
Use of load shifting or reduction strategies such as thermal energy storage to reduce capacity requirements	1	68	28	3
Use of life cycle cost or other discounted cash flow methods		68	28	4
Use of combinations of equipment capacities to meet part or full load requirements		72	25	3
Use of expected load frequency distributions to determine the number and size of components such as chillers		76	18	6

Source: Participant survey, n = 72

Table 15. Percentage of respondents indicating that the PEC influenced their HVAC behaviors in part or whole

Behavior	Percent		
	Not a reason	Partial reason	Main reason
Attention to the interactions between the HVAC system and other building systems and components in the design phase	7	33	11
Use of variable speed drives in HVAC applications	8	29	10
Attention and effort to commissioning and recommissioning	8	32	8
Efforts to convince customers of the benefits of a more sophisticated and extensive analysis during design	1	29	15
Use of monitored data in pre-retrofit designs	1	32	6
Use of more sophisticated control strategies such as condenser water reset to optimize instantaneous performance across climate and load conditions	3	28	8
Use of monitored data for post installation performance analysis	1	21	10
Use of sophisticated computerized analysis tools for systems such as cooling towers	8	17	7
Use of whole building simulations such as DOE-2	4	17	11
Use of load shifting or reduction strategies such as thermal energy storage to reduce capacity requirements	6	19	4
Use of life cycle cost or other discounted cash flow methods	6	11	11
Use of combinations of equipment capacities to meet part or full load requirements	4	13	8
Use of expected load frequency distributions to determine the number and size of components such as chillers	1	15	1

Source: Participant survey, n = 72; percent is percent of HVAC decision makers not percent who changed behaviors

For HVAC decision makers, as many as 44% indicated that the PEC was a partial or main factor in their decision to change. There were no behaviors for which more respondents said that the PEC wholly influenced their change in behavior than partially influenced their change.

The two behaviors that the PEC most influenced were efforts to convince respondents' clients of the benefits of more sophisticated analysis and to be more attentive to the interactions between the HVAC systems and components. About 40% of the decision makers reported that the PEC had at least some influence with respect to the use of variable speed drives.

The PEC has also had some partial influence for about a third of the respondents in terms of the use of monitoring in pre-retrofit situations, attention to commissioning and recommissioning, and the use of more sophisticated control strategies.

The amount of change in the HVAC area does not appear to be as great as in some of the other areas. We attribute this to the fact that the HVAC systems are more costly, more permanent, and perhaps more complex in nature than other systems and that the levels of risk may be perceived to be greater. Still, the PEC has clearly influenced change.

The effects of programs dealing with building simulations

The PEC has offered a series of programs dealing with building simulation. Slightly more than 10% of our sample had availed themselves of the opportunity to participate in these programs. Survey respondents were asked to identify the reasons (Table 16) why they attended the programs. The most commonly cited reason (28%) was that the respondent needed the tool for a specific project.

Table 16. Reason for attending building simulation sessions

Reason	Percent
Needed tool for a specific project	28
Competitor using it	20
Learn about the tool for the first time	20
Refresh knowledge of the tool	18
Wanted to have the skill	10
Thought it would help me to better understand how to design buildings	3

Source: Participant survey; multiple responses allowed; n= 28

Respondents were also asked whether they had changed any of their practices in the period since before they attended the workshop (Table 17). About 40% said that they changed the amount of attention paid to energy usage per square foot and materials being used in the shell. Smaller percentages indicated they were paying more attention to building systems integration issues and the sizing of heating and cooling systems relative to thermal loads. The smallest percentage reported changes to the use of architectural elements for shading and/or reflecting light.

For changes in practice related to this area, most cited the PEC as a partial factor, very few cited the PEC as the only reason for the change in practice, and there were a few who said that the PEC was not at all a factor in their decision to change practices (Table 18).

Table 17. Changes in practices since before attending the building simulation workshops

Practice	Percent		
	About the same	More	DK/NA
Attention to energy usage per square foot	61	39	
Attention to materials in the shell	57	39	4
Attention to the integration of the shell, windows, lighting, and the HVAC system	68	32	
Sizing of heating and cooling systems relative to thermal loads	68	29	4
Use of modeling to evaluate thermal dynamics	71	25	4
Use of architectural elements for shading and/or reflecting light	79	18	4

Source: Participant survey; n=28

Paying greater attention to materials used in the shell was the area in which the PEC was most often cited as having had an influence. The changes in practice for which people most often said that the PEC was not a factor were attention to energy usage per square foot and the sizing of heating and cooling systems relative to thermal loads. A reasonable interpretation of these findings is that building simulation is a tool that one may use in response to other motivators, such as Title 24, rather than itself being a driver of change. And, Title 24 is likely the driver motivating attention to energy usage per square foot.

Table 18. The PEC's building simulation workshops as a factor in changing practice

Practice	Percent		
	Not a factor	Partial factor	Main factor
Attention to materials in the shell		36	4
Attention to energy usage per square foot	7	32	
Sizing of heating and cooling systems relative to thermal loads	7	21	
Attention to the integration of the shell, windows, lighting, and the HVAC system	4	21	7
Use of architectural elements for shading and/or reflecting light		14	4
Use of modeling to evaluate thermal loads	11	14	

Source: Participant survey; n= 28; percent is percent of decision makers and not percent of those who changed.

The features of PEC workshops that have the most impact

Before examining the effects of some of the other products and services offered by the PEC, it is useful to examine the features of the workshops that have the most impact. The PEC has an underlying educational philosophy that translates into a style of communicating with workshop participants. For example, when staff facilitate workshops and classes they make substantial use of demonstrations. Examples of demonstrations used in lighting classes and workshops are the three dimensional unit sphere, illustrating the relationship between lumens, candela, and foot-candles; the inverse square law display, illustrating that the foot-candle level on a surface is inversely proportional to the distance of the surface from the light source; and displays that illustrate the basic operating principles of incandescent, fluorescent, and HID light sources. Also, the PEC staff strives to provide hands on experience in each workshop or class session. For example, students may go to the roof for a solar orientation exercise.

We identified several instructional techniques and types of material that are frequently used by PEC staff when they present workshops. To measure the effectiveness of these techniques, we asked respondents which techniques they used subsequent to the workshop and classroom experience. We told respondents that use might include thinking back to the material while engaged in some professional activity, physically referencing the material or technique while engaged in a professional activity, or sharing the material with others.

Respondents were presented with a list of 9 features of the classroom or workshop experience. Respondents were asked to rate each feature on a five point scale where “1” meant the respondent had not “used” the feature and “5” meant that the respondent had used the particular feature of a workshop or classroom experience a great deal. Table 19 displays the distribution of responses.

Between 58% and 63% of the respondents said that they use the technical data and technical explanations presented during the workshops *quite a bit* or *a lot*. PEC participants also make substantial use of knowledge gained from physical demonstrations and the hands-on methods. The written materials and case studies get less use. One-to-one discussions and the course organizing concepts get the least use. The technical and product information and the practical demonstrations and hands-on methods appear to be the most useful.

The impacts of the use of the heliodon

As described earlier, the heliodon is a device that allows one to analyze the sunlight and shadow effects on buildings. Fifteen survey respondents said that they had used the device to analyze a proposed structure. Nine of the 15 respondents had analyzed one

project using the heliodon. Three people had analyzed two projects. And, three respondents had analyzed three, four, five, or more projects.

Table 19. Use of workshop and classroom information subsequent to participation

	Percent					
	Have not used item	2	3	4	Used item a lot	DK/NA
Technology or product specific data	6	7	28	31	27	1
Technical explanations presented during the workshop or lecture	3	7	27	39	24	
Physical demonstrations of technology such as lighting fixtures, glazing, etc.	21	11	24	21	23	1
Hands on methods of calculation, problem solving, or data collection	18	15	21	25	19	2
Written course materials provided by the PEC	20	14	32	18	16	1
Case studies presented during the lectures	19	15	33	20	14	
One-to-one discussion with the instructor(s)	22	17	26	20	14	
One-to-one discussion with other attendees	24	19	29	14	14	
The course organizing concepts	32	22	20	10	11	5

Source: Participant survey; n = 188

Table 20 shows the reasons given for using the heliodon. Clearly, heliodon users are refining, validating, and evaluating as well as demonstrating the concept with the use the heliodon.

It is clear that the use of the heliodon results in design changes. Nearly all heliodon users Table 21 indicated that they had made changes to architectural elements in their designs as a result of the heliodon session. Roughly three-quarters indicated that the session had resulted in the validation of a design concept. It is not clear if a concept was invalidated for the other quarter of the respondents. Just about a quarter of the respondents said that they changed the orientation of a structure and one of the fifteen persons who replied to this series of questions said that he changed the footprint of a structure based on the heliodon session.

We then asked respondents what was important about the heliodon session (Table 22). The overwhelming majority said that actually seeing the design perform was most important. The ability to use the videotape with either colleagues or clients was viewed as extremely important by roughly half of the respondents.

Table 20. Reasons for using the heliodon

Reason	Percent
Refine an already accepted design	80
Validate a specific design concept and approach	73
Evaluate alternative concepts	67
Demonstrate results of a specific design for a client	67
Allow a client to choose among designs	27
Other reasons	27

Source: Participant survey, n=15

Table 21. Did the heliodon session result in:

Change	Percent
Changes to the architectural elements incorporated into the structure	93
Validation of design	71
Changes to the orientation of the structure	21
Changes to the footprint of the structure	7
Some other change	29

Source: Participant survey; n= 14

Table 22. Important aspects of heliodon sessions

Aspect	Not at all important	2	3	4	Extremely important
Seeing a design perform			7	13	80
Preparing a tape for later analysis and use with other professionals	13	20	7	7	53
Preparing a tape for use with clients	7	13	7	27	47
Discussing alternatives with PEC professionals	7	13	20	33	27

Source: Participant survey, n=15

If the *very important* and *extremely important* categories are combined and the important aspects of heliodon sessions compared, seeing the design perform is still the most valued part of the session. Using the tape with clients is the second most important feature

followed by discussing the alternatives with PEC staff and using the tape with colleagues. Clearly the interaction with the staff is a valued part of the experience.

Heliodon users were asked if they changed their practices as a result of using the heliodon. Between a half and two-thirds indicated that since the heliodon session, they had changed their practices and were paying more attention to solar orientation and siting, windows and glazing, the use of architectural elements for shading, and daylighting (Table 23). Between a quarter and a third said that they had changed the amount of attention they were giving to sizing heating and cooling systems and energy usage.

When we inquired about how much the heliodon session was a factor in their change of practice, all respondents indicated that heliodon was a factor and nearly all reported the heliodon as a main factor rather than a partial factor (Table 24). The fact that the heliodon is more of a main factor than a partial factor is different from the patterns of importance assigned we observed in earlier discussions of importance.

Table 23. Features of practice that may have changed in response to the use of the heliodon

	Percent	
Feature of Practice	About the same	More
Attention to solar orientation and siting	33	67
Attention to windows and glazing	33	67
Use of architectural elements for shading and/or reflecting light	40	60
Use of daylighting elements	47	53
Attention to energy usage per square foot	67	33
Attention to the sizing of heating and cooling systems relative to thermal loads	73	27

Source: Participant survey, n=15

During the course of the interviews, we discussed the heliodon with a number of professionals. Professionals in one or two of the larger firms said that while the heliodon was a very unique and powerful tool, they were more likely to use in-house software to accomplish similar analysis and validation functions. They also said that they are moving away from making scale models such as those required for the heliodon because of the cost of creating them. They are substituting software that permits them to create virtual environments. One executive said that scale models are only being made when there is an expectation on the part of the client that a scale model will be provided. On the other hand, architects who own or are in small firms say that the heliodon is an important resource especially because they say they cannot afford the cost of powerful 3-D modeling software and the time to learn how to use it.

Table 24. Heliodon as a factor in changing practices

Change in Practice	Percent		
	Not a factor	Partial factor	Main factor
Attention to solar orientation and siting		27	40
Attention to windows and glazing		27	40
Use of architectural elements for shading and/or reflecting light		20	40
Use of daylighting elements		27	27
Attention to energy usage per square foot		13	20
Attention to the sizing of heating and cooling systems relative to thermal loads		7	20

Source: Participant survey, n=15

Modeling software provides many of the functional capabilities of the heliodon, e.g., being able to make a virtual movie showing how building structure, building orientation, sunlight, and shading interact. As the price of this software declines, and its capabilities and user friendliness improve, the use of the heliodon may decline. The PEC is anticipating this and is partnering with allies to help create software that can serve the same functions. In the long term, this may be much more widely used and have more impact than the heliodon itself.

The impacts of measurement tool lending

Thirty-nine of the survey respondents indicated that they had borrowed measurement tools from the PEC. Slightly more than a third had borrowed a tool once, almost exactly a third had borrowed a tool two or three times, and more than a quarter had borrowed a tool four or more times.

The reasons for borrowing tools (Table 25) were primarily related to improving operations and maintenance of existing equipment, evaluating equipment efficiency, determining building and energy system utilization patterns, and improving the process efficiency of systems.

Table 25. Reasons for borrowing measurement tools from the PEC

Reason	Percent
Evaluate ways to change or improve operations or maintenance	59
Evaluate the efficiency of existing equipment	56
Determine use patterns	55
Find ways to improve the efficiency of a process or a system	51
Determine if existing equipment was operating according to specification	28
Evaluate a pilot project	28
Find ways to reduce energy consumption	23
Some other reason: dispute resolution, thermal storage project, education project	11

Source: Participant survey; n=39

Respondents reported that the key reason (Table 26) for initiating measurement projects was to increase their own understanding of how systems are working. Locating a problem with building systems and developing evidence for an argument to support a change were also reasons. A few projects were initiated in response to the request or suggestions from others such as management, a PG&E field representative, and complaints or suggestions from building users, clients, or vendors.

Table 26. Reason for initiating a measurement activity

Reason	Percent
Increase your own understanding of how a system(s) worked	66
Locate a problem with building systems	47
Develop evidence to support an argument for a change with people higher in the organization	40
In response to a request from your management	24
At the suggestion of a PG&E field representative	21
Locate unexpected changes in energy use	21
In response to complaints or suggestions from building users	16
For client or at client request	12
In response to a vendor or consultant suggestion	8
Commissioning	2
Only source of metering help	2

Source: Participant survey; multiple responses allowed; n= 39

Tool users were asked if they had taken specific actions as a result of their measurement activities. In 24 of the 39 cases (62%) the tool borrower reported follow-up actions. The largest percentage of tool borrowers (Table 27) reported installing more efficient equipment of the same type (44%), others added controls and adjusted equipment for better operations. About a quarter of the respondents reported reconfiguring a system to meet part load conditions. Reconfiguring systems will often lead to savings of 30% to 40% compared with savings of just a

Table 27. Changes made as a result of measurement and monitoring

Change	Percent
Install more efficient equipment of the same type	44
Add controls	38
Adjust equipment for better operations	36
Change maintenance practices	30
Reconfigure the system to better meet part loads	28
Reduce the amount of equipment	26
Change operating practices and procedures	26
Resize equipment	8
Install different type of more efficient equipment	5

Source: Participant survey; multiple responses allowed; n= 39

few percent for simply doing one-to-one replacements with more efficient equipment. In interpreting these data it should be remembered that borrowers probably had a project in mind and borrowed the equipment to assess the impact of the project. The tools probably enabled them to do the project.

While reducing energy use was the most frequently expected result of the projects (Table 28), reducing demand, improving comfort, and improving system operations were also frequently expected results. Clearly, many tool borrowers had multiple goals.

Interestingly, saving money was mentioned by two individuals. However, this response was not on the list of options. More people might have indicated this as an important goal had it been offered as a standard response.

Lastly, for projects where measurements had been completed but no action had been taken, we asked for an explanation. One reason that was given was that the projects were still awaiting decision. One project was waiting for budget. At least two of the projects were deemed to have a too high first cost and another did not meet payback criteria.

Table 28. Expected results from the measurement projects

Result	Percent
Reduce in energy use	54
Reduce peak demands	46
Improve comfort	44
Improve system operation	44
Change use patterns	23
Save money	4
Lower maintenance	2
Satisfy customer	2

Source: Participant survey; multiple responses allowed; n= 39

One-to-one consultations

The last set of services we inquired about in the survey was consultation with PEC staff. The staff consult with clients on a regular basis. Thirty-two percent of the sample (69 people) said that they had had one or more consultations with the staff. Slightly more than 75% of this group (23% of all respondents) had more than one consultation with staff. Table 29 shows the distribution of the number of consultations as a percentage of the sample.

Persons who initiate one-to-one consultations usually do so because they are looking for specific technical information. In some instances, they are seeking an alternative design or searching for an alternative technology (Table 30). They also may have identified an alternative concept or design and may approach the PEC for information about this concept. Clearly, the one-to-one consultations are oriented around new technologies and alternative designs.

Table 29. Number of times respondents reported having a consultation with the PEC staff

	Percent
Once	9
Two times	12
Three times	3
Four times	2
Five times or more	6
DK/NA	<1

Source: Participant survey; n= 69

Users may seek consultations from PEC staff for a variety of reasons, such as their expertise, knowledge of specific technical information, accessibility, perceived objectivity, etc. Respondents were asked how important each of these factors was in their decision to seek one-to-one consultations. Expertise is clearly the most important factor (Table 31). Knowledge of specific technical information and accessibility are the next most important. While objectivity and reputation with decision makers are also important, they are not as important as the other reasons the PEC staff may be consulted.

Table 30. Reason for a one-to-one consultation with PEC Staff

Reason	Percent
Obtain specific information about a technology	72
Look for an alternative design	49
Learn more about an alternative approach or design idea	49
Search for alternative technologies	48
Work on client related project	6
Work on measurement issues	5
Product development	3
Other	10

Source: Participant survey; n= 67

Table 31. Factors explaining the choice of PEC for a consultation

Factor	Not at all important	2	3	4	Extremely important	DK/NA
The unique expertise of the PEC Staff	1	4	9	16	70	
Knowledge of specific technical information		1	10	25	64	
Availability and accessibility of the PEC staff compared to other sources	3	1	9	43	43	
Perceived objectivity of the PEC staff	7	1	20	26	45	
Reputation of the PEC staff with your project decision makers	14	1	22	22	38	3

Source: Participant survey; n= 67; figures represent percent of participants using PEC consultation services

Summary and conclusions

In this chapter we have attempted to answer two very basic questions:

- Are professionals changing their behaviors in ways that would indicate that they are making decisions that would lead to greater energy efficiency?
- And, if behaviors are changing, can any of that change be attributed to the PEC?

