Effective Market Transformation from Energy Centers

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ABSTRACT

In this decade, several energy centers, such as PG&E's Pacific Energy Center in San Francisco, have played a particularly interesting role in educating building professionals and utility customers about energy-efficient design and technologies. Energy centers' upstream and mid-market efforts have evolved as practical, effective, and less expensive adjuncts or alternatives to promoting energy efficiency through downstream financial incentives. The centers' roles fit especially well in the context of a nascent deregulated gas and electric marketplace and its multiple market actors. Although California's centers differ in focus and objectives, they serve the common function of technology transfer and provide access to reliable information that balances the opportunism, and even recidivism, the evolving energy marketplace may create.

Energy centers can be well-positioned to influence the flow of information among actors in an inherently chaotic, yet rich, building market. In this market, research institutions will continue to evolve new energy-efficient technologies; manufacturers will continue to search for new applications for their products; ESCO's will search for new energy efficiency services to promote; building design professionals will continue to have a pronounced effect on the market penetration of new technologies by adopting (or not adopting) energy-efficient products and practices. Equally important, end-users will continue to want unbiased information about energy-efficiency.

This paper summarizes six year's experience with an energy center centered on a public good/energy conservation mission strategically targeted to building professionals. This approach facilitates and rationalizes the movement of information among market actors to transform the marketplace and accelerate implementation of energy efficiency.

Introduction

The Pacific Energy Center (herein referred to as the PEC and 'the Center') first opened its doors in downtown San Francisco in December, 1991, near its target audience of architects, engineers, designers, building owners, facilities managers, manufacturers, and distributors. Its objective, tuned by an advisory board of constituent professionals, was to provide a learning center and toolbox that supported the energy-efficient design and operation of commercial buildings. The PEC was considered an investment in the values and knowledge of the building design community, an investment that would pay continued dividends well into the future. Initial services included educational seminars, demonstrations, a library focusing on efficiency, application laboratories and tools, design and measurement tools (later to include simulation software), and consultations by a technical staff experienced in lighting, HVAC and building envelope design.

The original motivation to create the PEC came from PG&E's experience managing commercial energy efficiency programs during the 1980s. Program designers saw that potential efficiency savings in building design and equipment selection were being missed due to late intervention in the decision-making process. Though the resource acquisition programs of that time worked well to convince utility customers to make one-for-one equipment changes in buildings, few system-scale decisions or new building designs were being influenced through informed practice. And few efforts were being made to sharpen the skills and knowledge of building professionals, a prerequisite for permanent changes in practice.

The commercial building arena is huge, representing over 30% of all electric energy sold in PG&E's service territory. The similarity of end-use equipment over a large number of buildings pointed to enormous potential savings. Plus, the number of decision makers was relatively small in comparison to the general population: fewer than 10,000 architects, engineers and facility managers in the service territory were responsible for the great majority energy-efficiency decisions—less than one-tenth of one percent of the general population.

Few energy information centers existed in the late 1980s and none was developed specifically for the role of market transformation agents in the building industry. Seattle's Lighting Design Lab (LDL), created by a collaboration of Northwest utility interests, deserves much credit for its groundbreaking efforts. Both the Pacific Energy Center and Southern California Edison's Customer Technology Application Center (CTAC) followed in the early 1990s, the former focusing on the design community, the latter broadening its services to include its utility customer base. Southern California Gas' Energy Resource Center (ERC) opened more recently (1995) with an emphasis on gas-fired equipment in the food service and industrial process markets. While similarities exist between the centers, they have also evolved differently in response to variations in their target audience, physical location and business objectives.

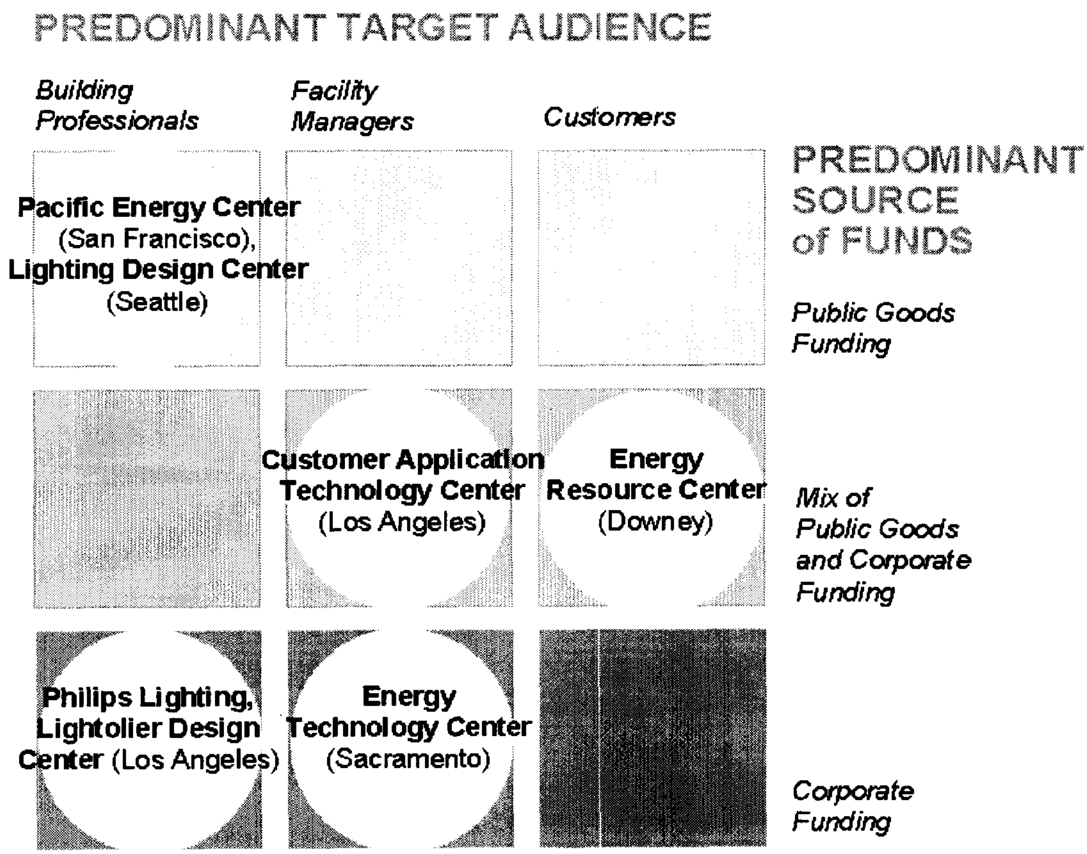

Figure 1 - Focus of Energy Centers

As shown in Figure 1, building-related energy centers can vary in the nature of their mission (ranging from public good issues to corporate agendas) and the target of their programs (building professionals to all building users). On the corporate end of the scale, the Phillips Lighting Center and the Lightolier Design Center are funded wholly with corporate dollars, are directed at building design professionals but expressly for promoting products manufactured by Phillips or Lightolier. CTAC and the ERC draw their funding from a blend of corporate and public goods monies, which they apply to promote a blend of corporate and energy conservation agendas to facility managers and utility customers. The Pacific Energy Center (PEC) is unique in targeting information and technical support to the design and engineering community in an undertaking based solely on a public goods agenda. This effort to move information from knowledge generators to knowledge users in the building industry presaged today's conceptual framework for market transformation. For the remainder of this paper we look at the market transformation context for building-related energy efficiency programs with specific examples drawn primarily from the building profession / energy conservation (BPEC) variant of energy centers.