In both cases, the answer appears to be an unequivocal yes. In each of the areas that we examined, architectural design, lighting design, HVAC system design, heliodon use, tool use, building simulations, and consultations services, respondents indicated that they have changed their behaviors from what they were before they used the PEC's services. The percentages of respondents reporting behavioral changes were highest in the lighting area, followed by the architectural design area, followed by the HVAC. This is probably not surprising because the lighting system is probably the building system that is physically the easiest to modify, while HVAC changes are more costly and more complex to implement.

PEC users trace changes in their behaviors in part or whole to the activities and experiences at the PEC. Small percentages of users attributed changes in their behaviors entirely to other influences. There were no instances where high percentages of respondents reported that the PEC was *not* a factor in changing their behaviors. On the basis of these data, we conclude that the PEC is causing changes in the behaviors of professionals in ways that will lead to the more efficient use of energy.

Chapter 8. Relative importance of the PEC among various market influences

Introduction

A major objective of the PEC is to increase access to and diffusion of information as a way of reducing barriers to the use of energy efficient products in the market place. But information is only one of a host of factors that can influence decision making. Cost is a major factor. PG&E's rebate programs influence decision making. Reliability is a factor that often enters into decision making. There is ample evidence that employers are becoming increasingly aware of the effects of building environments on productivity, and productivity is an issue with employers. Distributors, manufacturer representatives, and manufacturers all influence the decision making process in a variety of ways. The California energy code, Title 24, is a factor that influences the adoption of energy efficient practices. Given these influences, as well as other influences in the market place, one can ask how important the PEC's efforts to disseminate information are relative to other factors.

The purpose of this chapter is to describe the relative importance of information and other factors for decision making. One of the key points in this chapter is that there are four distinct styles of decision making and that the PEC is clearly a very important part of the decision making in one of the styles. The implication of decision making styles is that decision makers with different styles focusing on different decision criteria may be more or less susceptible to the influence of programs such as the PEC.

Relative importance of factors influencing decision making

In order to determine the relative importance of the PEC's programs in decision making, the survey included a battery of twenty questionnaire items that represent different types of influence on decision making. Respondents were asked to consider the recommendations or decisions that they made for their most recent projects. They were then asked to rate each of the 20 questionnaire items on a scale of "1" to "5" where "1" was an item that was not at all important to the decision and "5" indicated an item that was very important.

Table 32 shows the items and the percentage of respondents at each level of importance. The items are ordered by proportion of respondents in the *very important* and *somewhat important* categories.

Table 32. Percent indicating the importance of the factor in decision making

Decision factor	Importance (percent)					
	Not at all important	2	3	4	Very important	DK/NA
The reliability of product or design	2	1	12	32	50	3
First cost	4	0	17	27	49	3
Payback	4	7	19	29	38	3
Operating costs	2	6	22	33	34	2
Life cycle costs	6	10	24	28	29	3
A demonstration or test conducted by you	16	7	17	25	29	5
Rebates	13	10	28	21	26	2
Clients' recommendations	8	9	24	35	19	4
Peer descriptions or testimonials about actual installations	8	13	31	32	15	2
Information from the PEC	7	11	33	34	12	3
Advice from colleagues	5	9	36	32	15	3
Installations or buildings you have seen	19	10	31	29	16	6
Specifications from previous projects	8	11	35	24	19	3
The innovativeness of the design	6	9	37	31	13	4
Manufacturers catalogs or representatives	5	16	33	29	13	3
Professional publications	6	16	34	31	11	2
Technical information from utility representatives	14	13	30	24	14	4
The prestige of a product or design	18	16	33	21	10	4
Information from other professional workshops	9	11	42	26	9	3
Printed case studies	18	17	31	25	7	3

Source: Participant Survey; n=216

This group of respondents identified reliability as the most important factor in decision making, placing it ahead of first cost. While the high importance attached to reliability may surprise some, this is not the first time we have seen this. In other studies, respondents have told us that project margins are usually tight and they cannot afford to replace equipment that may fail. Furthermore, they do not want to alienate customers with products that fail. The focus on reliability may reflect major points in the work of

Moore (1991) and Rogers (1995), that the majority of adopters of technology are interested in stable products that work.

The importance of reliability is followed very closely by the importance of first cost. Payback and operating costs are in what might be considered the next group of decision factors, followed by life cycle costs. Respondents judged payback slightly more important than operating cost with life cycle costs bringing up the rear.

A demonstration or test of the product and client recommendations followed and are in the top half of the list. Conducting one's own demonstration or test is very much a product related issue and is tied to the idea of trialability and observability. A product test is rated about equally as important as life cycle costing. These are viewed as more important than peer testimonials, advice from colleagues, and information from the PEC.

The importance of information from the PEC is rated about equal to or slightly more important than information from manufacturer catalogs and professional publications. Information from utility representatives is less valued than information from the PEC as is also the case of information from other workshops. This is consistent with views of the PEC as a source of expertise and a place where information is easily accessible as highlighted in previous sections. Finally, it is worth noting that a product's prestige value falls near the bottom of the list, among rankings of information from sources other than the PEC.

Decision factors

Discussions of the importance of decision factors sometimes assume that there is a standard list of decision criteria that are the basis of decision making. Differences in decision making are assumed to stem from the different weights attached to decision criteria. In the market transformation model the failure to use information is attributed to barriers such as too high search costs for obtaining information or to asymmetries such that one party in a relationship has an information disadvantage.

Another possibility is that people have different clusters of decision criteria that are relevant and important. Even when search costs are zero and there are no asymmetries, individuals may choose to ignore information. For example, an investment manager in a commercial property firm may be interested in return on investment information at the property level. The details of energy efficiency investments may simply be noise in the decision making process. This suggests that different segments of the population will attend to different sets of decision criteria. If this is true, we should be able to detect it in this data.

In order to explore this question, we undertook a factor analysis of the decision criteria. Factor analysis finds subsets of highly correlated variables that explain the underlying

variance in a set of variables, in this case, factors that may explain decision making. Each variable in the analysis is related to a factor, or subset of variables within the data. A given variable will be highly related to a factor or factors that explain similarities in the patterns of variance but it will not relate to a factor that explains other parts of the variance to which it does not relate.

Typically, the researcher examines which variables are highly interrelated by examining how each relates to a factor and assigns a name to the factor based on which variables are highly related. Although the idea is to identify groups of highly correlated variables, factor analysis, if left unconstrained, will identify as many factors as there are variables. The factor analysis typically is stopped when the next factor or combination of variables explains less variation than individual variables would. Thus, if you start with 20 variables as we did, you end with some number of factors, four in our case, each of which explains more variance than any of the individual variables would.

In the current case, we used principal components analysis that identified four components explaining 61% of the variance. In a principal components analysis, the correlation between the factors is zero, meaning that each factor explains a unique part of the variance. The first component explained 38% of the variance and the remaining components, 9%, 8%, and 6% respectively. Table 33 shows the four components and the loadings (degree of relationship) of each variable on each of the four components. For those interested in the details, the eigenvalues are included in methodological note two in Appendix A (Table 41).

After examining the four components, we named the components: the *globally attentive* (1), the *client oriented creatures of habit* (2), the *systems oriented investors* (3), and the *first cost is primo* group (4). For each factor, the cells in Table 33 with the gray backgrounds highlight variables with high loadings. Variables that load highly define the content of the factors. In addition, some cells have been given a light gray border to call attention to them.

If we examine these data carefully, we see that there are four decision factors or styles. People who are *globally attentive* (Component 1) use a very broad range of criteria in their decision making. In effect, they attach importance to most decision factors. They weigh life cycle cost and paybacks, peer advice, information from all sources, data gathered from personal observation, etc. Information from the PEC loads most heavily on this factor but other forms of information also load heavily. It should also be noted that for this group, first cost is the variable that is least related.

The *client oriented creature of habit* decision style (Component 2) leverages the opinion of clients (the variable that loads most heavily) with information from manufacturer catalogs and specifications from prior jobs. As indicated by the other loadings, information from sources such as the PEC, utility representatives and other professions is negatively valued or perhaps, more aptly put, less valued. Also, information about long-

term costs, such as operating costs, payback, life cycle costs, and rebates, are less valued. However, this group does attend to first cost.

Table 33. Decision factors and their loadings on four components

Decision factors	Component			
	1	2	3	4
First cost	.384	.480	.282	.411
Operating costs	.674	-.183	.359	.287
Payback	.605	-.265	.501	.171
Life cycle costs	.639	-.362	.316	.225
Installations or buildings you have seen	.570	.277	.055	-.307
Specifications from previous projects	.617	.463	-009	.004
Advice from colleagues	.647	.319	.088	-.223
Clients' recommendations	.508	.537	.198	-.117
Manufacturer catalogs or representatives	.576	.401	-.256	.253
Professional publications	.619	.013	-.490	.162
Information from the PEC	.702	-.289	-.349	.197
Information from other professional workshops	.671	-.260	-.344	.156
Printed case studies	.674	-.394	-.255	-054
Peer descriptions for testimonials about actual installations	.681	-.027	-.298	-.254
Demonstration or test you conducted	.627	-.253	-.117	-.346
The prestige of a product or design	.591	.127	.019	-.403
The reliability of a product or design	.668	.166	-.073	.149
Design that is perceived to be innovative	.623	.110	-.101	.150
Utility rebates	.510	-.252	.442	-.208
Technical information from utility representatives	.714	-.203	.293	-.183

Source: Participant survey; n= 216

The *systems oriented investor* (Component 3) is primarily focused on payback and other cost issues. The fact that rebates load heavily on this factor suggests that they may be perceived as a way of addressing various cost issues. Information, demonstrations, and product attributes are not valued. To the extent the PEC can frame its system oriented message in terms of energy or productivity investments, it may be able to attract the attention of this group.

The fourth factor represents just one highly valued decision criterion, first cost. This is the group for whom *first cost is primo* (Component 4). Rebates do not influence this

group nor does information, with the possible exception of manufacturer catalogs. You will attract the attention of people who rank high on this factor when the efficiency choice is the same as the least cost choice.

Each individual can be given a score on each of the four factors. Different factors will predominate for different individuals. It is possible to examine the characteristics of groups of actors who are predominantly of one type or another. Some preliminary analysis we have done suggests that property owner managers are predominantly systems oriented investors. The *first cost is primo* group appears to be made up of architects from small firms. We suspect that this group is driven by the realities and/or their perception of the realities of what their clients can afford. The solution for them is to keep costs low.

Summary and conclusions

In this chapter we have examined variables that influence decision making. When the variables were ranked relative to each other, reliability was the most important variable. Different forms of cost turned out to be the next most important variable. Users' own demonstrations and tests, client recommendations, and peer description or testimonials about actual installations, along with information from the PEC, were the next most important set of influences.

However, when we looked at how the various influences related to each other, we found a set of four factors that represent different sets of criteria that influence decision making. These are patterns or styles of decision making among professionals. We have named these the *globally attentive* style, the *client oriented creature of habit* style, the *system oriented investor* style, and the *first cost primo* style. The first group is oriented to information seeking, the second to clients and the past, the third to system oriented investments, and the fourth to first cost. The PEC's programs currently serve the *globally attentive* group well. To the extent that messages from the PEC focus on investment issues, the PEC is likely to serve *system oriented investors* well. In order to be effective with the *client oriented creatures of habit*, the PEC probably has to reach clients of these people. For the group driven by first cost, efficient solutions will be considered when costs are competitive.

The analysis presented here is exploratory but highly suggestive. A similar analysis needs to be pursued with a larger and broader sample of market actors. We suspect that a very similar set of factors will emerge. With a larger sample it would be possible to examine the characteristics of decision makers with different styles and to begin to understand the content and messages that may be most effective in reaching them.

Chapter 9. The PEC's impacts in commercial markets

Introduction

The impact of the PEC's programs on participant behavior was discussed in Chapter 7. The purpose of this chapter is to extend that analysis by describing the ways and extent to which those changes in behavior impact firms, the professional community, and buildings.

The diffusion of innovation literature suggests that change is effected through social networks. An important question is whether PEC participants are influencing other non-participants. We also want to know if the changes in behavior described earlier will persist and if efficiency related actions are likely to continue in the future. A final issue is whether changes in behaviors result in the implementation of efficiency measures in buildings. In short, this chapter attempts to answer the question of whether the changes in behavior described earlier are causing the market to be transformed.

Participants are influencing professional and social networks

One of the key aspects of the diffusion concept has to do with the way in which word of an innovation or idea spreads. Information about innovations is spread either by broadcast methods or contagion. Broadcast methods, such as publications, flyers, advertisements, media announcements, etc., serve to inform innovators and early adopters. The early majority and later adopters learn about innovations and ideas through social contact and social networks, i.e., contagion. We know from the literature that innovations may fail to diffuse if the word of the innovation fails to enter professional networks or the evaluation of the innovation that is communicated within networks is negative.

An important way in which the PEC "markets" itself and its products and services is through the contacts and social networks of people who attend the PEC. We pointed out in the earlier descriptions of the PEC that professionals are highly aware of the PEC as a place.

On the basis of diffusion theory, we would expect that if the PEC is transforming its target markets that its participants would be communicating what they learn at the PEC to others. That is, there would be secondary communications flows.

To investigate this, we asked respondents how often and in what ways they might have influenced others (Table 34). For six of the seven types of behavior influencing communications about which we asked, a majority of the survey participants said that they had communicated in that way one or more times. Many had communicated in these ways several times. For instance, not quite half said that on *several* occasions they had recommended that a client or colleague attend a PEC event. Just under a third told us that on several occasions they had demonstrated a technique, used technical data to support a decision, lent materials to others, promoted or implemented policy changes, or encouraged a partner or subcontractor to incorporate ideas based on something they had learned at the PEC.

The exception to this pattern of secondary influence was communication with manufacturers. About 40% of the respondents said that they had talked to a manufacturer about product changes based on what they learned. Still, it is quite impressive that 40% of the respondents would have

Table 34. Percent of respondents influencing colleagues or policies

	Never	Once or twice	Several times	DK/NA
Recommended that a client or colleague attend a PEC event	16	40	44	
Demonstrated or explained to a colleague a technique that was presented at the PEC	19	50	30	0
Used technical data from the PEC to support a decision	25	44	30	0
Lent or copied materials obtained at the PEC to others	30	42	28	0
Promoted or implemented changes to internal policies or practices in response to something presented at the PEC	31	41	26	2
Suggested or insisted that a partner or subcontractor incorporate ideas learned at the PEC	38	37	25	1
Discussed ideas presented at the PEC with a manufacturer or manufacturers representatives to encourage product changes	61	25	13	1

Source: Participant survey; n= 216

Behaviors are long term

An important issue in transformation studies is whether individuals temporarily alter their behaviors in response to market interventions or whether they continue to practice the new behaviors in the long term. For the 198 respondents who indicated that they had changed their behaviors in response to participation in PEC activities, we asked whether they would discontinue almost all, only continue some, continue nearly all or continue all of the changes. More than half of the respondents (Table 35) said that they would be likely to continue all of their new behaviors, a quarter said they would continue nearly all, and a fifth said they would continue only some of the changes. Only two respondents indicated that they would discontinue the newly learned behaviors.

Table 35. Likelihood of continuing behaviors changed as a result of participation in PEC activities

	Percent (n=198)
Discontinue almost all changes	1
Continue only some of the changes	19
Continue nearly all of the changes	26
Continue all of the changes	54
Total	100

Source: participant survey

We also asked if, in the future, respondents would make additional changes based on what they had learned at the PEC. About 80% of respondents anticipated making additional changes.

Respondents are using behaviors in buildings

In the context of a telephone survey, respondents are not likely to be able to provide or even estimate energy savings from actions prompted by participating in events at the PEC. However, in a survey format they are able to report estimates of the numbers of buildings that may have been influenced by changes in their behavior since their participation and the numbers of buildings that they expect may be influenced in the next two years. For participants who indicated at least some behavioral changes as a result of using the products and services of the PEC, we asked a series of questions designed to understand the impact of those changes on buildings.

Some 173 participants (80%) said that changes in their behavior as a result of participation in events at the PEC had influenced at least one building. Ninety-one percent (Table 36) reported that multiple buildings had been influenced, with 34% reporting that eleven or more buildings had been affected.

The number of respondents estimating future impacts (160) is slightly smaller than those who estimated prior impacts (173). The distribution of the projected number of buildings likely to be influenced in the next two years is similar, although 8% more respondents reported that 21 or more buildings would be influenced.

Table 36. Number of buildings influenced now and in the next two years

Number of buildings	Buildings influenced since participation Percent n=173	Buildings influenced in the next two years Percent n=160
1	9	8
2-5	38	32
6-10	20	17
11-15	8	8
16-20	3	4
21+	23	32
Total	101[a]	101[a]

[a] total exceeds 100 due to rounding
Source: participant survey

We also asked the respondents if these buildings represented some or all of the buildings with which they are involved. About 40 percent of the 198 respondents who answered (Table 37) said that changes in behavior applied to half or fewer of the buildings on which they worked. About 43 percent said the changes applied to nearly all the buildings on which they work. The remainder said that the changes applied to between half and three-quarters of the buildings.

For those buildings for which recommended changes were not adopted, we attempted to assess why. Respondents were asked why changes were not adopted when changes were recommended. Table 38 shows that the primary reason for not adopting a recommended change was initial cost, followed by the general category of "other," followed by lack of interest. In a small proportion of cases, lack of information was the reason.

Table 37. Proportion of buildings influenced by changes in behavior resulting from PEC participation

	Percent n = 198
Less than a quarter	17
A quarter to a half	21
A half to three-quarters	19
Most of the buildings	43
Total	100

Source: participant survey

Finally, we asked whether changes were a personal adoption, a workgroup adoption, or an adoption by the firm. We assume that adoption of changes by workgroups and firms will be more resilient and have more substantial impact than adoptions by individuals. A bit more than half of the respondents (Table 39) said the changes were either a personal adoption or an adoption by their firm. About a third said

the changes were adopted by workgroups. We believe that adoption by a firm represents a fairly high level of adoption.

Table 38. Reasons for not adopting changes in buildings

Reason	Percent[a] n = 186
Higher initial cost	47
Lack of interest on the part of the owner / builder	31
Lack of information	16
Length of the payback	14
Other reason	40

[a] Respondents were allowed to give multiple responses
Source: participant survey

A couple of caveats are in order. We do not know how many of the buildings in this list may be the same building either because we may have interviewed two people from the same firm who worked on the same building or because we may have interviewed respondents from different firms who may have participated in designing or constructing the same building. Also, we do not know the size or characteristics of these buildings. We can say that the largest firms, which are likely to have worked on larger buildings, did report having applied the changes to numerous buildings.