The 1980s had been the decade of resource acquisition DSM programs focused on the end user. Then, the early 1990s saw a shift toward influencing upstream market actors (such as the Golden Carrot Refrigerator Program) through educational efforts and incentives. Environmentalist's desire an energy-efficient world in which individuals act on sound information and long-term vision as opposed to short-term gain and expediency. The building marketplace falls short of this ideal. Building professionals make decisions about products and services for a variety of reasons: risk, productivity and profit, aesthetics, and comfort. Preoccupied with short-term issues, they often fail to appreciate the long term benefits of energy efficiency in the creation of buildings – objects whose life may be measured in centuries.

After considering the complexity of decision-making among building professionals, the PEC staff (during 1993 and 1994) expanded its thinking beyond providing educational services as a technical transfer agent in support of energy efficiency. The PEC also sought to adopt the role of integrator or intermediary in the design process. By addressing the design process as a whole, efforts could be targeted at areas where energy efficiency could be most successfully integrated. The approach explicitly recognized that energy efficient practices and the use of energy efficient products are more likely to be supported and sustained when there are multiple reasons for adopting them.

In parallel with this shift in thinking at the PEC, many others began to recognize that partnerships and alliances between market actors amplified efforts. This led to a closer examination of market structures, a recognition of the regional and national scale of markets and a search for strategic points of intervention. The prospect of deregulation in the electric industry and a competitive energy market also arose during the very late 1980s and early 1990s. A rebate-centered program did not seem consistent with the envisioned competitive market.

California formally stepped away from traditional DSM in 1997 when the California Public Utilities Commission (CPUC) created the California Board for Energy Efficiency (CBEE) to select independent administrators and implementers of energy efficiency market transformation programs. It also instituted a transitional strategy between traditional utility-based DSM programs and independent administration of public goods efforts. The CPUC directed the state's utilities to orient their 1998 programs away from resource acquisition DSM programs toward market transformation.

Energy centers and market transformation

Market transformation happens when a market intervention overcomes market barriers to permanently change decision-making processes of actors in that market. As applied to energy efficiency, the market intervention targets barriers to energy efficient products and services. As a market is being transformed, new behaviors increase and new products or services emerge. Decision makers in the design process accept new technologies and new behaviors into standard practice. If market transformation is successful, the improved behaviors become self-sustaining. If, following the withdrawal of support, market actors have not adopted the changes or those who did revert to prior practice and behavior, then the market is not transformed.

It is useful to examine market intervention in a slightly broader context to understand why utility energy centers, such as the PEC, are well-positioned to effect positive change in the building industry. Figure 1 diagrams a model of the diffusion of innovations (Rogers, 1995). This process-oriented model defines how market actors adopt a new innovation. Actors must first become aware of the innovation. Once awareness is established, a persuasion stage ensues during which the actor seeks and processes information in order to decide whether to adopt the innovation. The market actor then makes a decision not to adopt, to postpone adoption, to continue the search for information, or to adopt the new innovation. An implementation stage in which the actor enacts the decision is followed by re-evaluation or confirmation of the decision and subsequent continuance or discontinuance of the adoption.

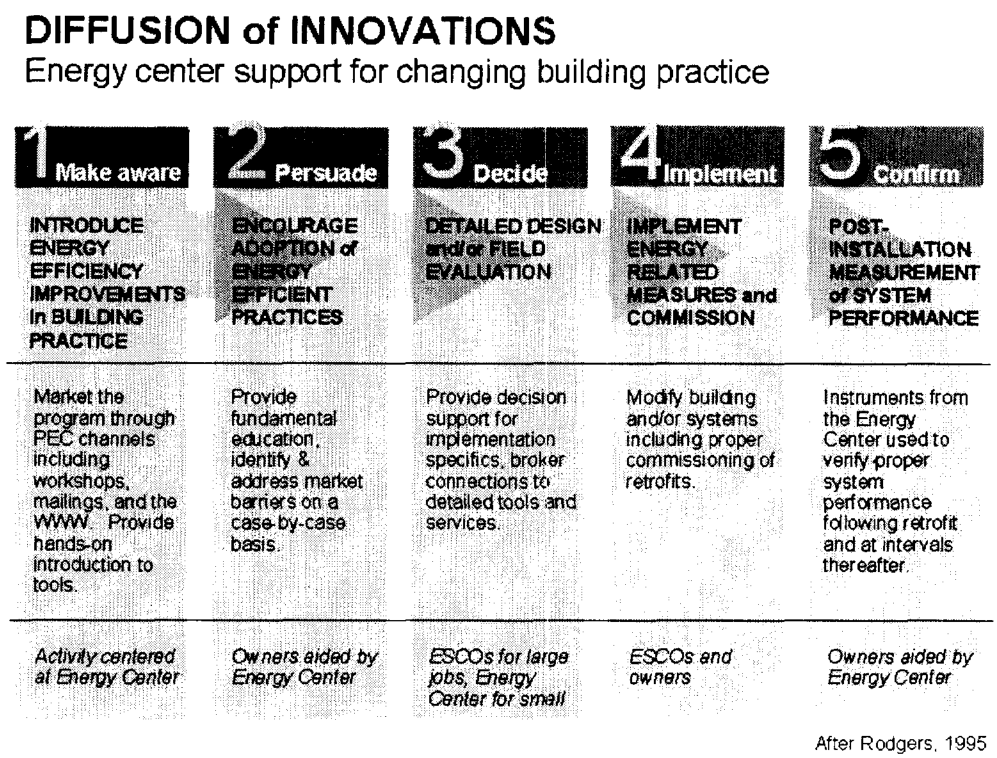

Figure 2. Model of innovation diffusion

Operating in all stages of the model in Figure 2 (after Rogers 1995), energy centers such as the PEC gently align the values of their customers towards energy-efficiency. In the 'awareness', 'persuasion' and 'confirmation' stages of the model, the PEC operates largely without assistance from others. Simply put, entities not engaged in public goods efforts find little to be gained from promoting building energy efficiency in a thorough yet unbiased way. Conversely, in the 'decision' and 'implementation' stages of the model, the PEC plays a smaller, collaborative role and operates with the assistance of other market actors, e.g. designers, engineers ESCO's, researchers, manufacturers, professional societies. The PEC focuses on overall knowledge and values rather than immediate adoption or rejection of specific project features - a strategy that produces on-going positive effects over the course of many designs.

It might seem self-evident that "energy-efficient equipment providing aesthetic appeal" would be the natural choice of a designer attempting to do the best possible job for a client. Yet design choices counter to this philosophy are made daily. But, why? In a continuously evolving marketplace for building technologies, new products are constantly introduced, new design approaches are regularly proposed, and innovative analysis techniques are invariably created. A designer must struggle to keep abreast of new developments while balancing the immediate concerns of client programming, cost constraints, planning/construction schedules, and a design concept against a variety of equipment, envelope and operational criteria -- some energy-efficient and some not. In this rich, chaotic environment, the designer rarely has the time and resources to 1) become a multidisciplinary technological expert, 2) know all the players in the manufacturing community, along with their reputations and motives, 3) keep up-to-date on releases of new equipment, assemble and test viable alternatives, 4) remain aware of product successes and failures, and also 5) complete design jobs on time and within budget. The result is often simply an adherence to 'standard practice'.

Utility energy centers are positioned to be 'experts-next-door', network and information processors that perform these adjunct functions for the design community in an unbiased way. Energy center programs reduce the risk of applying new technologies and evaluation techniques by providing detailed performance specifications, demonstrations, case studies and presentations of research. Also, the physical location of centers can become a locus for the design community and symbolic of the reality and timeliness of energy efficiency issues.

Energy centers help transform the market for energy-efficient products, design and systems in the building industry by serving as the connecting tissue among actors in the building market. They provide channels for the flow of information and methods related to energy efficiency from knowledge generators to building practitioners. Furthermore, the PEC's programs in particular have evolved to provide a conduit for communicating market needs to knowledge generators. The concept of an energy center acting bi-directionally in the marketplace was unprecedented in 1990. Terminology describing "upstream and downstream" markets was seldom heard.