Summary and conclusions

In this chapter, we addressed the issue of whether behaviors that people indicated were changed were actually translated into changes in buildings and whether PEC participants are likely to continue engaging in new behaviors. About half of the respondents said that they will continue with nearly all changes. More than 90% of the respondents said that the changes have influenced two or more buildings. The majority of participants said that the changes have influenced more than half of the buildings with which they are involved. Nearly all respondents indicated that they will continue to use new behaviors in the future and make more changes. Finally, the changes are being adopted by organizations which bodes well for their continued use. Clearly, markets are being transformed and the PEC's clients say they will continue to act upon what they have learned at the PEC.

Table 39. Changes adopted by firms as well as by individuals

Category of adoption	Percent[a] n = 186
Personal adoption	54
Work group adoption	36
Adoption by firm	57

[a] Respondents were allowed to give multiple responses
Source: participant survey

Chapter 10. Key findings and lessons for measuring market transformation

This chapter summarizes the major findings of the research and suggests some lessons for the future assessment of market transformation. We start by reporting the key findings relating to the PEC's programs and activities. We then call attention to selected findings related to the market and close with lessons for measuring market transformation.

Key findings about the PEC's programs and activities

The PEC is reaching its target audiences. The PEC has served more than 30,000 clients providing more than an estimated 100,000 instances of service since its inception in 1991. Architects have been the most frequent users followed by engineers and lighting designers. The PEC has also served a large number of "end-users" in the commercial sector outside the primary target audiences. Notable among these have been facility managers for computer companies. We estimate that the PEC has reached more than 40% of its key targets in Northern California and substantially higher percentages of its target audience in areas of close proximity to the PEC.

The PEC's program offerings are very strong. An indicator of this strength is the high percentages of users who used the PEC's products and services multiple times. For the key target audiences – architects, engineers, and lighting designers – more than 40% have participated two or more times. As many as 10% of these same audiences have participated 5 or more times. Computer company facility managers are among the most frequent repeat users of the PEC.

The PEC's program efforts are evolving in directions that appear to be consistent with the direction of the market. Informants report that architectural and engineering firms are evolving their use of computer tools. The PEC's future program directions include providing enhanced computer tools for analyzing the impact of daylight for different room geometries and a suite of HVAC analysis design tools called Cool Tools.

Because of convenience issues, members of the target audiences at a distance from the PEC have made less use of the PEC's products and services. The PEC is putting much of the content of its programs and technology base on its World Wide Web site. The Web site will significantly increase the accessibility to PEC's message and may partially address the problem of remote clients. It also will likely create a new clientele from outside the PG&E service territory.

One of the keys to the PEC's success has been the interactions with staff and hands-on experience with the enabling technologies and exhibits at the facility. The high traffic

volume generated by providing meeting services has increased the visibility of the Center and its messages. The interactions at the facility have been enriching for both the staff and the users. The Web site will increase the reach of the PEC but it will not and should not displace important face-to-face activity or the physical facility.

The PEC is influencing the behaviors of target market professionals. We conclude that the PEC is influencing professionals to change their behaviors. Nearly 70% of the building design professionals who have used PEC products and services say that they are spending more time discussing integration issues with their clients. Slightly more than half say they are devoting more effort to analyzing integration issues and incorporating daylighting into structures. Slightly fewer than half say they are doing more with shading devices and the use of lighting controls in conjunction with daylighting. *When asked, just under half of these respondents typically said that the changes in their behaviors were almost entirely due to the PEC. The other half said the changes in their behaviors were partially due to the PEC.*

We found similar patterns of changes in behavior and attribution of motivation among decision makers who influence lighting design. Nearly 89% of the lighting designers said that they were specifying more efficient components than they did before they first attended the PEC. Seventy percent said they were making greater use of energy efficiency as a criterion in decision making. Slightly more than 60% said that they were doing more analysis to determine lighting needs and around half said that they were paying more attention to the interactions between lighting and other systems and/or attempting to enhance productivity through the careful integration of daylighting, lighting, and task lighting. *Here again, roughly half of these respondents attributed the changes in their behavior entirely to the PEC with most of the remainder attributing the changes in their behaviors partially to the PEC.*

Among HVAC decision makers, we found that about half said that they had changed their behaviors to take into account interactions with other building systems. Roughly similar percentages said they were now using variable speed drives, were paying more attention to commissioning and recommissioning or had increased their efforts to convince customers of the value of more extensive analysis. *Between 15% and 30% of these PEC users attributed their motivation for changing entirely to the PEC.* Equal numbers attributed the changes to other sources and the balance said that the changes were partially due to the PEC.

The PEC is influencing the design and construction of buildings in ways that are likely to continue. Market actors told us that they were implementing what they learned at the PEC in buildings. Eighty percent of the sample indicated that what they had learned at the PEC had actually influenced their treatment of one or more buildings. A quarter of those said that what they had learned had influenced 21 or more buildings and more than half said what they had learned had influenced five or more buildings. Slightly higher percentages (32%) believed that what they had learned would influence 21 or more

buildings in the next two years. About 40% of the respondents said that what they learned at the PEC influenced most of the buildings with which they deal. *Finally, three quarters of our respondents said that in the future they expected to continue all or nearly all of the changes in behavior that they had made as a result of their interactions with the PEC.*

Both PEC staff and users stated a preference for more off-site programming. Although the target audiences are highly aware of the PEC and its facilities, less frequent users and senior level managers of key firms in the target audiences are not as knowledgeable about the PEC's products and services as they might be. Short, targeted presentations at the offices of firms and organizations near the PEC facility might improve awareness of program and service offerings and perhaps lead to increases in the use of other products and services. Programs presented at sites outside the City, particularly in the area south of the Bay and targeted to facilities management professionals, might enable the PEC to serve audiences that do not now take advantage of the PEC's services because distance to the PEC is a barrier.

Findings about market audience and market structure

Reliability, various forms of cost, user performed tests of products and information were among the most important decision criteria. When survey respondents were asked about the importance of different decision criteria, reliability emerged as the most important followed closely by first cost. Cost factors such as payback and life cycle cost followed. The next most important criterion was conducting a demonstration or test or product and access to client's recommendations. Information from the PEC was next and fell approximately in the middle of the distribution.

The market actors served by the PEC can have distinctive decision styles. When we analyzed the decision making criteria we found four distinct decision styles. Every participant is likely to have traits of each of the styles but one of the styles is likely to predominate. We labeled the first style the "globally attentive." Decision makers with this style search for and consider a broad spectrum of information and sources of information. Their style is a searching style. A second style of decision making is driven by client recommendations and by specifications from prior work. Decision makers who rely on these criteria for their decision making also attend to manufacturer specifications. We labeled this style the "client oriented creatures of habit." The third style is the "system oriented investors." Decision making for this group is motivated by investment opportunities. They mainly consider financial criteria including life cycle costs but also factor rebates into their decision making. The last group focuses on first cost as the key decision factor. Unless energy efficiency product or service is the least cost service, this group is not likely to adopt it. They do not make use of information nor do they consider rebates in decision making.

The PEC can use the insight about decision styles to guide new program efforts. As a group, users of the "globally attentive" style are very responsive to the current programming provided by the PEC. For the client oriented decision maker, the PEC needs to make sure that the message gets to the decision maker's client. Systems oriented investors would be responsive to demonstrations of all forms of return on investment including energy savings, productivity improvements, etc. There may be little that the PEC can do for decision makers who are driven only by first cost.

Building engineers are a target market that may deserve more attention. Building engineers often play key roles in decision making about changes to buildings. Building engineers, especially those serving buildings in areas adjacent to the PEC, are making good use of PEC programs. However, there are more than 15,000 members of the building engineering union in Northern California and Nevada. The union local has an established training program that has relocated to a new facility. That program provides the basic hands-on training that building engineers need to do their job. Building engineers might benefit from greater exposure to programs about commissioning and recommissioning and measurement. The PEC may want to explore the potential for collaborative training programs and ways to supplement or augment the union efforts.

A great deal of construction activity in the Bay Area is being organized around a design/build approach. Informants estimate that design/build now accounts for anywhere from 25 to 50% of the construction market. It is probably the predominant mode of organization in areas with concentrations of rapidly growing high technology companies. *Several respondents suggested that there is a need for increased attention to the design/build community*. It appears that the PEC is already attracting facilities managers who are a key to influencing construction organized in this way. The PEC may want to focus more resources on this group or on the contractors who do the actual construction. It is not clear how effectively the PEC is reaching this latter group.

There is an emergent approach to organizing building activity called the collaborative process model. In this model professionals form teams to bid on projects. The collaborative process model places a much higher degree of emphasis on communication and integration of activity among the members of the team. In the collaborative process, teams use common tools and human relations skills to build teamwork. The collaborative process stresses that the quality of buildings emerges from the integrated nature of the teams. *There would appear to be a natural fit between the integrative nature of the PEC's approach to buildings and the collaborative process model.* The PEC may want to assess whether its message is reaching proponents of this model and encourage its adoption by them.

Lessons for market transformation

The key to assessing the market transforming effects of the PEC in this report has been the focus on measuring behavior. The PEC's product is a message with two threads. The first is that the potential for acceptance of efficiency is more likely when it is combined with owner value and customer comfort. The second is that system inefficiencies are at least as important, if not more important, than component inefficiencies, and that by collecting data, doing more analysis of all kinds, using more sophisticated tools, considering different combinations and arrangements of equipment, applying new knowledge and technology and organizing systems, substantial gains in efficiency can be achieved.

The PEC's goal is to get professionals to conceive of the design of buildings in new ways. The PEC's activities may cause the use of efficient components, the removal of components, the integration or arrangement of components, and/or the substitution of the function of components. As a result, one cannot tell the extent to which the PEC is influencing the market from sales data. However, one may be able from the behavioral data to assess the degree to which the PEC is influencing efficient equipment sales. The key then has been to develop a strategy for measuring behavior.

It is clear from the diffusion of innovation literature that certain things have to happen in a market transformation process. Potential adopters have to be aware of a product. Potential adopters have to persuade themselves that a product is beneficial. If the product is to be successful in the market, adoptions have to reach a critical mass. Adopters have to decide to use a product and then implement their decision.

To confirm that transformation is taking place, we can look for evidence that each of these conditions is being met. If we can demonstrate that the conditions have been met, then we have evidence for market transformation. If we observe that only some of the conditions are met, then the market is only partially transformed or the transformation effort has failed. This is a strategy that can be applied to almost any market transformation effort.

The first step in any such process is to determine who the key actors are in the key market segments. Without this knowledge, it is difficult to assess whether an attempt to transform the market is reaching key market actors. As we demonstrated in Chapter 3, the key actors vary by market segment. It is not enough to identify "owners" as the target. For large property owners, the key actors are the planning and design staff, perhaps the facility manager, and most certainly the facility engineer. When targeting new construction organized using design/build principles, the key actor is probably the "owner" who may be the property (facility) manager for the firm commissioning the building or that firm's design staff or consultants. Without understanding who the actors are, one can only guess at whether a program is reaching actors who have the power to decide.

The second step is to show that the program is reaching the key actors in the market. If the key actors are not being reached, then it is difficult to argue that the market is being transformed. For a change agency like the PEC, the participant tracking system becomes an essential tool for gauging reach. Without the tracking system, we would not have had information about attendance nor would we have known very much about the PEC's clients.

When tracking systems are to be used to assess market effects, special attention needs to be given to their design. For a PEC-like organization, the consistent identification of firms, the location of facilities, and identification of the discipline and responsibilities of individual participants is vital. This is much easier said than done.

An additional step is to show that a program is engaging its clients. The persuasion stage is an information seeking stage. Clients who come more than once are clearly searching for and processing information. If a program like the PEC's has a pattern of repeated use, that is a sign that the program is influencing the participants.

In order to demonstrate market transformation, a link needs to be established between the use of a product and service and changes in behavior. In this study, this was done by asking survey questions. People had no trouble reporting that they had changed their behaviors. And, they had no trouble attributing different levels of motivation for those changes to their exposure to the PEC.

We do not know to what extent the responses to the questions reflect actual behaviors. Validating reported behavior against actual behavior is a potential issue for the future.

To further establish that market transformation is occurring, it is important to document the link between changes in behavior and desired outcomes. In this case, we attempted to establish that changes in behavior resulted in actions affecting buildings. If the market place is being transformed, then there should be a consistent pattern of actions that have been taken and there should be expectations that the actions will continue in the future.

Finally, the actions need to reflect some significant level of activity in the market. A few actions in a few buildings are not sufficient to argue that transformation has taken place. Additionally, for a maturing program the size of the effects need to be sufficient to warrant continuing the program and for choosing one program over another.

That brings us to what is perhaps a most crucial variable, time. *Market transformation takes time.* The PEC did not just appear and start influencing the market. It took four years to make the concept of a PEC move from a glimmer in the eye to a physical reality. It has been six more years since it has opened. Although it has had its ups and downs, the program has been sustained through the years. In measuring, one has to understand where one is in the transformation process. The measurements and the expectations for the measurements have to be consistent with where the program is in its life cycle.

The study described in this report is essentially a snapshot of a program in progress. Cross-sectional analysis of "single-shot data" may or may not capture the essence of market changes and the causal factors involved. *To effectively measure and isolate the transformational effects of a program requires time series experimental designs with multiple measures and multiple measurements.* Good time series designs will reduce or eliminate many of the concerns that people have about current efforts to measure market transformation such as the data recall issue.

Time series designs require that market transformation efforts be carefully tracked and measured. A market and program baseline will need to be established. It also requires the careful selection of measures that reflect key program activities, intermediate outcomes and impacts, and factors that influence the market environment. Finally, it requires an ongoing data collection and monitoring effort. Such systems will be useful to program managers as well as evaluators.

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Appendix A. Methodological Notes

Table 40. Disposition of the survey sample

Disposition of the survey call	Number	Percent of total (1258)
Completed surveys	216	17
Refusals	104	8
Terminations during survey	2	0
Never there or no answer	84	7
Answering machine with multiple attempts and no return calls	250	20
Unresolved callbacks	120	10
Language problems	4	0
Duplicate records	31	2
Not qualified because did not participate during the period of interest	65	5
Respondent no longer at the telephone number, telephone line disconnected, wrong number	319	25
Fax modem line	30	2
Always busy	26	2
Removed from sample because interviewed for another study	3	0
Other	4	0
Total	1258	98

Table 41. Eigenvalues from the factor analysis

Component	Initial Eigenvalues			Extraction sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of variance	Cumulative %
1	7.7	38.5	38.5	7.7	38.5	38.4
2	1.8	9.2	47.7	1.8	9.2	47.7
3	1.6	8.1	55.7	1.6	8.1	55.7
4	1.1	5.6	61.3	1.1	5.6	61.3
5	.9	4.7	66.0			
6	.9	4.5	70.5			
7	.8	3.9	74.4			
8	.7	3.4	77.8			
9	.6	2.8	80.5			
10	.5	2.6	83.1			
11	.5	2.5	85.6			
12	.4	2.1	87.7			
13	.4	2.0	89.7			
14	.4	1.9	91.6			
15	.3	1.7	93.3			
16	.3	1.6	94.9			
17	.3	1.5	96.4			
18	.3	1.3	97.7			
19	.2	1.2	98.8			
20	.2	1.1	100			

The factor analysis is a principal components analysis.

Appendix B. Comments received on the report and responses

Two sets of substantive comments were received on the December 15, 1997 draft of this report. Those comments are reported below along with the authors' response.

First reviewer

Executive Summary

Comment

The limitations and issues raised by relying on self-reports should be stated clearly.

Response

The self-report issue really requires more explanation than can be addressed in the executive summary. Sentences have been added describing the general methodology. Text has been added elsewhere to address the self-report issue.

Chapter 2

Comment

Its not clear to me that there is any inconsistency between framing the energy-efficiency issue as one that can be described using market barriers and one that can be described using diffusion of innovation concepts. I think a lot of interesting work has been done in this field. But, I don't see any particular value in suggesting that one approach is superior to the other.

Hence, I request that selected characterizations of the Scoping Study be revised.

On page 12 (page number refer to draft page numbers): Market barriers can be used to discuss aspects of both products and market participants; diffusion of innovation has a richer vocabulary for some of these aspects, but longer discussions of some of these market barriers are certainly consistent with this vocabulary. Also, while market barriers per *se* do not speak to the dynamics of the transformation process, other parts of the Scoping Study do speak to these dynamics (see, for example, page 112 of the Scoping Study). Also, in the Scoping Study's market influence diagrams (pages *23-25* of the Scoping Study), the role of incentives, options, and knowledge in changing the behavior of market actors appears to be quite compatible with the model presented in figure 4 (and

later discussed at the top of page 95 in the draft). Finally, the framework described on page 16 seems entirely consistent with the prescriptions for market transformation evaluation studies; it certainly does not derive uniquely from the insights garnered from the diffusion literature.

On page 83, the draft says "the market transformation model seems to have an implicit assumption that actors will use information, if it is available.[1]" What the Scoping Study actually says (on page 8) is that "We recognize, however, that reducing any one market barrier may or may not lead to increases in adoption because other barriers may remain or be reinforced, or new barriers may be introduced."

Response

We agree that the market transformation and diffusion of innovation concept are not inconsistent with each other. Our main point is that the existing market transformation literature is a work in progress and that it needs to evolve rapidly if we are to be successful in market transformation endeavors. Many of the issues that arise in the market transformation literature have been extensively explored in the adoption of innovation literature. We need to draw on that enormous body of literature wherever we can.

We have changed some of the language of these characterizations.

Chapter 3

Comment

Since detailed interviews were conducted with individuals that appear to have been hand-picked by PEC staff (and in 9 of the 38 interviews were PEC staff), findings that are directly attributable to these interviews should be distinguished from those derived from the telephone survey (more on this point in Chapter 10).

Response

The people chosen to be interviewed were hand picked by the researchers based on our best judgment about the data we needed and who might best be able to provide it. The PEC staff as well as many others provided input to that selection process. More than half of the interviews were conducted with people who were not identified by the staff but who were identified by calls to leaders of professional organizations and associations, other persons being interviewed, and others who were asked to provide names. A serious effort was made to find people who might view the Center in ways that differed from the staff. The PEC staff was quite open about furnishing names of people who did not necessarily share their views. The person who took the strongest exception to PEC,

viewing it as competitor and suggesting that it was not be needed, was identified by a staff person. We might have used a random selection process but that would likely have resulted in a much less rich data set.

We have strengthened the text to make it clear that people were selected independently.

In selected places we have added the word *one-to-one* in front of the word *interviews* to distinguish the interviews from the surveys. In general, we have tried to use the word *interview* to refer to the one-to-one interviews and have tried to reserve the words *survey* and *questionnaire* to refer to the survey. In almost every case, we think the context makes clear the source of the data.

Comment

Given concerns about self-reporting, defend the methodological decision to rely on self-reports and, in Chapter 3, describe the sampling methods more thoroughly. The data in Chapter 6 suggests that nearly 5000 individuals have participated in PEC events since Jan.1995. Discuss the reasons for sampling 1258 with the telephone survey and any potential concerns regarding representativeness of the 1/6 of these that completed interviews.

Response

We have added text discussing the self-report issue. From our perspective, the important issue in market transformation studies is one of experimental design rather than the method of data collection or the type of data. Studies of change require time series designs with multiple methods and multiple measurements from existing records, surveys, etc. It is important that future generations of market transformation programs be tracked and analyzed as they are unfolding and that measurements be made while the programs are in process. This will require good tracking systems that track participation, program changes, changes in the market environment, and repeated data collection from participants.

By default, a retrospective study, or even one based on a good time series design, is going to have to rely somewhat on self-reports. The key to using self-report data from surveys is to design good questions that focus on behaviors and that minimize self-reporting bias. It is important to ask multiple questions and then to examine the consistency in the patterns of response. Also it is important to triangulate with other data wherever possible. The picture that emerges from the various sources of data in this study is amazingly consistent.

As to the sampling issue, we have strengthened the text and added Table 40 in Appendix A. Note that we interviewed more than 60% of the people that we were able to contact.

This is a highly mobile population and we lost a large number of sample points because people were no longer at the telephone numbers that we had. The text does point out that those in our sample appear to be more mature professionals than we might have expected. Partially this is a function of the fact that those who stay in positions are more likely to be more mature professionals.

Chapter 4

Comment

Pg. 29 (in the draft) contains a discussion of owner perspectives in design/build; provide a parallel discussion of owner perspectives for plan/design/build and collaborative.

Response

As much as we would like, we don't feel the data set is rich enough to adequately support such a discussion.

Comment

Pg. 30 (in the draft) describe the conflicts that the collaborative approach tries to address more fully; what are they, why do they arise in other approaches?

Response

We have added text to deal with this.

Comment

Pg. 31 do investment strategies change over time? If so, what phase were we in between 1991-today? What's next? How prevalent are these strategies among in the market addressed and served by the PEC?

Response

Investment strategies can change but we believe that most firms retain the same strategies over long periods of time. Partially this is in the culture of the firm. Partially it is a function of the expertise and staffing necessary to successfully execute a strategy. Partially it is a function of tax laws, etc.

We've added some text to this effect.

Comment

In general, provide more quantitative estimates of the prevalence of the various investment approaches, ownership structures, and the perspectives in the industry today?

Response

We would like to but the data that we have limits our ability to do this.

Comment

Are there important differences in owner perspectives between current building owners and future building owners (i.e., those engaged in constructing a new building)?

Response

Building new buildings is part of an investment strategy. The same owners have new buildings as well as old buildings. Investment managers focus on returns rather than the details of how returns are achieved. There are many ways to achieve returns. They are going to rely on their staff to tell them whether a beautiful lobby, high speed elevators or advanced lighting systems will yield the best returns.

Comment

Later in the report, I expected to see a clearer link between the discussion of the industry in this Chapter and that part(s) of the industry actually served or influenced by the PEC and in particular a discussion of how big a part of the industry the PEC is serving.7"

Response

We think many of those links are already in the text. For instance, we know that facilities managers have used the PEC.

Chapter 6

Comment

Define participation clearly. Pg. 47 says 30,000 individuals have participated; visually integrating under the curve on page 48, I get about half that amount (e.g., if peak year is 3500; 7 years times 3500/year is still only 24,000). Later (in chapter 7) a definition will also be important in distinguishing between use of PEC for professional meetings and use of PEC for PG&E sponsored workshops.

Response

We have changed the text in several places to help clarify this issue. Thirty thousand is the number of discrete individuals who have "registered" with the PEC. Collectively they have probably received more than 100,000 individual services. The curves represent workshop and classroom attendance that may include multiple attendance by the same individual. Workshop attendees are a subset of attendees and the number of services provided.

Comment

A note on page 48 was intriguing: that attendance drops off when the economy is robust; what is the implication for future PEC performance — this issue relates also to my comments on Chapter 4 about relating larger economic trends to the ownership/investment strategies and the role of energy efficiency.

Response

Several people indicated to the interviewer that they had more time when the economy was down and building activity was lower. It is not clear that this is directly linked to the discussion of investment strategies. We think investment strategies are a different matter. If your strategy is to buy buildings that are partially leased and refurbish and lease them with a view to selling them to obtain the capital gains, you may stay with that strategy regardless of the economy. However, your tactics, given the economy at a specific point in time, may differ. For instance, you might hold existing buildings for a longer period if prices are depressed or you might buy buildings at bargain basement prices and hold them until demand starts to increase before renovating them.

Comment

Expand comment on page 54, which finds that more experienced staff were attracted to PEC; this seems to be in sharp contrast to the CTAC findings we heard last week. What is the explanation?

Response

The CTAC data indicated that 62% of the population had been in their current position five years or less. This was true of 47% of the population in our study. The real difference appears to be in the experience in the field. Our population appears to have been in their disciplinary field quite a bit longer. A key difference may be that the CTAC sample is focused on end-users, distributors and vendors whereas the PEC sample is focused more on design professionals. There may be very real differences in the longevity

of people in the two fields. We know from our fieldwork that many of the staff at distributors are people with sales skills which are transferable to other technologies. Such people may move on to other positions fairly quickly. This is an interesting issue which may bear further investigations.

Comment

Indicate the fraction of the total population of firms reached on tables 7 and 9; e.g., what percent of the population of firms of size X to Y did the PEC attract.

Such an analysis really needs estimates of the number of relevant professionals in each firm which we cannot obtain very easily. We agree this would be an interesting analysis.

Chapter 7

Comment

Would be useful (later on in Chapter 9) to have a bottom-line total for each table: what fraction of the total said they made at least one change (in the "more" direction) for the list of behaviors and, of this total, how many attributed the change either partial or entirely to PEC.

Very few respondents, if any, did not report a change in the "more direction."

Comment

Since N is sometimes small, reporting absolute numbers may be more informative. For example, instead of "a modestly higher percentage of respondents" (on last line of page 64), say "12 out of 20 said entirely, while 8 out of 20 said partially." This is especially important whenever samples are lower than 100 (such as in tables 16 onward).

Response

We are sympathetic to the issue being raised here. For some tables, we debated whether to use counts or percentages. Small cell sizes are always present a presentation problem. It has been our experience that once the N's get above 20, many readers want the percentages because they find it difficult to do the calculations in their heads. In this case, we decided to use percentages throughout for purposes of consistency and to reduce the potential for confusion. The N's are in the tables and can be calculated.

Comment

The percentages on Table 15 don't seem to correspond to the percentages on Table 14 that indicated either "more" or "less" for at least the first few behaviors.

Response

Whoops, the items in the stubs of Tables 14 and 15 were not in the same order. They are now in the same order and the numbers now appear to be more consistent. We sorted tables into high to low order to make the patterns clearer. Table 15 should have been left in the same order as Table 14 instead of being sorted.

Chapter 8

Comment

I have a couple of concerns about the factor analysis and its interpretation. First, can it be truly said that the individual factors can be mapped to identifiable groupings of *individual respondents?* I think its true that the factors correspond to identifiable groupings of responses; I don't think that this necessarily means that individuals can be well-typed into one or another factor category. That is, the factors indicate how well-correlated responses were among themselves (i.e. if someone gave a 5 to an item in a factor group, they were more likely to give a S to another item in the same factor group); but they don't, I think, say anything about whether individuals can be mapped into one category versus another — only that they answered certain groupings of questions consistently.

That said, I find the first factor baffling. Rather than "globally attentive," I read: "if all these other things (in which distinctions between them can't be discerned) are important, then first cost is not." Since this is the most important factor, I'm at a loss with what to conclude from this finding. See also comments on Chapter 10.

I'm also concerned about the internal consistency of the final factor: If first cost is so important, how can rebates not be important?

Response

We all have a little of each factor "in us" but usually one factor tends to predominate.

Some people may not perceive that a rebate alters first cost or may simply perceive that getting the rebate is a hassle and therefore dismiss it as a factor in first cost.

Chapter 9

Comment

I had a hard time reproducing the sample sizes used in this chapter (198, 173, 160, and 186); see comment on reporting bottom-line (above under Chapter 7).

Response

We have double checked the sizes and they are correct.

Comment

Was information collected to determine how on-going changes in behavior might depend on continuing existence of PEC?

Response

No. We do know that people used other sources of information following their use of the PEC. Our sense from the interviews was that the PEC was a focal point for professional activity and that levels of professional activity might significantly suffer from the demise of the PEC. People will find other sources of information. It may not be the same information. It may not have the same effect.

Chapter 10

Comment

Clearly identify which of the key findings on page 91 are based on the 38 hand-picked interviews and which are based on the telephone surveys.

Response

In most cases, I think the 'source' data for the comment is clear from the context. The one exception by be the one about the direction of the programs. We were told by numerous individuals in the interviews that architectural firms are rapidly evolving the use of computer tools.

Comment

Add "first cost" to "reliability" to the second sentence in the first finding about market audience and structure on page 93.

Response

Yes

Comment

Clarify that the "distinct decision styles" cannot necessarily be attributed to distinct market actors (see comment on factor analysis).

Response

Actors may have a predominant style.

Without more analysis of the extent to which future PEC participants are likely to be similar to past PEC participants, statements based on factor analysis need to be tempered (and especially about the meaningfulness of "globally attentive")

Comment

Our point is that people with different styles need to be provided with different kinds of information or approached through different avenues. The problem is one of matching program content and communication channels to the audience.

Comment

Discuss reasons for not targeting facilities managers in the past and whether there may obstacles to doing so in the future.

Response

This discussion is really about building engineers as distinguished from facility managers. We have changed the language to make this clear. The PEC's main target has always been the design community. Building engineers are not directly a part of that community. The building engineers found their own way to the PEC. It is an audience that needs to be served but the Union Local 39 is probably the right agent, perhaps with support from the PEC.

Comment

Given concerns of design/build market participants (Chapter 3), in what ways has PEC demonstrated that it can influence this market segment?

Response

We have added some material about interactions with facility managers which is directly relevant to this issue. We have also added a sentence in the conclusions.

Comment

Without an estimate of the market for collaborative approaches, it is hard to conclude that this should be a priority for PEC. While there is a natural fit, there may be higher priorities; moreover, PEC may be less incrementally effective in changing outcomes, since design integration has already taking place.

Response

All we are suggesting is that the PEC make sure that its concerns are being addressed by people using this approach. At a minimum, the PEC needs to know more about this movement.

Comment

Will the responses to all the questions on the survey be tabulated and presented (in an appendix)? Some of the information gathered in questions 175-185 seems particularly germane to this study, but I did not see them discussed or analyzed as part of the findings.

Response

We have added a short section that deals with the above referenced questions as well as a section for questions 153 to 161. Since tabulations of nearly all of the data are now in the report, placing tabulations in an Appendix is redundant. PG&E has a complete set of the raw data.

Second reviewer

Before giving my comments on this report, I would like to disclose my analysis frame. As I went through this study, I was looking for answers to the following five questions: **(My answers appear in bold)**

Comment

What markets and clients are served by the PEC? **TecMRKT Works did a good job here**

Response

None

Comment

What types of market actors make the key decisions with respect to energy efficiency in the these and to what extent have these programs " reached" each sub market? **Good job here**

Response

Comment

What criteria should be used in assessing the extent to which a particular market or segment has been " transformed" to the point where minimal or no program funding is still necessary? (this is particularly important for this program given that some parties believe this market has been transformed) **More work needed here (If in project scope)**

Response

The key here is to get beyond the stage where the PEC is dealing with innovators and early adopters. The measurement criterion is that the mainline firms have begun to adopt the techniques and are pushing them. Look at HOK's home page on sustainability for an example.

Also keep in mind that there are:

- The goal is to accelerate the adoption of new concepts and technologies
- New technologies constantly entering the market
- There are many segments within the market that may not have been reached

Comment

To what extent can we rely on participants self reports from key market actors to answer the question of sustainability? **Needs to be addressed at least at the level of developing plausible theories which can be tested later.** If some market segments are transformed and other segments aren't should the program design be continued or do changes need to be made to meet needs of "unreached" segments? **Some design suggestions given, more could come.**

Response

The discussion about self-reports needs to be refocused to a discussion of experimental design that can help one to adequately assess market transformation. Self-reports are likely to be a feature of almost any attempt to measure market transformation. With good designs the limitations of self-reports become less problematic. See changes to the text as well as comments to the other reviewer.

Comment

To what extent can the information in this report be used to guide future program design changes as well as define a set of baseline conditions for future program evaluations? **More work here would be useful.**

Response

None

Given this bias, here are my comments.

GENERAL COMMENTS

Comment

The report introduces some useful information from the diffusion literature but did not have time to take the next step and apply it to this project or the market barriers frame in general. In particular the notion that product characteristics have important effects on the rate of adoption or diffusion curves should be expanded. For example are the goods and services sought by PEC clientele, search goods, experience goods or credence goods? Each type will have important ramifications on the delivery of information and its sustainability. If they are search goods, i.e. consumers can make good decisions about products just based on getting complete project information, then this implies a need to concentrate on helping customers sort through reams of data and find the right " tool" to analyze it,. If these are perceived as " experience " goods, then PEC must take steps to

either insure the equipment is demonstrated or that other users that have installed the equipment can provide testimonials/ interview about their experience or try to allow the user to self confirm the value of the equipment through after the fact testing. . If the efficient equipment is perceived as a credence good(e.g. you may not be able to " directly experience the products benefits without increased effort), then steps must be taken to bolster the reputation or brand name of players with high quality/ efficiency inventories . The point is that the relevant PEC networking/ communication strategy may need to vary based on the underlying product characteristics and that in turn may effect the diffusion dynamics.

Response

We have added some text to address this issue. Users are saying it is the technical data, the technical explanations, and the demonstrations that are the most important. See the discussion related to Table 19.

Comment

The report did a good job of describing the types of market players reached by the program but it could be improved in terms of describing the geographic reach of the center. For example, what fraction of the PEC participants live or work within 50 miles of the center versus 100 miles versus 150 miles? Does it vary by type of actor? Or type of community (urban, suburban, rural)? Is there a need to establish satellite centers every 100 miles due to these constraints in urban areas? Does PEC's reach extend to the southern Central valley or up the North coast? ? Please add some more information in this realm in the next draft.

Response

We think this is really part of a separate market assessment study that may need to be done. Jim Chace is currently looking at various models for future activity. Our sense from dealing with the data is that two thirds of the users probably work within 10 – 15 miles. The needs in the Central Valley are somewhat different than in San Francisco. There are different ways of addressing the needs for physical proximity.

Comment

At the presentation, John suggested that the PEC had reached the early majority segment of the diffusion curve. Later adopters need to " reference themselves" to spread the product. The evidence gathered supporting these observations and its implications for future program design or strategies should be provided in the final draft.
Attribution of information- I liked your point about the difficulty in establishing causality or attribution from programs because information is mediated through secondary sources

in the later stages of adoption. Does this suggest programs should shift strategies or even cut back on effort once the message has reached 50% of the target market? Or maybe that it is futile to attribute causality after this 50% level or point is reached?. What implications does this have for future program or research designs?

Response

We believe that the PEC has reached the early majority stage for some of its audiences based on the penetration data. Also, some of the major firms are using the language of sustainability to market clients.

Probably someplace after you reach fifty or sixty percent of the market, the value of the additional effort diminishes to the point of few returns. That does not mean that low level maintenance efforts may be needed.

One think to keep in mind is that there are constantly new products and concepts entering the market. These don't just get adopted.

Comment

Sustainability- What evidence, other than self reports, exists that the actors will persist in their changed behaviors that are listed in the report? For example, are some market actors making more money as a result of this new information/ changes in behavior, or do they perceive that this additional information helps their firm to be more competitive or increases client awareness of their work? I think you need a section that specifically addresses sustainability and puts forth some plausible explanations discussing why the observed changes are likely to be sustainable for specific actors (other than I plan to keep doing this) Evidence about the fraction of the new buildings where actors plan to install efficiency is necessary but not sufficient to increase the chances of sustainability. For example, think about what might changes might cause designers/ managers to backslide towards old . less efficient practices. What contributions can the innovation of diffusions literature bring to this question of sustainability?

Response

Given the data we have we really can't take the sustainability issue much beyond the point where we left it. It is an issue that we want to think about and work in future studies.

Comment

TecMRKT Works should spell out its recommendations for improving market transformation/evaluation paradigm- How would a achieving a better understanding of

adoption processes help in describing or evaluating market effects or designing programs? How could we accomplish more focus on market structures as recommended in last slide? What sort of broader definition of products and services is needed to help guide MT efforts? Etc

Response

We are thinking about this. At the moment there is not much we can add within the context of this report. Perhaps this would be a good topic for a working session at the ACEEE meetings.

Specific Comments

Comment

Page 27 The discussion of three types of decision making suggests that the PEC might want to design its programs differently to reach the actors in different decision processes. How should they do this? For example, If the PEC's goals are similar to the goals espoused by the collaborative process, should they support this model, or tailor their approach to meet the needs of members in the other two processes?
The point of this comment is to try and get the authors apply this typology to make some assessments about the current and future design of the PEC and its likelihood in reaching these groups.

Response

We agree the programs need to be targeted to different audiences. We offered these observations because we believe that it may help the PEC think about how they may want to target their resources. Since the original draft we have done some reanalysis which shows that they have reached facility managers in some large computer firms and have provided that analysis in the report. We think more of this type analysis needs to be done before firm conclusions about direction can be drawn. We think the PEC needs to look more closely at the collaborative effort and see what the appropriate response might be. Maybe they should get involved with this group. Perhaps, those involved in this neither need nor want assistance from the PEC. Perhaps the administrator may want to encourage those involved in developing the collaborative paradigm to submit program plans.

Comment

Page 47- Is it possible to come up with a count of unique individuals who use the PEC as opposed to the over 30,000 individuals number here which may include repeat visitors.

Response

The 30,000 is a good best estimate of unique individuals. The actual number of services rendered is much higher than that. We have changed the text to try and reflect this.

Comment

Page 50 Do the authors agree with the perceived need for PEC to have luncheon programs at outside facilities and or spend more money on direct mailings?

Response

The PEC has two products to sell. Itself and what it is trying to promote. Given the widespread comments about the direct mailings we certainly think it would be worthwhile to re-institute them or something like them to see if they impact attendance. If they are re-instituted and they don't impact attendance they should be dropped. Likewise, we think some informal experiments with more direct outreach are warranted. The program people need to decide if they can get more bang for their buck from doing direct mail or outreach or creating program alternatives. Our general assessment is that the PEC has done a pretty good job of abandoning what isn't working and trying new things.