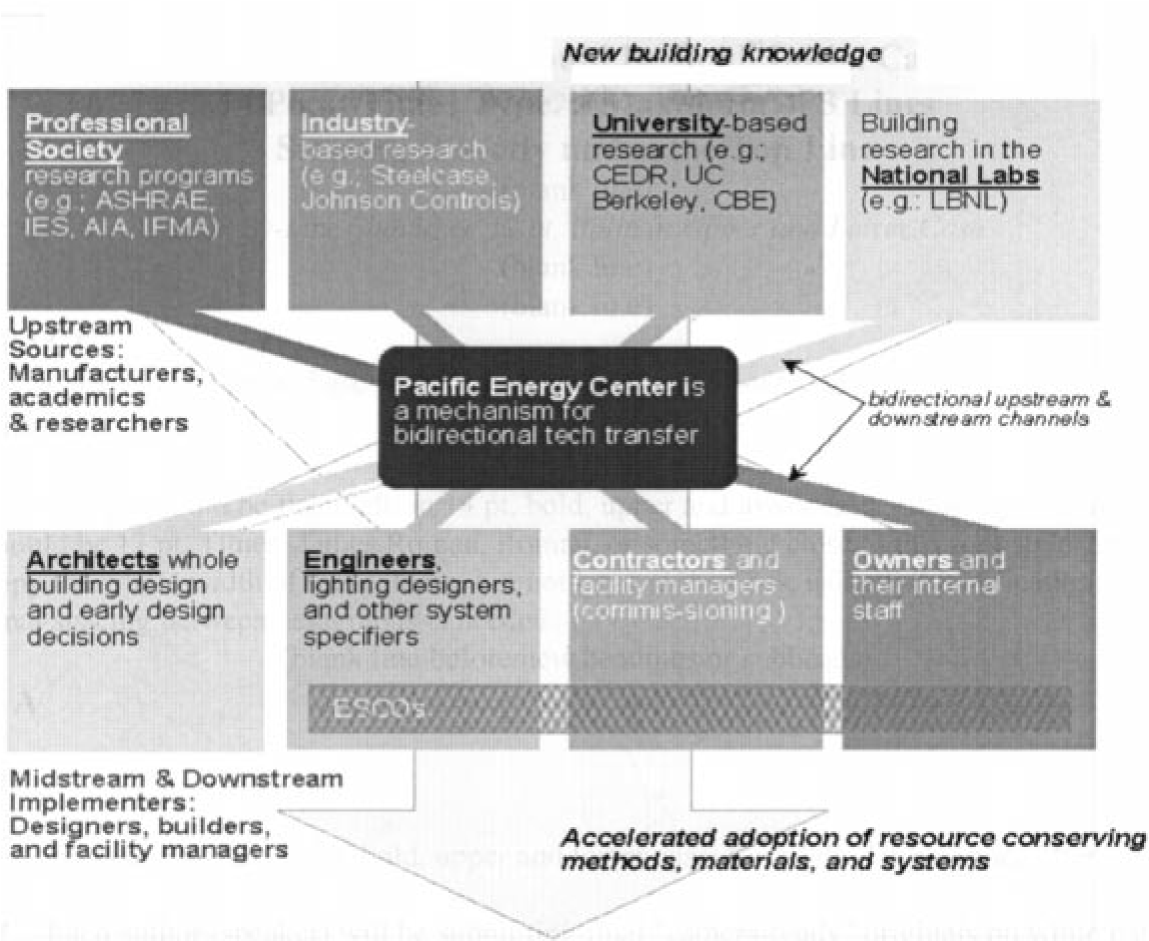

Figure 3 - Energy Centers as knowledge transfer mechanisms

A variety of barriers keep the marketplace on its own from increasing energy efficiency. Some of these barriers were described in the early 1990s by Amory Lovins (Lovins, 1992) and are listed in Table 1. Later efforts by Eto, Schlegel and Prahl (Eto et al. 1996), Table 2, refined market barriers in a more formalized structure which has since become a template for the redesign of energy efficiency programs in a restructured electric utility environment. While some barriers are related to first cost, many others involve the flow of information being constrained or poorly applied. In some cases, information is proprietary and closely held as a competitive advantage. In others cases, there is simply no incentive for parties to work together, or issues of greater urgency, in the short run, grab attention. Tables 1 and 2 show specific examples of market barriers to adopting energy efficiency. Table 1 is from a 1992 *E-source* report and Table 2 represents the more formalized structure of Eto et al. 1996.

Table 1 - Barriers to implementing energy efficiency (Lovins 1992)

Barrier	Energy Center Response
Designers often have had little training in the physical performance of buildings	Train designers and provide building measurement tools
Designers are risk-averse and naturally reluctant to stray from standard practice	Target owners as well as designers and assist designers in making a case to their client
Designers do not have enough time, nor are they paid, for any added research or analysis	Make energy efficient design an easier and faster process via tools, facilities and resources
Designers often lack the necessary knowledge, skills, tools, or resources for energy efficient design	Offer a wide range of learning experiences, from full-day seminars to the learn-as-you-go approach while using our tools
Designers find it hard to keep up with rapidly changing technologies	Provide product demonstrations and case study literature
The design professions are highly compartmentalized and thus miss potential for savings from integration	Provide tools and classes that promote cooperation between disciplines
There are financial disincentives for owners driven by first cost and owners who pass on energy costs	Make owners aware of utility rebate and incentive programs that reduce the cost of energy efficient choices, identify qualitative benefits
Designers are disconnected from and often not accountable for building performance	Provide building measurement tools and demonstrate the benefits of understanding building performance
Energy efficiency is generally not a high priority for any of the players	Stress awareness of the side benefits of energy efficiency : building value, comfort, sustainability, client retention, and marketing image
When energy efficiency is considered, it is often too late to be significant	Showcase the importance of early design decisions and tailor resources to assist early interactions
There is a general lack of appreciation for the link between comfort/productivity and energy efficiency	Demonstrate energy efficient products and design that have high aesthetic value and comfort benefits

Table 2 - Energy Efficiency Market Barriers (Eto et al. 1996)

Market Barrier	Addressed by Energy Center
Information or search costs	YES
Performance uncertainties	YES
Asymmetric information and opportunism	YES
Hassle or transaction costs	NO
Hidden costs	NO
Access to financing	NO
Bounded rationality	YES
Organization practices or custom	YES
Misplaced or split incentives	NO
Product or service unavailability	NO
Externalities	YES
Nonexternality pricing	NO
Inseparability of product features	YES
Irreversibility	NO

Specific examples of how Energy Centers transform markets

One specific example where the PEC provides a uniquely valuable role is in promoting energy efficient fluorescent lighting. In its lighting demonstration classroom, T-8 lamps are not only promoted as energy saving, but are also demonstrated as providing a higher quality light source. With the addition of an electronic ballast, the four market barriers to fluorescent lighting were overcome: noise, poor color, lower efficacy and flicker. In our experience, the qualitative barriers are primary issues. Thus their experiential engagement at the PEC is pivotal in the adoption decision.

While the PEC reduces barriers for designers, it also communicates needs to knowledge generators, manufacturers and research organizations. Repeated requests for assistance by a designer or end-user indicate both a market need for information and a market lacking readily available tools and or time to serve these needs. Where appropriate, the PEC develops specific solutions in the form of new tools or information by market sector or end-use technology. The creation of new design or evaluation tools begins the process of linking upstream market actors—manufacturers and research organizations with designers and end-users. This is the market transformation role that has so neatly fit the competencies and position of the PEC in the marketplace: Needs move upstream and information moves downstream, a cycle that improves both product and practice over time (refer to Figure 3).

The CoolTools chilled water plant simulation tool (Hydeman et al. 1997, CoolTools 1998) serves as a specific example of this process. Pressed by EPA regulations for the phase-out of certain refrigerants, utility customers and design professionals asked the PEC for information and options concerning the optimal redesign of their cooling plants.