Comment

Page 58- Is there any way of converting the information provided on designers or architects use of new information in designing buildings (Table 34 and 35) into either a fraction of the new construction or remodeling market affected by the PEC or ultimately into energy impacts?

Response

Not on the basis of the data we have. We have toyed with the ideas such as trying to use Title 24 filings to get at this in some way but we don't have the resources to do the necessary research.

Comment

Page 96 the lessons of market transformation: You posit three conditions that must exist for market transformation to exist: awareness, means to persuade customer that product is beneficial, and a critical mass must be reached. Should all market effects evaluations look for these three conditions or is this just specific to the PEC evaluations? Are there other conditions; how about a theory as to why program intervention could lead to sustainable changes? Repeat business?

Response

Yes, we think that all market transformation programs have to meet these conditions if they want to claim they have transformed the market.

Comment

Page 97- Do the authors recommend that PEC market effects continue to be tracked over time even if the administrator running the operation changes? What steps should be taken to ensure the existing tracking system is not lost? How often should market effects be measured from Energy Centers? Is once every four years sufficient?

Response

We think every market transformation program should be tracking what it is doing and tracking what is happening in the market. For instance, an organization needs to constantly monitor how its audience is changing through the use of participation records. If really efficiency systems can be evolved, it is relatively easy to track who is attending and how often. We would recommend smaller more focused data collection steps rather than massive periodic efforts.

Appendix C. PEC Educational Programs in 1997

Date	Program Title
January 16	Passive Solar Design
January 22	1997 Lamp Technology Update
January 23	Palms, Bayviews and Streetcars: The New Embarcadero
January 30	Light and Space
February 1	Composing Color and Light in Interior Space
February 11	Data Acquisition for Lighting Systems
February 13	Using Glazing Films Effectively
February 18	Application and Design of Dual Fan/Dual Duct VAV Systems: Why VAV Reheat May Be a Dinosaur
February 21	An Architect's View of the Sun: Solar Geometry
February 27	Renewable Architecture in Europe
March 3-5	Applied MS Access (2.0) Workshop: Learning to Manage Large Data Collection Projects
March 6	Advanced Lighting Design Using the New Lumen Micro
March 7	How Architects Can Learn from Buildings
March 13	Lightscape Visualization Software
March 18	Residential Summer Comfort: Alternatives to Air Conditioning
March 18	A Tour for the Internet Innocent: The Mechanics
March 25	Performance Contracting for New Construction: Insuring Value for your Investment
March 27	Technology Frontiers: Changing the Way We Build
April 1	Internet Applied: Building Science Resources in Cyberland
April 10	Specifications, Construction Administration, & Commissioning of Lighting Systems
April 22	Advanced Data Collection Workshop: Tools and Techniques for Field Assessment of Pumps and Fans
April 24	Pac Bell Park: Making a Grand Stand
May 6	Peak Reduction Strategies: Gas Cooling and Thermal Energy Storage Systems
May 8	Data Collection Systems & Design for Electrical Engineers: Measuring Power, Energy, and Quality
May 15	Monterey Bay Aquarium's New Outer Bay Wing
May 20	The ABCs of ESCO Contracts
May 20	Advanced Glazing Seminar
May 22	Outdoor Lighting for Public Spaces
May 23	An Architect's View of the Sun: Solar Radiation
May 28	Site Analysis for Architects

Date	Program Title
June 3	Motormaster Plus Software Hands-on Training
June 12	Advanced Lighting Controls
June 17	Weaning Ourselves From CFCs: How to Avoid Penalties and Improve Cashflow
June 19	The New Demands of Electric Restructuring: Building Profiles and Business Partners

Appendix D. Interview guides

General Protocol for Interviews with Staff and Others

Pacific Energy Center (PEC)

Goal and Vision of the PEC

- What is your vision for the PEC?

1. Does the PEC have a long term goal (5 years or more)? What is that goal?
2. Does the PEC have some shorter term goals? What are they?
3. What are the PEC's general strategies for attaining those goals?
4. If the PEC's activities are successful, what do you think the consequences would be? How would the PEC be able to describe its success to others? Examples?

PEC Organization

- How is the PEC organized?

2. What is its structure?
3. How many employees does it have?
4. What are the responsibilities of the various employees?
5. How many are PG&E? How many contract personnel are involved?
6. How is the organization chartered?
7. Does it have a board? If so, how is the board organized? Who sits on the board? How are they chosen? What are the powers of the board? To what degree is the board involved in content?
8. Are there any anticipated changes in the organization?
9. To what extent are trade and professional organizations involved in the PEC? Does the PEC have partnerships? If so what are the purposes of the partnerships? How do they function? Who is involved?
10. What are the sources of the Center's budget? What is the level of the budget? How has the budget changed? How is the budget spent?
11. Does the center receive fees for services?
12. How is the budget likely to change in the future? How are the sources of income likely to change? What may be the impact of these changes?

Information about participation in the PEC

- How many people have come to the PEC in 1997?

5. What have the annual attendance figures been since 1991 when the PEC opened? What are the projections for the future?
6. Who are the specific target audiences?

7. Why are those specific groups being targeted?
8. Who else attends beside the target audiences?
9. How would you categorize people who have come to the PEC in 1996 and 1997 in terms of their reasons for coming? What proportion come out of general interest (i.e., school children on tour, drop-ins, etc.), professional reasons, business reasons, etc.?
10. How have the percentages of these different groups changed over time?
11. How would you categorize those who come out of general interest? Large groups? Schools? Families?
12. How would you segment those who come for professional reasons? architects, engineers, other building designers, contractors, lighting maintenance persons, vendors, manufacturers representatives, distributors, building owners, building operators? What are the relative proportions of the various groups?
13. What do you consider to be your market shed?
14. How do you think attendance at the center might change in the future? What might cause those changes?

Communication Issues

- Who handles communications for you? Is it in-house? Do you have a contractor?

3. How does the PEC communicate with its target audiences?
4. Does PEC use mass media (radio, television, newspapers, cable)? How often? What is the typical message? Can you provide examples?
5. Has the PEC been the subject of a bill insert? A bill insert for a specific class of customer?
6. Does PEC place advertisements in trade and professional publications? Which ones? How often? Can you provide examples?
7. Does PEC send information to trade and professional association newsletters? If so, which ones? How often? Can you provide examples?
8. What about PG&E publications such as a newsletter to commercial customers? If so, which ones? How often? Can you provide an example?
9. Does the PEC have its own publication program? What are the goals of the publication program? What publications are produced? Who receives them? How often? Are there lists of those who regularly receive publications? Is the publication program designed to convey significant content or is it more designed to tell the story of the center and attract potential participation in the center?
10. Does PEC purchase mailing lists? If so, which ones? How often?
11. Does PEC use mailings? How often? How were the original lists generated? How are they kept up-to-date?
12. What about e-mail? How often? How were the original lists generated? How are they kept up-to-date?
13. Do you track how often your Web-site is hit? What are the hit rates? Do you have any sense of which pages get hit most often?

14. What proportion of those participating in your programs are referrals? Do you get referrals from people outside of PG&E? People inside of PG&E? Where do most of the referrals come from?
15. How about presentations by staff and other PG&E employees to outside groups? How often do those occur? Who typically might do the presentation?
16. How much of the attendance at the PEC is driven by contagion versus mass media exposure? Does that vary by whether the audience is a general audience or a professional audience? Which is which?
17. How have communications changed over time?
18. How effective are these different methods of communication in attracting participation? How would you characterize how people learn about the PEC and its programs? How about for general audiences? How about for professional audiences?
    - general media advertising (radio, television, cable advertising)
    - word of mouth from prior participant
    - professional newsletter
    - trade or professional publication
    - referrals
    - web-site
    - PEC mailings
    - PEC e-mail
    - etc.
19. Does the PEC receive requests for classroom materials and outlines? Does the center provide such materials? How often is that done? Is there a list of people who received such materials?
20. Have you found ways to leverage the communications program? Are others picking up your materials and using them in their own publications? How often is this happening? Do you know who, when and where this leveraging is occurring?

Program and program development issues

1. How are program needs determined? Give examples?
2. Is there a formal process for determining how to proceed with a new program? If so, how does it work? Who decides? If the process is less formal how does it work?
3. Do you have formal or informal mechanisms for getting input about potential program ideas from clients and potential clients? What are the mechanisms? How do they work?
4. Do you use any kind of formal or informal market research? Have you used focus groups? Have you conducted formal or informal interviews with potential clients?
5. If you were to think about the various inputs that may drive your program decision making how would you rank the following?
    - Staff experience and expertise
    - Staff interest
    - PG&E field reps

- Other internal clients
- External client requests
- Discussions with clients
- Trade publications
- Scientific publications
- Discussions with experts in the field
- Product announcements / information from manufacturers
- New technology
- Achievable technology

6. At the present time it appears that PEC program is oriented around the following topics? Is this a fair list? What would you add? What would you subtract? Are there new topics that are likely to added in the future?
   - Solar design
   - Daylighting
   - Glazing
   - Lighting
   - Controls
   - Data acquisition / metering
   - Commissioning
   - Motors
   - Chillers
   - HVAC systems
   - Power quality
   - Modeling simulation
7. What are the key technologies or concepts (innovations) that are being promoted in each area? For each technology / concept how recently would you say it has been introduced into the market? What it introduced (partially introduced) because of PEC efforts? Does the product have 10% or more of market share?
8. Here are some stages through which a building might pass over a period of years. If you look at the key technologies and think about the PEC program, for which of the following stages are the technologies being promoted?

Conceptual design — Design — Engineering — Contract — Construct — Operation — Maintenance — Remodeling renovation

9. For each of the major technologies, which of the following techniques are used to promote the technology?
   - exhibits with real equipment
   - exhibits pictures
   - hands on experience
   - class room lecture
   - class room demonstration

- information only
- performance data
- simulation / calculations
- modeling
- performance measurement opportunities

10. Are there lecture notes from the courses? Handouts? Could we look at or have these for selected courses.

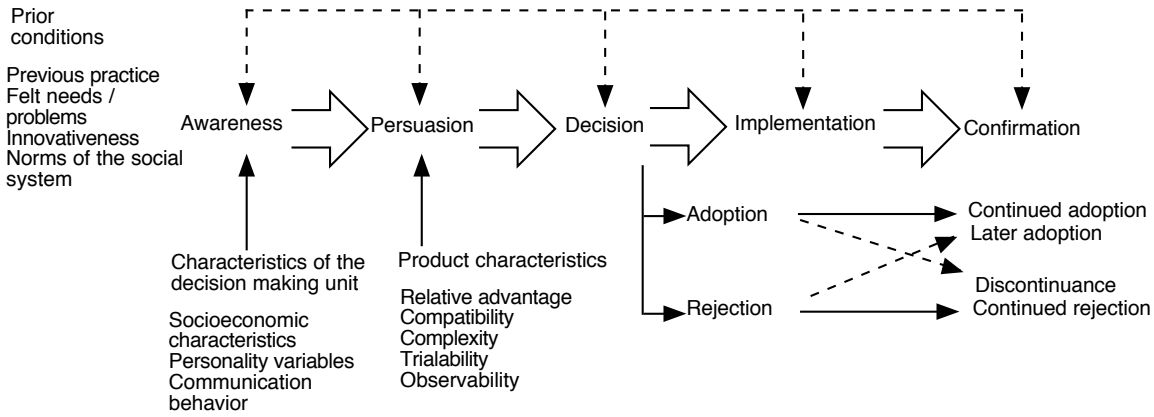
Class room participants

Let's talk about the people who participate in PEC classes (substitute other major categories here, for example people who use the simulator or who check out measurement instruments).

1. What types of firms or organizations do they represent?
2. Does this vary by the type of technology you are presenting in the course? For example, solar design, windows, lighting, HVAC, networks and building networks, controls, measurement?
3. In general what size firms do they represent? Could you estimate the proportions who have 10 or fewer employees, 11 to 50?, 50 to 100?, 100 to 250, 350 and up? Do these vary by technology?
4. In terms of the positions of participants, what proportion of them are lower level technical staff, middle level technical staff or managers? Vary by technology?
5. How would you characterize the technical knowledge of people who sign-up for the courses? What proportions would have little knowledge, some knowledge, a great deal of knowledge? Vary by technology?
6. Relative to their knowledge, what is the motivation of people who come to the classes? First time exposure to knowledge, increase an existing base of knowledge, knowledge refresher, confirm what they know or update? Vary by technology
7. What motivates people to attend? Personal interest, specific problem, continuing education requirements, request from superior, client request? Vary by technology?
8. We sometimes use an adoption model to locate where people are in terms of their adoption of an idea or technology. The model describes a series of stages. The stages are as follows:
    - lack awareness — no information about the technology or idea
    - aware — have little specific information
    - persuasion — have a little information and are actively pursuing more information prior to deciding whether to adopt the idea
    - adoption — have decided they will use the idea or technology
    - implementation — in the process of actually implementing the idea or technology may be seeking specific implementation information
    - confirmation — trying to confirm that their adoption or implementation an idea was the a good thing

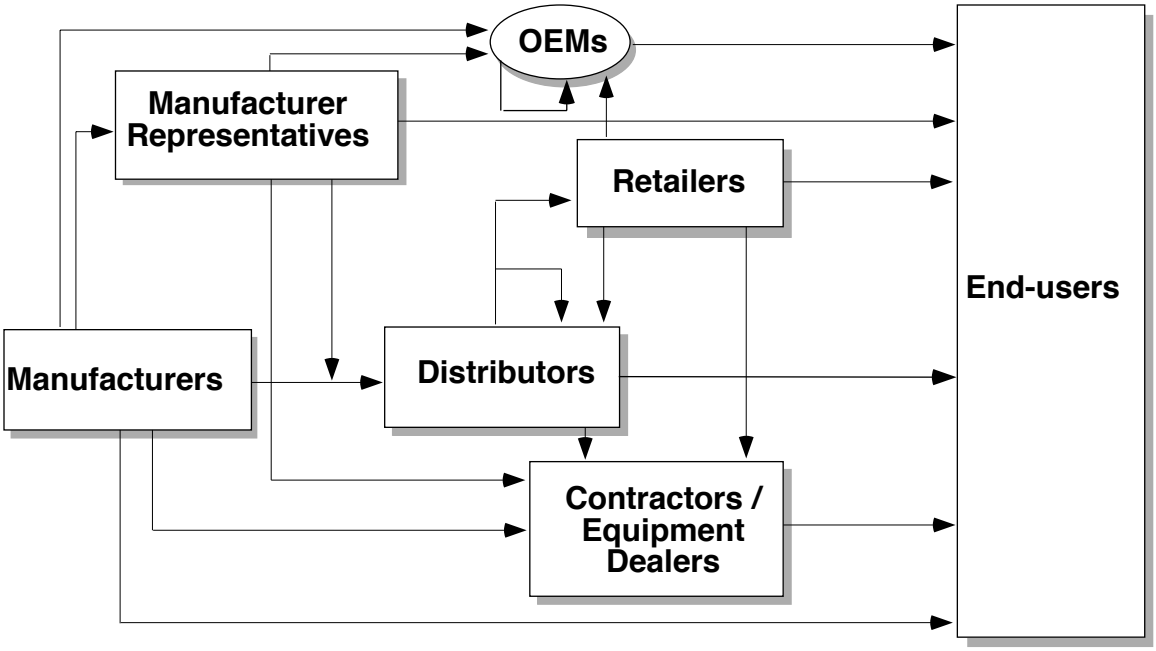
- Can you give me your impressions of the proportions of people are in the process for the various technologies?

9. Firms might be characterized as going through these same stages. Can you characterize the proportion of firms represented by attendees that might fall into these various categories?



Market Structures

1. For the key HVAC, lighting and window products, who are the key manufacturers in the PG&E market shed who are providing efficient products? Which manufacturers are competitors who are not providing products?
2. Can you identify key contacts with those manufacturers for us?
3. Who are the key distributors in the Bay area in these product areas? Which of those distributors are now promoting efficient targeted products?
4. For each of the product areas, who are the most likely specifiers for products? architects? engineers? contractors? etc.?
5. Can you identify key firms in the area and personnel in those firms with whom we should talk?
6. Can you identify key professional associations and contacts in the professional associations for us?
7. What about trade associations? Can you identify key contacts?
8. Here is a model of a market structure. How well might this model represent the key technology? Which links exist? Which links have the most flow of product? Can you identify professional and trade associations associated with each of these areas?



Perceived program impacts

PEC programs can have many different impacts. For PEC's programs and the key technologies which we are discussing, are you aware of any of the following kinds of impacts for any of the market actors that we identified above?
changes in:

- promotional practices
- business strategies
- prices offered to customers
- creation of new players
- stocking and distribution changes
- design practice
- service offerings
- employee compensation packages
- contract provisions
- new skills
- underwriting practices
- financial instruments
- product quality
- product attributes
- new products
- bundling of features or products
- retooling rates
- shipping practices

- standards
- compliance with standards

Architect Interview Guide

Personal Background

- What is your professional background?
- How long have you been in the architectural community?
- What kinds of positions have you held?
- What professional affiliations do you have?

Current involvement with the PEC

- Have you been involved with the PEC and, if so, how much?
- If you haven't been involved with the PEC what are some of the reasons why?
- If you have been involved, how did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?
- How has that changed since you first became involved with the PEC?

Perceptions of the PEC program

- What do you see as the major strengths in the programs offered by the PEC?
- Are there areas where you think there could be more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its architectural programs?
- Who do you think the PEC is actually reaching?
- Are there groups which the PEC should be reaching that they are not currently reaching?
- What are peoples' reasons for attending events at the Center (new knowledge, update knowledge, tracking the competition, etc.)?
- How about reasons for not using the services of the Center?

The architectural community

- How would you describe the architectural community in terms of the number of people and the size of firms?
- Who are the main players in the commercial markets?
- How does this vary by segment of the commercial market (hospitals, schools, office buildings, strip malls, etc.)?
- How are energy and environmental issues handled by your firm?

- By other firms?
- Does this vary by size?
- How has this changed in recent years?
- What has driven these changes?
- When you think about new construction and retrofits, who are the key decision makers (engineering firms, contractors, building owners, etc.)?
- How is decision making done?
- What are the key criteria (first cost, payback, reliability, etc.) that drive decision making?
- How does this vary by type of project, firm, etc.?
- How does the architect fit into this?
- What are the key professional associations?
- What are typical ways members of the architectural community learn about new products and new ways of doing things?
- How rapidly do innovations permeate this field?
- What is the range of variation in the amount of time it takes?
- What are the barriers to change in the field?
- If you want to initiate change, to whom do you direct your attention?

The reach and impact of the PEC

- What portion of the architectural community do you believe the PEC has reached?
- What impacts do you think the PEC may be having?
- Is the PEC driving changes in architectural practice?
- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- How is the PEC addressing barriers to change?
- Which barriers are not being addressed?

Building Owner Interview Guide

Personal Background

- What is your professional background?
- How long have you been a building owner or manager?
- What kinds of positions have you held?

- What are your current responsibilities?
- What professional affiliations do you have?

Firm Background

- How large is your company?
- How is the company structured?
- How many buildings does the company own and/or manage?
- How are specific buildings managed?
- How does this vary by the size of the building?
- What is the overall investment strategy for your company?
- Who are the key decision makers with respect to constructing a new building, purchasing a building, renovating or refurbishing a building?
- When you think about new construction and retrofits, who are the key decision makers (engineering firms, contractors, building owners, etc.)?
- What is the process for making those decisions?
- What is the relative importance and contributions of the different decision makers?
- What are the key criteria (first cost, payback, reliability, etc.) that drive decision making?
- How does this vary by type of project, firm, etc.?
- How do you as an owner/manager fit into this picture?
- How do you influence decision making?

Architectural, energy and environmental issues

- How important is energy efficiency as an issue in terms of the buildings you own?
- What about issues such as indoor air quality?
- How has the importance of these issues changed over time?
- What is driving these changes?

Innovation in building designs and equipment

- What are typical ways building owners / managers learn about new products and new ways of doing things?
- How rapidly do innovations permeate this field?
- How rapidly do energy and environmental innovations permeate the field?
- What is the range of variation in the amount of time it takes?
- What causes the variation?
- What are the barriers to changes?

Current involvement with the PEC

- Have you been involved with the PEC and, if so, to what extent?
- Have your firm's employees used the services of the PEC? If so which ones?

- If you haven't been involved with the PEC what are some of the reasons?
- If you have been involved, how did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?
- How has that changed since you first became involved with the PEC?

Target audience

- Do you think the PEC is trying to reach owners with its programs?
- Do you think the PEC is reaching them?
- What are some reasons owner/managers would attend events at the Center (new knowledge, update knowledge, tracking the competition, etc.)?
- How about reasons for not using the services of the Center?

Perceptions of the PEC program

- What do you see as the major strengths in the programs offered by the PEC?
- Could the offerings of the PEC be made more relevant to owners and managers of buildings?
- What would make them more relevant?

The reach and impact of the PEC

- Do you believe the PEC has impacted you, the people you work with, or the consultants you hire?
- What impacts do you think the PEC has had?
- Is the PEC driving changes in equipment purchases and architectural design? If so, how so?
- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are your employees asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- How is the PEC addressing barriers to change?
- Which barriers are not being addressed?

Engineer Interview Guide

Personal Background

- What is your professional background?
- How long have you been in engineering?

- What kinds of positions have you held?

The engineering community

- How would you describe the relationship between your company and the building community?
- How is your company involved in new construction and renovation?
- What can you tell me about design build? How does it work?
- When you think about new construction and retrofits, what role does a firm like yours play?
- What are the key criteria (first cost, payback, reliability, etc.) that drive decision making?
- What are typical ways members of the engineering community learn about new products and new ways of doing things?
- How rapidly do innovations permeate this field?
- What is the range of variation in the amount of time it takes?
- If you want to initiate change, to whom do you direct your attention?

Current involvement with the PEC

- Have you been involved with the PEC? If so, why? If not, why not?
- Are other members of your firm involved with the PEC?

Perceptions of the PEC program

- What do you see as the major strengths in the programs offered by the PEC?
- Are there areas where you think there could be more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its programs?
- Who do you think the PEC is reaching?
- Are there groups which the PEC should be reaching that they are not currently reaching?
- How effectively is the PEC reaching engineers?
- What would make engineers respond if they are not already responding?
- What are people's reasons for attending (new knowledge, update knowledge, tracking the competition, etc.) events at the Center?

The reach and impact of the PEC

- What portion of the engineering community do you believe the PEC has reached?
- What impacts do you think the PEC may be having?

- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- What roles do distributors and manufacturers play in changing the market?
- If you had to assess the impact of the PEC on markets, what would you look at?

HVAC Interview Guide

Personal Background

- What is your professional background?
- How long have you been in the HVAC industry?
- What kinds of positions have you held?

Current involvement with the PEC

- How long have you been involved with the PEC?
- How did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?
- How has that changed since you first became involved with the PEC?

Perceptions of the PEC program

- What do you see as the major strengths in the programs offered by the PEC?
- Are there areas where you think there could be more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its HVAC programs?
- Who do you think the PEC is reaching?
- Are there groups which the PEC should be reaching that they are not currently reaching?
- What are people's reasons for attending events at the Center (new knowledge, update knowledge, tracking the competition, etc.)?

The HVAC community

- How would you describe the HVAC community in terms of the number of people and the size of firms?

- How does product move through the market?
- When you think about new construction and retrofits, who are the key decision makers (engineering firms, contractors, building owners, etc.)?
- How is decision making done?
- What are the key criteria that drive decision making (first cost, payback, reliability, etc.)?
- How does this vary by type of project, firm, etc.?
- What are the key professional associations?
- What are typical ways member of the HVAC community learn about new products and new ways of doing things?
- How rapidly do innovations permeate this field?
- What is the range of variation in the amount of time it takes?
- If you want to initiate change, to whom do you direct your attention?

The reach and impact of the PEC

- What portion of the HVAC community do you believe the PEC has reached?
- What impacts do you think the PEC may be having?
- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- What roles do distributors and manufacturers play in changing the market?
- If you had to assess the impact of the PEC on markets, what would you look at?

Lighting Designer Interview Guide

Personal Background

- What is your professional background?
- How long have you been in the lighting design community?
- What kinds of positions have you held?
- What professional affiliations do you have?

Current involvement with the PEC

- How long have you been involved with the PEC?
- How did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?

- How has that changed since you first became involved with the PEC?

Perceptions of the PEC program

- What do you see as the major strengths in the programs offered by the PEC?
- Are there areas where you think there could be more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its lighting programs?
- Who do you think the PEC is actually reaching?
- Are there groups which the PEC should be reaching that they are not currently reaching?
- What are people's reasons for attending events at the Center (new knowledge, update knowledge, tracking the competition, etc.)?

The lighting design community

- How would you describe the lighting design community in terms of the number of people and the size of firms?
- What is the variation in the community in terms of training and background?
- For whom do lighting designers typically work (architects, distributors, retailers, etc.)?
- Who are the decision makers and how is decision making done?
- How much influence does the designer have?
- How do these things vary with the type of job?
- What are the key professional associations?
- What are typical ways that designers learn about new products and new ways of doing things?
- How rapidly do innovations permeate this field?
- What is the range of variation in the amount of time it takes?
- What about examples like T-8s or electronic ballasts?
- If you want to initiate change, to whom do you direct your attention?

The reach and impact of the PEC

- What portion of the design community do you believe the PEC has reached?
- What impacts do you think the PEC may be having?
- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?

- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- If you had to assess the impact of the PEC on markets, what would you look at?

Lighting Manufacturer Interview Guide

Personal Background

- What is your professional background?
- How long have you been in the lighting field?
- What kinds of positions have you held?
- What are your current responsibilities?
- What professional affiliations do you have?

Firm Background

- What does your firm do?
- What kinds of products does it make?
- How are the products you make distributed?
- Are you involved with controls?
- What parts of the market does your firm target?
- What types of products do you offer in those markets?
- What proportion of those markets does your firm have?

Identifying new product lines

- Where does the impetus for new products come from (end-users, designers, manufacturers representatives)?
- Which are the most important sources for new product ideas?
- What is the process for developing new products?
- Who is involved in the design process?
- How are specifications for new products established?
- What are the important criteria that are used in defining a product?
- How important is energy efficiency?
- What kind of research is done in terms of developing a new product?
- How does a product get from a concept to a manufactured product?
- What kinds of physical testing is done?
- How are prototypes tested and with whom?
- How are the markets for new products established?
- Who is involved in promoting the products?

Relationships

- Who does a manufacturer have relationships with (distributors, designers, manufacturer representatives)?
- What is the nature of these relationships?
- What is the relative importance of the various parties?
- How do you go about introducing a new product?

The lighting design community

- How would you describe the receptivity of the lighting community to new designs?
- How about acceptance of existing designs?
- What is the lighting community looking for in new designs?
- What are typical ways that designers learn about new products and new ways of doing things?
- How rapidly do innovations permeate this field?
- What is the range of variation in the amount of time it takes?
- What about examples like T-8s or electronic ballasts?
- If you want to initiate change, to whom do you direct your attention?

Current involvement with the PEC

- Have you been involved with the PEC?
- How did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?
- Are any of the connections you have related to product development?

Perceptions of the PEC program

- What do you see as the major strengths in the programs offered by the PEC?
- Are there areas where you think there could be more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its lighting programs?
- Who do you think the PEC is actually reaching?
- Are there groups which the PEC should be reaching that they are not currently reaching?
- What are people's reasons for attending events at the Center (new knowledge, update knowledge, tracking the competition, etc.)?

The reach and impact of the PEC

- What portion of the design community do you believe the PEC has reached?

- What impacts do you think the PEC may be having?
- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- If you had to assess the impact of the PEC on markets, what would you look at?

Lighting Vendor Interview Guide

Personal Background

- What is your professional background?
- How long have you been with firms that sell lighting products?
- What kinds of positions have you held?
- What professional affiliations do you have?

What products and services do manufacturers' representatives offer?

- Who are your direct customers (by category)? How do they vary?
- Who are the indirect customers? How do they vary?
- What is the range of products that you offer?
- What is the range of services that you offer?
- How do you represent manufacturers?
- How does this vary by manufacturer?
- How are your employees trained?
- Do they receive training from the manufacturers?

Current involvement with the PEC

- Have you been involved with the PEC and, if so, how much?
- If you haven't been involved with the PEC, what are some of the reasons why?
- If you have been involved, how did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?
- How has that changed since you first became involved with the PEC?
- Do your firm's employees use the services of the PEC?

Perceptions of the PEC program

- Relative to the products and services that you offer, what do you see as the major strengths in the programs offered by the PEC?

- Are there areas where you think there could be more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its programs?
- Who do you think the PEC is actually reaching?
- Can you cite anecdotal evidence for this?
- Are there groups which the PEC should be reaching that they are not currently reaching?
- What are peoples' reasons for attending (new knowledge, update knowledge, tracking the competition, etc.) events at the Center?
- How about reasons for not using the services of the Center?

Lighting Suppliers

- How important are architectural, energy, and environmental issues in terms of the products and services that you provide?
- How has this changed over the last several years?
- What is driving these changes?
- When you think about new construction and retrofits, who are the key decision makers (engineering firms, contractors, building owners, etc.)?
- How is decision making done?
- What are the key criteria (first cost, payback, reliability, etc.) that drive decision making?
- How does this vary by type of project, firm, etc.?
- How do you as a lighting supplier fit into this picture?
- When are you most likely to influence decision making?
- In what circumstances are you least likely to influence decision making?
- What are the key professional associations?
- What are typical ways members of the members of your firm learn about new products and new ways of doing things? What about your customers?
- How rapidly do innovations permeate this field?
- What is the range of variation in the amount of time it takes?
- How do innovations spread?
- What are the barriers to change in the field?
- If you want to initiate changes in products, to whom do you direct your attention?

The reach and impact of the PEC

- Do you believe the PEC has impacted you as a vendor of lighting products?
- What impacts do you think the PEC may be having?
- Are the programs of the PEC driving changes in equipment purchases? If so, how so?

- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- How is the PEC addressing barriers to change? Which barriers are not being addressed?

Manufacturers Representative Interview Guide

Personal Background

- What is your professional background?
- How long have you been with firms that represent manufacturers?
- What kinds of positions have you held?
- What professional affiliations do you have?

What products and services do manufacturers representatives offer?

- Who are your direct customers (by category)?
- How do they vary?
- Who are the indirect customers?
- How do they vary?
- What is the range of products that you offer?
- What is the range of services that you offer?
- How do you represent manufacturers?
- How does this vary by manufacturer?
- How are your employees trained?
- Do they receive training from the manufacturers?

Current involvement with the PEC

- Have you been involved with the PEC and, if so, how much?
- If you haven't been involved with the PEC what are some of the reasons why?
- If you have been involved, how did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?
- How has that changed since you first became involved with the PEC?
- Do your firm's employees use the services of the PEC?

Perceptions of the PEC program

- Relative to the products and services that you offer, what do you see as the major strengths in the programs offered by the PEC?
- Are there areas where you think there could be more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its programs?
- Who do you think the PEC is actually reaching?
- Can you cite anecdotal evidence for this?
- Are there groups which the PEC should be reaching that they are not currently reaching?
- What are peoples' reasons for attending (new knowledge, update knowledge, tracking the competition, etc.) events at the Center?
- How about reasons for not using the services of the Center?

Manufacturers' Representatives

- How many manufacturers' representatives are there in the PG&E Service territory?
- How do they vary in size?
- Do they specialize in certain products and services?
- Are these specialties determined by the manufacturers they represent or other factors?
- How important are architectural, energy, and environmental issues in terms of the products and services that you provide?
- How has this changed over the last several years?
- What is driving these changes?
- When you think about new construction and retrofits, who are the key decision makers (engineering firms, contractors, building owners, etc.)?
- How is decision making done?
- What are the key criteria (first cost, payback, reliability, etc.) that drive decision making?
- How does this vary by type of project, firm, etc.?
- How do you as a manufacturers' representative fit into this picture?
- When are you most likely to influence decision making?
- In what circumstances are you least likely to influence decision making?
- What are the key professional associations?
- What are typical ways members of the members of your firm learn about new products and new ways of doing things?
- What about your customers?
- How rapidly do innovations permeate this field?

- What is the range of variation in the amount of time it takes? How do innovations spread?
- What are the barriers to change in the field?
- If you want to initiate changes in products, to whom do you direct your attention?

The reach and impact of the PEC

- Do you believe the PEC has impacted you as a manufacturers' representative?
- What impacts do you think the PEC may be having?
- Are the programs of the PEC driving changes in equipment purchases? If so, how so?
- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- How is the PEC addressing barriers to change? Which barriers are not being addressed?

Operating Engineer Interview Guide

Personal Background

- What is your professional background?
- How long have you been in facilities engineering?
- What kinds of positions have you held?

Current involvement with the PEC

- How long have you been involved with the PEC?
- How did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?
- How has that changed since you first became involved with the PEC?

Perceptions of the PEC program

- What do you see as the major strengths in the programs offered by the PEC.
- Are there areas where you think there could be more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its programs?

- Who do you think the PEC is reaching?
- Are there groups which the PEC should be reaching that they are not currently reaching?
- How effectively is the PEC reaching facilities engineers?
- What would make facilities engineers respond if they are not already responding?
- What are people's reasons for attending (new knowledge, update knowledge, tracking the competition, etc.) events at the Center?

The engineering community

- How would you describe the engineering community in terms of the number of people and the size of firms?
- How are facilities engineers involved in decision making?
- When you think about new construction and retrofits, what role do facilities engineers play?
- What are the key criteria (first cost, payback, reliability, etc.) that drive decision making?
- How does this vary by type of project, firm, etc.?
- How is decision making done with respect to operations and maintenance?
- What can you tell me about the membership of Union Local 39?
- What are typical ways members of this community learn about new products and new ways of doing things?
- How rapidly do innovations permeate this field?
- What is the range of variation in the amount of time it takes?
- If you want to initiate change, to whom do you direct your attention?

The reach and impact of the PEC

- What portion of the engineering community do you believe the PEC has reached?
- What impacts do you think the PEC may be having?
- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?
- What roles do distributors and manufacturers play in changing the market?
- If you had to assess the impact of the PEC on markets, what would you look at?

Operating Engineers (Local 39) Interview Guide

Personal Background

- What is your professional background?
- How long have you been in facilities engineering?
- What kinds of positions have you held?

Questions about Local 39

- How long has Local 39 been in existence?
- What are the goals and purposes of Local 39?
- How does one become a member of Local 39?
- Are there apprenticeship and training programs?
- What is the range of programs that are offered?
- How do these programs operate?

Local 39 Membership

- Approximately how many members does Local 39 have?
- What is the range of educational backgrounds of the members?
- What types of employment do members have?
- For whom do they work?
- What would the breakdown of membership be by type of employment?
- How would the membership of Local 39 compare with facilities engineers who are not members of the Local?

Current involvement with the PEC

- What do you know about the PEC and what if any involvement have you had with the PEC?
- How did you get involved with the PEC?
- What kinds of activities have you been involved with at the PEC?
- How has that changed since you first became involved with the PEC?

Perceptions of the PEC program

- What do you see as the major strengths in the programs offered by the PEC?
- How do Local 39's programs differ from those offered by the Center?
- In what ways are the programs similar?
- Are there areas where you think the PEC could provide more offerings?
- How would you change the offerings?

Target audience

- Who do you think the PEC is trying to reach with its programs?
- Who do you think the PEC is reaching?
- Are they reaching members of Local 39?
- Do you think you membership would like more or less involvement with the PEC?
- What would make facilities engineers respond if they are not already responding.
- What are peoples' reasons for attending events at the Center (new knowledge, update knowledge, tracking the competition, etc.)?

The engineering community

- How would you describe the facilities engineering community in terms of the number of people and the size of firms?
- How are facilities engineers involved in decision making?
- When you think about new construction and retrofits, what role do facilities engineers play?
- What influence do they have on decision making?
- What are the key criteria that drive decision making (first cost, payback, reliability, etc.)?
- How does this vary by type of project, firm, etc.?
- How is decision making done with respect to operations and maintenance?
- What are typical ways members of Local 39 learn about new products and new ways of doing things?
- We have heard that facilities engineers want updated buildings and equipment. Is this generally true or true only of some facilities engineers?
- How rapidly do innovations permeate this field?
- What is the range of variation in the amount of time it takes?
- If you want to initiate change, to whom do you direct your attention?

The reach and impact of the PEC

- What portion of the facilities engineering community do you believe the PEC has reached?
- What impacts do you think the PEC may be having?
- What types of evidence and anecdotes can you cite that might indicate the impacts that the PEC is having?
- Do you see specifications changing?
- Are decision makers asking different questions?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?

- What roles do contractors and manufacturers play in changing the market?
- If you had to assess the impact of the PEC on markets, what would you look at?

PEC Staff Interview Guide

Personal Background

- What is your professional background?
- How long have you been involved with the PEC?
- How did you get involved with the PEC?

Current involvement with the PEC

- What are you currently doing at the PEC?
- How has that changed since you first became involved with the PEC?

The workshops and classes you teach and lead?

- What are the purposes of the technical library?
- How do you decide on what to place in the library?
- What services does the library offer?