Because of the inter-relationships among chiller components, a new simulation tool is needed to analyze chilled water plant operation. With the help of industry contacts, field experience with chiller optimization, and knowledge of the most up-to-date simulation tools, the PEC is building the

CoolTools software toolkit. The toolkit contains 1) user-friendly simulation tools which can be calibrated from manufacturers or field measured data, 2) guides that assist the process from design to performance specification, 3) products to help building owners and project financial officers understand how to reduce investment risk. The CoolTools product has received broad support from government, manufacturing, design and ESCO communities.

The PEC Evaluated

The PEC has been evaluated continuously during its six years of operation. The most recent external study concluded that the Center is producing positive and persistent effects in the practice of building professionals (Reed and Hall, 1998). Previously, PG&E commissioned two major surveys of PEC customers with very favorable results. Additional external reviews have come from the Results Center (IRC, 1994), E-Source (Newcomb and Gustafson 1994), and the California Public Utilities Commission. In addition, the PEC has been favorably reviewed in popular publications (e.g. Progressive Architecture (Bryan, 1993) and Places (1995)).

At the end of 1992, PG&E's Market Research and Planning Department commissioned a study (Faibisch, 1993) to evaluate the user awareness and attitudes toward the Center. Of the 8,000 first-year visitors to the PEC, 43% attended an educational program. Education programs overall were rated 7.9 out of a possible 10 for their usefulness. From the total, 1,882 visitors were selected for further analysis as "prime targets", architects, engineers, lighting designers, facility managers etc. Fully two thirds of these had visited the Center more than once during the year with the average number of visits at 3.8. Over half felt that the information received at the PEC was more helpful than expected and 91% planned a return visit. In addition, the survey found that over half of the respondents took action as a direct result of their visit to the PEC. 68% of facility managers and 60% of building owners took action with a lighting retrofit being the most common choice followed by HVAC and motor upgrades.

In 1994, PG&E commissioned an internal survey of its customer representatives (RJR, 1994) to evaluate the awareness of, and satisfaction with, the Center among the reps. Overall they rated the PEC highly with 82% selecting the highest and next-to-highest quality ratings. Two thirds of the representatives stated that they were "very familiar" with energy-efficient technology and this group also used the PEC services more frequently than others with less familiarity. 62% of the

Figures 4 and 5 - The PEC Lighting Classroom and a daylighting workshop.

representatives had at least one meeting at the PEC and 32% used it for at least one customer consultation - a significant number in light of the wide geographic distribution of representatives over the PG&E service territory.

The most recent study of the PEC's effectiveness (Reed and Hall, 1998) concluded that the PEC is producing significant, positive and persistent effects in the practices of building professionals. This study, commissioned by the California Demand Side Management Advisory Committee (CADMAC) presents results from a survey of 254 building professionals who attended at least one PEC-sponsored event between January 1995 and the present. PEC usage databases, data from professional societies, and Dun and Bradstreet demographic data were also evaluated. The study found that after six years and 40,000 visitors, the PEC has achieved remarkably high target market penetration.

Specifically, Reed and Hall find that:

1) The PEC is influencing behavior. Seventy-nine percent (79%) of lighting designers indicated they were consistently specifying more efficient equipment and 44% of this 79% said that the change was entirely due to the influence of the PEC. 58% spend more time analyzing the quantity and quality of light and 24% of these attributed this behavior change to the PEC. Roughly half of 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.

2) 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. In addition, three fourths of the sample indicated 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 interaction with the PEC. This result can be considered a positive indicator of sustained market transformation effects. Furthermore, it is well-aligned with the initial intent of the center -- to make an investment in the knowledge and values of actors in the building marketplace that can manifest not only in current but future projects.

3) Changed behaviors are influencing many buildings. Eighty percent of the respondents said that changed behavior 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 deal. This result is an indication that the PEC's programs and information transfer efforts are in fact broadly applied and not restricted to projects underway at the time of contact with the center.