Target audience

- Who do you see as the target audience for the library?
- Who actually makes use of library services?
- Do you track requests?
- In what form do requests come?
- What types of requests have you had over the last three years?
- How have the requests changed if at all?
- What types of factors drive the requests, for example, the need for specific technical information, the need for general information?

The communities who use the library

- Which groups of people use the library the most?
- For what do they use it?
- What other library resources are available in the area that might serve clients needs?
- Do clients use those resources?
- Why do they use the PEC library?

The reach and impact of the PEC

- What needs do you think that the technical library is meeting?
- What impacts do you think it may be having?

- What types of evidence and anecdotes can you cite that might indicate its impact?
- For instance, do you think that information in the library may be being used as a basis for writing specifications?
- Are decision makers asking questions that are different than they might otherwise ask because of the library?
- What about the impact of the Center more generally?
- Do you have anecdotes or evidence that would suggest that the PEC is having an impact in the target communities?
- How would you assess the impact of the Center relative to other sources of change such as professional publications, other PG&E programs such as rebate programs, changes in product availability, changes in manufacturers lines, Title 24, etc.?

Appendix E. Participant survey questionnaire

PEC Market Transformation Survey Questionnaire

Respondent Information (pre-filled)

1. Name: _____ ___ _____
2. Title: _____
3. Company name: _____
4. Address 1: _____
5. Address 2: _____
6. City: _____ State: _____ Zip _____
7. Telephone: (___) ____ - ____
8. Fax: (___) ____ - ____

Center Event Participation Record (pre-filled most recent to least recent)

Event.	Date mm dd yy	Name of event
9.	a.___ ___ ___	b. _____
10.	a.___ ___ ___	b. _____
11.	a.___ ___ ___	b. _____
12.	a.___ ___ ___	b. _____
13.	a.___ ___ ___	b. _____

Contact log

Date month, day, year mm dd yy	Time in (24 hour clock) h h m m	Time out (24 hour clock) h h m m	Result: 1. Complete, 2. Callback, 3. No Answer, 4. No contact, 5. Wrong number, 6. Refusal, 7. Moved known, 8. Moved unknown, 9. Other (describe) Write in call back date and time
14.a.___ ___ ___	b. __ __ __ __	c. __ __ __ __	d. _____ _____
15.a.___ ___ ___	b. __ __ __ __	c. __ __ __ __	d. _____ _____
16.a.___ ___ ___	b. __ __ __ __	c. __ __ __ __	d. _____ _____
17.a.___ ___ ___	b. __ __ __ __	c. __ __ __ __	d. _____ _____
18.a.___ ___ ___	b. __ __ __ __	c. __ __ __ __	d. _____ _____
19.a.___ ___ ___	b. __ __ __ __	c. __ __ __ __	d. _____ _____

Good (morning / afternoon). My name is _____. I am calling on behalf of Pacific Gas and Electric Company. We are conducting a survey about the impacts of the PG&E Energy Center. According to our records you have attended Center events or used the services of the Center.

Is that correct?

20. ❑ Yes ❑ No ❑ DK/NA

Let me just double check. At one time the PG&E Energy Center was called the Pacific Energy Center. PG&E's Energy Center is located on Howard Street near the Moscone Center in San Francisco. The Center conducts workshops and classes related to energy efficiency in commercial buildings. It has classrooms and exhibits.

21.a If our records are correct, you participated in a (insert 6b.) in (insert 6a). Is that correct?

❑ Yes ❑ No ❑ DK/NA

I am sorry to have bothered you. We must have gotten your name in error. Thank you for your time and patience.

Terminate and record data in call log

PG&E is trying to determine how the Center may have influenced how people make decisions about energy efficiency in buildings. The results of the study are to be reported to the California Public Utilities Commission. We would like to ask you some questions related to your experiences with the Center and what has happened since your use of the Center. The survey will take approximately 25 minutes. Your responses will be kept confidential.

May I proceed?

22. ❑ Proceed ❑ Call back (Interviewer don't read just record)

I would be more than happy to call back. Can you suggest a time?

Hour_____AM/PM Month _____ Day _____

Thank you very much for speaking with me. I will call again.

Terminate and transfer information to call log

Initialize change flag to "no"
Initialize workshops flag to "no"

Use of PEC Services

In order to speed things along, I will sometimes refer to the Pacific Gas and Electric Energy Center as the PEC or the Center. OK?

23. Can you recall about how many times you have attended events or used the services of the PEC? *(Do not read, categorize answer. If the respondent asks what you mean by an event say "classes, workshops demonstrations, consultations, heliodon sessions, etc." If no response or vague response, probe. Example, by "several do you mean less than 5 or perhaps more than 5)*

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5 - 10 times ❑ More than 10 times ❑ DK/NA

I am going to read a general list of activities, events, and services that the PEC provides. Can you please tell me in which kinds of activities you have participated or which services you have received? *(Read the list)*

		Not participated	Participated	DK/NA
24.	Workshops or classes	❑	❑	❑
25.	Use of the library resource center	❑	❑	❑
26.	A technology demonstration tailored to your needs	❑	❑	❑
27.	A loan of a meter or some other measurement tool	❑	❑	❑
28.	A heliodon session to analyze a model	❑	❑	❑
29.	On-site or telephone consultation	❑	❑	❑
30.	Viewed of exhibits or had a tour	❑	❑	❑
31.	Attended a meeting sponsored by someone other than the PEC	❑	❑	❑
32.	Other: _____	❑	❑	❑

If 24 = participated set the workshops flag to "yes"

The PEC's offerings address a wide range of topics. I am going to quickly list different topic areas. As I mention each topic area, please tell whether it is a primary interest, a secondary interest or of little or no interest with respect to your attendance at the Center.

	How about . . . . . is that of primary, secondary or not of interest	No interest	Secondary Interest	Primary Interest	DK/NA
33.	Solar geometry, shading and architectural design	❑	❑	❑	❑
34.	Windows and glazing	❑	❑	❑	❑
35.	Lighting fundamentals, lighting design, lighting applications	❑	❑	❑	❑
36.	Daylighting	❑	❑	❑	❑
37.	Controls	❑	❑	❑	❑
38.	Thermal loads, HVAC systems and building design and operation	❑	❑	❑	❑
39.	Environmental and code compliance	❑	❑	❑	❑
40.	Measuring, handling and analyzing building systems data	❑	❑	❑	❑
41.	Other: _____	❑	❑	❑	❑

Reasons for participating in PEC events

Now, I would like you to think about all of the events you have attended and/or the services you have sought from the Center. I would like you to pick the one Center sponsored event or service that you found most beneficial. (*Interviewers: ASHRAE meetings, IES meetings, any meeting sponsored by an outside organization is not a Center sponsored event*)

42. Could you tell me what that event was or describe it in a few words?

_____

43. About when did the event occur? (*Interviewer: record what they remember.*)

_____ m _____ d _____ y ❑ DK/NA

For the next few questions I am going to refer to this as the service. OK?

Now, I am going to list some reasons why people may use a service. On a scale of 1 to 5 where "1" is not a reason and "5" is a very important reason, please tell me if the reason I list motivated you to use the service. Let me emphasize that I am interested in your reason for seeking the service in the first place.

		1	2	3	4	5	DK/NA
44.	Acquire new knowledge, skills or information	❑	❑	❑	❑	❑	❑
45.	Update existing knowledge, skills, or information	❑	❑	❑	❑	❑	❑
46.	Find ways to be more competitive	❑	❑	❑	❑	❑	❑
47.	Because of involvement with other PG&E efficiency programs (*example: rebate program*)	❑	❑	❑	❑	❑	❑
48.	Title 24 or environmental compliance issues	❑	❑	❑	❑	❑	❑
49.	To solve a specific problem	❑	❑	❑	❑	❑	❑
50.	Recommended by a colleague	❑	❑	❑	❑	❑	❑
51.	Training or education requirement	❑	❑	❑	❑	❑	❑
52.	PEC expertise	❑	❑	❑	❑	❑	❑
53.	Unique subject offerings	❑	❑	❑	❑	❑	❑
54.	Center's reputation for providing	❑	❑	❑	❑	❑	❑

		1	2	3	4	5	DK/NA
	objective information Are there any other reasons for using the services of the PEC that have not been mentioned.						
55.	Other reason 1 _____	❑	❑	❑	❑	❑	❑
56.	Other reason 2 _____	❑	❑	❑	❑	❑	❑

Stages of adoption

Now, thinking about this same service, I am going to ask you some questions about the content or topic area represented by this service. I would like for you to think about the period **before** you received the service? (*Interviewer please emphasize the before aspect of this question*)

57. Had you received any formal education or training on this topic?

❑ No ❑ Yes ❑ DK/NA

58. Had you actively sought information, publications, or views of colleagues on this topic?

❑ No ❑ Yes ❑ DK/NA

59. For business or personal reasons, had you decided that you needed to identify and learn new concepts, skills and technologies on this topic?

❑ No ❑ Yes ❑ DK/NA

60. Prior to participating in Center events had you actually used concepts, skills and technologies on this topic?

❑ No ❑ Yes ❑ DK/NA

Now, I would like to have you think about the period **since** you received the service. (*Interviewer please be sure to emphasize the "since."*)

61. Have you sought more information, attended more classes, or received more services from the Center in this area?

❑ No ❑ Yes ❑ DK/NA

62. Have you sought more information about this area in trade publications, journals, and or from colleagues?

❑ No ❑ Yes ❑ DK/NA

63. How about getting information from manufacturers or distributors?

❑ No ❑ Yes ❑ DK/NA

64. Have you visited sites or talked with personnel at sites where the concepts and technologies related to this area may have been implemented?

❑ No ❑ Yes ❑ DK/NA

65. Since then have you decided to use some of the concepts and technologies you learned in a specific building or a project?

❑ No ❑ Yes ❑ DK/NA

66. Have you actually implemented projects using the knowledge or skills you learned as a result of receiving the service?

❑ No ❑ Yes ❑ DK/NA

Changes in practice attributable to the Center

In the previous questions, we asked about a specific center event. Now, I am going to ask about specific areas where you may make or substantially influence decisions.

67. In your current practice are you involved in or do you substantially influence decisions about HVAC systems?

❑ No (skip to 81) ❑ Yes

Have you attended events, classes or activities at the PEC related to HVAC systems?

❑ No (skip to 81) ❑ Yes

I am going ask some questions about your HVAC related work now *(emphasize the now)* compared to before you participated in PEC activities. I am going to read a list of things people might do and I want you to tell me if you are doing more, less or about the same as before your PEC participation. If you are doing more or less, I am going to ask if your participation in Center events was a main reason, a partial reason or not a reason for the change in the way you do your work.

Compared with your past practice is (are) your . . . . (fill in 68 - 80) more less, or about the same? (*Once you have established the pattern say, "how about your use of . . . is it more, less or about the same"?)*	*(if respondent says "about the same" or "don't know" go to next item)*				(*If the respondent says less or more then ask*) Was your participation at the PEC a partial reason, a main reason, or not at all a reason for the change?			
	Less	About the same	More	DK/ NA	Not a reason	Partial reason	A main reason	DK/NA
68. use of monitored data in pre-retrofit designs	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑
69. use of monitored data for post installation performance analysis	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑
70. attention and effort to commissioning and recommissioning	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑

Compared with your past practice is (are) your . . . . (fill in 68 - 80) more less, or about the same? (*Once you have established the pattern say, "how about your use of . . . is it more, less or about the same"?)*	*(if respondent says "about the same" or "don't know" go to next item)*				(*If the respondent says less or more then ask*) Was your participation at the PEC a partial reason, a main reason, or not at all a reason for the change?			
	Less	About the same	More	DK/ NA	Not a reason	Partial reason	A main reason	DK/NA
71. use of variable speed drives in HVAC applications	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑
72. use of sophisticated computerized analysis tools for systems such as cooling towers	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑
73. use of whole building simulations such as DOE-2	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑
74. attention to the interactions between the HVAC system and other building systems and components in the design phase	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑
75. use of load shifting or reduction strategies such as thermal energy storage to reduce capacity requirements	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑
76. use of expected load frequency distributions to determine the number and size of components such as chillers	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑
77. use of combinations of equipment capacities to meet part or full load requirements	a. ❑	❑	❑	❑	b. ❑	❑	❑	❑

Compared with your past practice is (are) your . . . . (fill in 68 - 80) more less, or about the same? (*Once you have established the pattern say, "how about your use of . . . is it more, less or about the same"?)*	*(if respondent says "about the same" or "don't know" go to next item)*				(*If the respondent says less or more then ask*) Was your participation at the PEC a partial reason, a main reason, or not at all a reason for the change?				
		Less	About the same	More	DK/ NA		Not a reason	Partial reason	A main reason	DK/NA
78. use of more sophisticated control strategies such as condenser water reset to optimize instantaneous performance across climate and load conditions	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
79. efforts to convince customers of the benefits of a more sophisticated and extensive analysis during design	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
80. use of life cycle cost or other discounted cash flow methods	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑

If any of change items = "less" or "more" then set change flag to "yes"

Architectural design

81. In your current practice are you involved in or do you substantially influence decisions about architectural design?

❑ No (skip to question 92) ❑ Yes

82. Have you attended classes or engaged in activities at the PEC related to this topics?

❑ No (skip to 92) ❑ Yes

I am going ask some questions about how you do your work now *(emphasize the now)* compared to t before you participated in PEC activities. I'm going to list things people might do and I want you to tell me if you are doing more, less or about the same as before If you are doing more or less, I am going to ask if your participation in Center events was a main reason, a partial reason or not a reason for the change in the way you do your work.

Compared with your past practice is (are) the. . . . (*fill with 83 - 91*) more, less, or about the same? (*Once you have established the pattern say, "How about your use of . . . is it more, less or about the same?*							(*If the respondent says less or more then ask*) Was your exposure to the PEC a reason, a partial reason, or a reason in the change:				
		Less	About the same	More	DK/NA		Not a reason	Partial reason	A main reason	DK/NA
83. amount of discussion with clients about the interactions among different building systems such as building orientation, shell construction, shading devices, windows and glazing, mechanical systems and lighting	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
84. amount of effort devoted to analyzing the initial and long term costs associated with the trade offs among building orientation, shell design, shading devices, windows and glazings, mechanical systems and lighting	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
85. use of external shading devices	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
86. use of daylighting	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑

			Compared with your past practice is (are) the. . . . (*fill with 83 - 91*) more, less, or about the same? (*Once you have established the pattern say, "How about your use of . . . is it more, less or about the same?*	Less	About the same	More	DK/NA		(*If the respondent says less or more then ask*) Was your exposure to the PEC a reason, a partial reason, or a reason in the change:	Not a reason	Partial reason	A main reason	DK/NA
87.	use of physical or computer models to understand the thermal and visual effects of daylight entering a structure	a.		❑	❑	❑	❑	b.		❑	❑	❑	❑
88.	use of controls in conjunction with electric lights and daylight to reduce energy consumption and increase visual comfort	a.		❑	❑	❑	❑	b.		❑	❑	❑	❑
89.	use of measured site specific environmental data in design decisions	a.		❑	❑	❑	❑	b.		❑	❑	❑	❑
90.	use of integrated controls to integrate systems	a.		❑	❑	❑	❑	b.		❑	❑	❑	❑
91.	attention to commissioning building systems and controls	a.		❑	❑	❑	❑	b.		❑	❑	❑	❑

If any of change items = "less" or "more" then set change flag to "yes"

Lighting design

92. In your current practice are you involved or do you substantially influence decisions about lighting or lighting controls?

❑ No (skip to 105) ❑ Yes

93. Have you attended classes or activities at the PEC related to lighting?

❑ No (skip to question 105) ❑ Yes

I am going ask some questions about how you do your work now *(emphasize now)* compared to the way you did it before you participated in PEC activities. I am going to read a list of things people might do and I want you to tell me if overall you are doing more, less or about the same as before. If you are doing more or less, I am going to ask if your participation in Center events was a main reason, a partial reason or not a reason for the change in the way you do your work.

Compared with your past practice is (are) your (insert 94 - 105). . . . more less, or about the same? (*Once you have established the pattern say, how about your use of . . . is it more, less or about the same?)*							(*If the respondent says less or more then ask*) Was your exposure to the PEC a reason, a partial reason, or a reason in the change:				
		Less	About the same	More	DK/NA		Not a reason	Partial reason	A main reasons	DK/NA
94. use of analysis to determine the quantity of illumination, quality, and color of lighting to make space visually comfortable and attractive	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
95. use of computerized tools to evaluate lighting performance and equipment efficiency options	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑

	Compared with your past practice is (are) your (insert 94 - 105). . . . more less, or about the same? (*Once you have established the pattern say, how about your use of . . . is it more, less or about the same?)*		Less	About the same	More	DK/NA		(*If the respondent says less or more then ask*) Was your exposure to the PEC a reason, a partial reason, or a reason in the change: Not a reason	Partial reason	A main reasons	DK/NA
96.	use of energy efficiency as a decision criteria when selecting equipment	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
97.	use of life cycle cost or other discounted cash flow methods in decision making	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
98.	attention to the interactions between lighting systems and other building systems	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
99.	specification and use of more efficient lamps, ballasts, reflectors	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
100.	the use of daylighting in conjunction with controls for electric lights	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
101.	the integration of lighting controls with other building control systems	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
102.	attention to the commissioning and fine tuning of controls	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
103.	attempting to enhance productivity through the careful integration of daylighting, quality lighting, and task lighting	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
104.	use of measurement equipment to evaluate lighting performance	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑

If any of change items = “less” or “more” then set change flag to “yes”

Heliodon sessions

105. Have you used the heliodon at the PEC to analyze a building that is being built

❑ No (skip to 119) ❑ Yes

106. For how many projects have you used the heliodon?

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5-10 ❑ 10+ ❑ DK/NA

107. Did you initiate your most recent heliodon session to (*read all and check all that apply*):

❑ evaluate alternative concepts
❑ refine an already accepted design
❑ validate a specific design concept and approach
❑ demonstrate results of a specific design for a client (through video)
❑ allow client to choose among designs
❑ some other reason. What reason?: _____

108. Did the session result in changes to (*read all choose all that apply*):

❑ the footprint of the structure
❑ the orientation of the structure
❑ architectural elements incorporated into the structure
❑ validation of the design
❑ some other aspect. What aspect?: _____

Heliodon sessions allow one to see a design perform, to discuss a design with PEC professionals, to use video tape to capture design performance for discussion with other professionals or the client. Based on your experience with heliodon sessions, we would like to know which of the following outcomes is most important. On a scale of 1 to 5 where "1" is "not at all important" and "5" is "extremely important", what importance would you attach to each of the following (*fill 109 - 114*)?

		1	2	3	4	5	DK/NA
109.	seeing a design perform	❑	❑	❑	❑	❑	❑
110.	discussing alternatives with PEC professionals	❑	❑	❑	❑	❑	❑

		1	2	3	4	5	DK/NA
111.	preparing a tape for later analysis and use with other professionals	❑	❑	❑	❑	❑	❑
112.	preparing a tape for use with clients	❑	❑	❑	❑	❑	❑

I would like to have you think back to the period before the heliodon sessions and then to what you are doing now.

	When you compare what you were doing before your heliodon session with your practice after the heliodon sessions, would you say that your *(fill 114-119)* is more, less or about the same?						Was your exposure to the PEC not a factor, a partial factor, or a main factor in the change:			
			Less	About the same	More	DK/NA		Not a factor	Partial factor	A main factor	DK/NA
113.	attention to solar orientation and siting	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
114.	use of architectural elements for shading and/or reflecting light	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
115.	use of daylighting elements	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
116.	attention to windows and glazing	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
117.	attention to the sizing of heating and cooling systems relative to thermal loads	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
118.	attention to energy usage per square foot	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑

If any of change items = “less” or “more” then set change flag to “yes”

One-to-one consultations

119. Have you initiated any kind of one-to-one expert discussion with PEC staff related to a project or issue?

❑ No (Skip to 129) ❑ Yes ❑ DK/NA

120. How many times have you done this?

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5+ ❑ DK/NA

121. In a few words, can you describe the purpose of your most recent consultation?

_____

_____

122. Did you seek this one-to-one discussion in order to (*check all that apply*)

❑ Look for alternative design idea
❑ Learn more about an alternative approach or design idea
❑ Search for alternative technologies
❑ Obtain specific information about a technology
❑ Some other reason: _____
❑ DK/NA

I am going to list some reasons why you may have sought a consultation. On a scale of 1 to 5 where "1" is "not at all important" and "5" is "extremely important", how important would you say (*fill 123 - 128*) was in your decision to seek a consultation?

		1	2	3	4	5	DK/NA
123.	the unique expertise of the PEC Staff	❑	❑	❑	❑	❑	❑
124.	knowledge of specific technical information	❑	❑	❑	❑	❑	❑
125.	reputation of the PEC staff with your project decision makers	❑	❑	❑	❑	❑	❑
126.	perceived objectivity of the PEC staff	❑	❑	❑	❑	❑	❑
127.	availability and accessibility of the PEC staff compared to other sources	❑	❑	❑	❑	❑	❑
128.	Some other reason: _____ _____	❑	❑	❑	❑	❑	❑

Metering

129. Have you borrowed any metering or measuring equipment from the Center?

❑ No (Skip to 138) ❑ Yes ❑ DK/NA

130. How many times have you done this?

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5+ ❑ DK/NA

131. Why did you borrow the equipment (read and check all that apply)?

❑ determine if existing equipment was operating according to specification
❑ evaluate a pilot project
❑ evaluate the efficiency of existing equipment
❑ determine use patterns
❑ evaluate ways to change or improve operations or maintenance
❑ find ways to reduce demand charges
❑ find ways to reduce energy consumption
❑ find ways to improve the efficiency of a process or a system
❑ some other reason:

Please tell me the reason:

_____

_____

132. Did you initiate the project (check all that apply)

❑ in response to a request from your management
❑ at the suggestion of a PG&E field representative
❑ in response to a vendor or consultant suggestion
❑ to locate unexpected changes in energy use
❑ in response to complaints or suggestions from building users
❑ to increase your own understanding of how a system(s) worked
❑ to develop evidence to support an argument for a change with people higher in the organization
❑ some other reason:

Please tell me the reason:

_____

_____

133. Based on the measurements and analysis from your metered project did you decide that changes in equipment and/or operations and maintenance might be beneficial?

❑$_0$ No (skip to 138) ❑$_1$ Yes❑ DK/NA

134. Have you implemented those changes

❑$_1$ Yes❑$_0$ No ❑ DK/NA

135. When you implemented the changes, Did you ?

- ❑ Install more efficient equipment of the same type
- ❑ Resize equipment
- ❑ Reduce the amount of equipment
- ❑ Reconfigure the system to better meet part loads
- ❑ Add controls
- ❑ Change operating practices and procedures
- ❑ Adjust equipment for better operations
- ❑ Change maintenance practices
- ❑ Other:

Please identify _____

136. Did you expect these changes to?

- ❑ Reduce energy use
- ❑ Reduce peak demand
- ❑ Improve comfort
- ❑ Change use patterns
- ❑ Other, what reason

_____

137. Why haven't you implemented changes?
Enter response and code to one of following

_____

_____

- ❑ Project in process
- ❑ Too expensive

❑ Not enough time
❑ Decision not yet made
❑ Doesn't meet payback criteria
❑ Life cycle benefits not sufficient
❑ Concerns about reliability
❑ Concerns about comfort
❑ Concerns about aesthetics
❑ Low priority
❑ Didn't have the skill to do the analysis
❑ Believe there is a problem with the results
❑ other:

Building modeling

138. Have you attended any of the sessions involving modeling of the thermal characteristics of buildings like the DOE-2 sessions?

❑ No(Skip to 146) ❑ Yes ❑ DK/NA

139. Why did you attend the sessions?

❑ needed to use the tool for a specific project
❑ refresh knowledge of the tool
❑ learn about the tool for the first time
❑ wanted to have the skill
❑ needed to use the tool for a specific project
❑ thought it would help me to better understand how to design buildings or systems
❑ saw it as a way to attract customers
❑ competitor is using it
❑ other:
Please identify _____

I am going ask some questions about how you do your work now compared to the way you did it before you participated in PEC activities. I am going to read a list of things people might do and I want you to tell me if you are doing more, less or about the same as before. If you are doing more or less, I am going to ask if your participation in Center events was a main reason, a partial reason or not a reason for the change in the way you do your work.

	Compared with your past practice is (are) your . . . . more, less, or about the same? (*Once you have established the pattern say, how about your use of . . . is it more, less or about the same?*		Less	About the same	More	DK/NA		Were the simulation sessions not a factor, a partial factor, or a main factor in the change: Not a factor	Partial factor	A main factor	DK/NA
140.	use of modeling to evaluate thermal dynamics	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
141.	attention to materials in the shell	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
142.	use of architectural elements for shading and/or reflecting light	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
143.	attention to the integration of the shell, windows, lighting, and the HVAC system	a..	❑	❑	❑	❑	b.	❑	❑	❑	❑
144.	sizing of heating and cooling systems relative to thermal loads	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑
145.	attention to energy usage per square foot	a.	❑	❑	❑	❑	b.	❑	❑	❑	❑

If any of change items = “less” or “more” then set change flag to “yes”

General impacts of change

If changes flag = yes do this section, else skip to question 153

146. Thinking about all of the changes that you have made in response to your experience and involvement with the PEC, do you think that you will (*check one*)

- ❑ discontinue almost all of the changes
- ❑ continue some
- ❑ continue nearly all
- ❑ continue all
- ❑ DK/NA

147. Do you think you are likely to make additional changes based on what you learned at the PEC?

❑ no ❑ yes ❑ DK/NA

148. Approximately how many buildings or structures do you think the changes you have made may have influenced.

❑ 1 ❑ 2 - 5 ❑ 6 - 10 ❑ 11-15 ❑ 16 -20 ❑ 21+ ❑ DK/NA

149. Approximately how many buildings or structures do you think the changes will influence in the next two years.

❑ 1 ❑ 2 - 5 ❑ 6 - 10 ❑ 11-15 ❑ 16 -20 ❑ 21+ ❑ DK/NA

150. Are the changes being adopted for

- ❑ less than a quarter of the buildings with which we are involved
- ❑ a quarter to a half of the buildings
- ❑ a half to three quarters of the building
- ❑ most of the buildings
- ❑ DK/NA

151. Have the changes been mostly adopted by you, by you and your work group, or by your firm as a whole (check all that apply)

- ❑ personal adoption
- ❑ workgroup adoption
- ❑ adopted by firm
- ❑ DK/NA

152. Why haven't the changes been adopted in some buildings?

- ❑ lack of interest on the part of the owner / builder
- ❑ lack of information
- ❑ higher initial cost
- ❑ length of the payback
- ❑ Other, please specify _____

Materials from workshop

(If workshop flag = "yes" complete this section, else go to question 162)

Earlier you said that you attended workshops and classes. People can use the information from classes and workshops differently. For instance you might think about an example while doing your work or you might reference the written materials. You might cite examples when talking with colleagues. I am going to read a list of things that are a part of the workshops and classes presented by the Center. On a "1" to "5" scale where "1" means you haven't used the item and "5" means you have used it a lot please tell me how much you have used the item. Remember that for some things, just recalling an item from time to time is a use.

		1	2	3	4	5	DK/NA
153.	Written course materials provided by the Center	❑	❑	❑	❑	❑	❑
154.	The course organizing concepts	❑	❑	❑	❑	❑	❑
155.	Technical explanations presented during the workshop or lecture	❑	❑	❑	❑	❑	❑
156.	Technology or product specific data	❑	❑	❑	❑	❑	❑
157.	Case studies presented during the lectures	❑	❑	❑	❑	❑	❑
158.	Hands on methods of calculation, problem solving, or data collection	❑	❑	❑	❑	❑	❑

		1	2	3	4	5	DK/NA
159.	Physical demonstrations of technology such as lighting fixtures, glazing etc.	❑	❑	❑	❑	❑	❑
160.	One-to-one discussion with other attendees	❑	❑	❑	❑	❑	❑
161.	One-to-one discussion with the instructor(s)	❑	❑	❑	❑	❑	❑

Information about Center Programs

People find out about programs like those at the PEC in different ways. As I read a list of ways, people get information please tell me if the item almost never, sometimes, or frequently is a source of your information about Center programs

		Never or almost never	Sometimes	Frequently	DK/NA
162.	Calendar of events from the PEC	❑	❑	❑	❑
163.	Information obtained through professional / trade association newsletter or mailing	❑	❑	❑	❑
164.	PEC Homepage	❑	❑	❑	❑
165.	Recommendation of a PG&E employee	❑	❑	❑	❑
166.	Information from a colleague within your own firm	❑	❑	❑	❑
167.	Information received from colleague outside firm	❑	❑	❑	❑
168.	Fax received from center	❑	❑	❑	❑
169.	Mailing from Center	❑	❑	❑	❑
170.	E-mail	❑	❑	❑	❑
171.	Internal electronic bulletin board	❑	❑	❑	❑
172.	Notice posted on bulletin board in office	❑	❑	❑	❑
173.	Attendance at events at PEC	❑	❑	❑	❑
174.	Discussion with PEC staff	❑	❑	❑	❑

Professional Networking

Now, I would like to ask some questions that will help us understand how information flows gets passed among professionals? For each item please tell me if you have "never" done this, done it "once or twice," or done it "several times or more."

	Have you ever . . .	Never	Once or twice	Several times	DK/NA
175.	recommended that a client or colleague attend a Center event	❑	❑	❑	❑
176.	lent or copied materials obtained at the Center to others	❑	❑	❑	❑
177.	used technical data from the Center to support a decision	❑	❑	❑	❑
178.	demonstrated or explained to a colleague a technique that was presented at the Center	❑	❑	❑	❑
179.	promoted or implemented changes to internal policies or practices in response to something presented at the Center	❑	❑	❑	❑
180.	suggested or insisted that a partner or subcontractor incorporate ideas learned at the Center	❑	❑	❑	❑
181.	Discussed ideas presented at the Center with a manufacturer or manufacturers representatives to encourage product changes	❑	❑	❑	❑

182. Thinking about firms that do the same kind of things you do, which firms do you consider to be your strongest competitors?

1._____
2._____
3._____
4._____

183. Not considering you own firm, which firms offering products and services similar to yours do you consider to be the firms that set the standards in your field

1._____
2._____
3._____
4._____

184. Which firms would you be most likely to partner with to offer comprehensive products and services for constructing or renovating a building?

1._____
2._____
3._____
4._____

185. To which professional or trade associations do you belong?

1._____
2._____
3._____
4._____

Factors that influence the market

I am going to read a list of factors that can influence decisions about designs and technology in commercial new construction and renovation projects. On a scale of "1" to "5" where "1" is not at all important and "5" is very important you tell me how important each of the following was in shaping a decision or making a recommendation for your most recent projects.

		1	2	3	4	5	DK/NA
186.	first cost	❑	❑	❑	❑	❑	❑
187.	operating costs	❑	❑	❑	❑	❑	❑
188.	payback	❑	❑	❑	❑	❑	❑
189.	life cycle cost	❑	❑	❑	❑	❑	❑
190.	installations or buildings you have seen	❑	❑	❑	❑	❑	❑
191.	specifications from previous projects	❑	❑	❑	❑	❑	❑
192.	advice from colleagues	❑	❑	❑	❑	❑	❑
193.	clients' recommendations	❑	❑	❑	❑	❑	❑
194.	manufacturers catalogs or representatives	❑	❑	❑	❑	❑	❑
195.	professional publications	❑	❑	❑	❑	❑	❑
196.	Information from the PEC	❑	❑	❑	❑	❑	❑
197.	information from other professional workshops	❑	❑	❑	❑	❑	❑
198.	printed case studies	❑	❑	❑	❑	❑	❑

		1	2	3	4	5	DK/NA
199.	peer descriptions or testimonials about actual installations	❑	❑	❑	❑	❑	❑
200.	a demonstration or test that you conducted	❑	❑	❑	❑	❑	❑
201.	the prestige of a product or design	❑	❑	❑	❑	❑	❑
202.	the reliability of a product or a design	❑	❑	❑	❑	❑	❑
203.	a design that is perceived to be innovative	❑	❑	❑	❑	❑	❑
204.	utility rebates	❑	❑	❑	❑	❑	❑
205.	technical information from utility representatives	❑	❑	❑	❑	❑	❑

Firmographics

206. What is the principal business of your firm? _____

(Interviewer: enter what the person says then code one of the following. You may use the following categories to probe. If not sure, leave the answer for later coding. If the respondent indicates that they are a contractor or engineering firm, ask what kind. If the respondent indicates that the firm is manufacturing, distributor or retailer, ask if they manufacture or sell building related equipment or if they manufacture or sell something else.)

- ❑ Architects
- ❑ Lighting Design
- ❑ Engineering
  Would that be?
  - ❑ Electrical
  - ❑ HVAC
  - ❑ Both
- ❑ Contractor
  Would that be?
  - ❑ Electrical
  - ❑ HVAC
  - ❑ Both
- ❑ Property Owner / Management
- ❑ Manufacturer (building equipment related, i.e., sells equipment)
- ❑ Manufacturer other
- ❑ Distributor (building equipment related, i.e., sells equipment)
- ❑ Distributor other
- ❑ Retailer (building equipment related, i.e., sells equipment)
- ❑ Retailer other

207. About how many offices or locations does your firm have in Northern California

❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5-10 ❑ 10+ ❑ DK/NA

208. For all locations of your company about how many full-time employees are there?

❑ <10 ❑ 10-19 ❑ 20-29 ❑ 30-49 ❑ 50-100 ❑ 100-499 ❑ 500+

209. About how many full time employees are there at your office or location

❑ <10 ❑ 10-19 ❑ 20-29 ❑ 30-49 ❑ 50-100 ❑ 100-499 ❑ 500+

210. What would a reasonable estimate that gross revenues of your office be?

❑ less than a million ❑ 1 up to 5 million ❑ from 5 million up to 10 million
❑ from 10 million up to 20 million ❑ from 20 up to 40 million
❑ from 40 up to 100 million ❑ 100 million or more ❑ DK/NA

Personal Information

211. What is your title? _____

(Interviewer: enter what the person says then code one of the following. You may use the following categories to probe. If not sure, leave the answer for later coding.)

❑ Owner / Partner
❑ President
❑ Executive vice-president
❑ Senior manager
❑ Manager
❑ Senior engineer
❑ Engineer
❑ Senior architect
❑ Architect
❑ Senior designer
❑ Designer
❑ Other:

212. What are your primary responsibilities?

_____

_____

213. Do you supervise the work of others

_____ Years

❑ No ❑ Yes

214. Approximately how many people do you supervise directly or indirectly(full time equivalents)

_____ people

215. How long have you been in your current position?

_____ Years

216. How long have you been doing this kind of work?

_____ Years

217. How many years of formal education have you had

❑ high school or less
❑ technical education
❑ some college
❑ college
❑ college and some additional education
❑ Masters degree
❑ Masters degree with some addition education
❑ Ph. D or its equivalent

Appendix F. List of interviews

Name	Title	Affiliation
Charles C. Benton	Daylighting Consultant	The PG&E Energy Center
Jim Chace	Director	The PG&E Energy Center
Marc E. Fountain, Ph.D.	Information Systems Coordinator	The PG&E Energy Center
Mark Hydeman, P.E.	Consulting HVAC Programs Coordinator	The PG&E Energy Center
George Loisos	Architectural Program Coordinator	The PG&E Energy Center
Robert Marcial	Energy Consultant	The PG&E Energy Center
Ryan Stroupe	Energy Consultant	The PG&E Energy Center
Marlene Vogelsang	Resource Specialist	The PG&E Energy Center
Christine S. Williams	Consultant	The PG&E Energy Center
David J. Attard	Vice President	California Hydroponics Corporation
Steve Austin		
Larry Ayers		Bevilaqua Kurp
Dick Charles	Principal	C&B Consulting Engineers
Marty Chetatis	Mechanical/Electrical Engineer	
Ken Cleaveland		Bank of America
Fiona Cousins		OVE Arup
Darrell DeBoer		DeBoer Architects
John Deakin		
Dan F. Dibble, P.E.	Principal	The Engineering Enterprise
Jim Elder		ALR
Jeannine Fisher, P.E.	Lighting Designer	Design +
Ray Holstead, P.E.	Electrical Engineer	City of Oakland
Brian Liebel		Design +
Jim M. Lunsford	Director of Training (Apprentice/Safety & Health)	International Union of Operating Engineers, Local No. 39
Nancy McCoy, IESNA		Lindsley-McCoy
Eric A. Meub	Vice President	Stone Marraccinin Patterson
William F. Newman, CPP	Manager, Contract Administration	Shorenstein Company, L.P.
Peter Ngai		Peerless Lighting
Dan Norton		
David Patten	Designer	
Richard Roth		Cushman and Wakefield
Lynn Simon		U.S. Green Building Council

Fred Smothers		Northwest Asset Management Company
Andrew Stelman	Architect	City of San Francisco
Geoffrey Syphers	Energy Engineer	Charles Eley and Associates
Dennis W. Thompson	Manager, Building Automation Systems	Pacific Coast Trane Controls
Greg VanMechelen	Architect	V. E. Architects
Stan Walerchzyk		Alamo Lighting