In all, the Reed and Hall study found that the PEC is successfully influencing a small target audience that has disproportionately large power affecting the single largest energy consuming sector of California's economy.

Conclusion

Environmentalists and concerned citizens peering into the future of electric utility restructuring cannot help but be anxious about the invisible hand of the marketplace. If restructuring really does reduce energy costs, interest in energy efficiency may wane and progress in energy efficient buildings may backslide.

And yet, there is something exciting about the emergence of new energy services providers, state-wide efforts versus service-territory efforts, and the increased ability of millions of individuals to chose suppliers. But unlike well-informed environmental advocates, can a million individual decision makers benefiting from short term gains, see, or feel responsible for, the cumulative impacts of their decisions on the environment? Is the marketplace now organized to send not only the right pricing signals but the right environmental signals, as well?

Individuals, businesses and new energy service organizations seem largely unprepared to play the role that regulators and environmentalists have played for the last twenty years. And yet, energy users must do just that if they are to enjoy the benefits of restructuring and continued environmental protection.

Though conceived before the current construct of market transformation, energy centers like the PEC align nicely with the market transformation objectives of addressing market barriers and producing persistent effects. This market transformation occurs in the single most important sector for energy efficiency: the design and operation of buildings. Furthermore, the PEC's efforts in support of building professionals, are tuned to market transformation objectives and appear to produce persistent effects.

It is our belief that informed decision-making will never be as important as it is now. Energy centers are already positioned as trusted and neutral sources for information, evaluation tools, and design assistance to building market actors. As utility service territory boundaries will become less limiting, there is reason to be optimistic that a network of state-wide energy centers can play an even greater role in coordinating the flow of unbiased information among all market actors, helping to assure the greatest value from the energy that we use.

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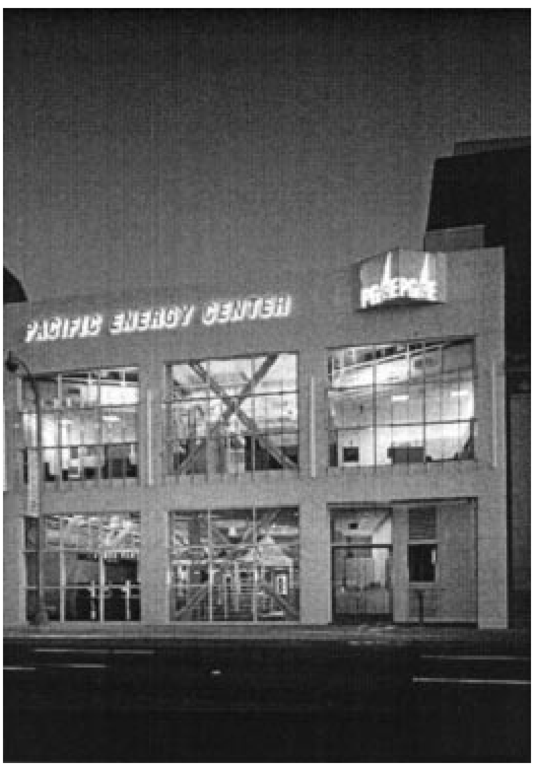
Appendix



The PEC facility is a 32,000 square foot building that is itself a technology demonstration. The building envelope incorporates a variety of shading and daylighting technologies while the HVAC system utilizes ice-storage and a whole-building control system. The PEC features exhibits, classrooms, tools and demonstrations of building energy efficiency principles and applications.

Educational programs, primarily workshops, seminars and classes are offered regularly (typically over 80 per year) on energy efficiency topics such as: 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; daylighting controls and electric lighting; HVAC systems design; simulation models; control systems and measurement tools and methods. The PEC also loans measurement tools including dataloggers, sensors, and handheld equipment (Benton et al. 1996). For more detailed descriptions of specific PEC offerings, visit the website at <www.pge.com/pec>.