Accelerating the Adoption of Energy Efficient Business and Consumer Electronics

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ABSTRACT

For over 30 years, Pacific Gas and Electric Company (PG&E) has been instrumental in bringing energy efficiency programs to energy customers in California. As part of this effort, PG&E's Emerging Technologies (ET) Program commissioned a study in 2005 to evaluate the opportunity to save energy among business and consumer electronics. This study identified significant savings opportunities—hundreds of gigawatt-hours of energy and tens of megawatts in demand—that could be achieved. However, the study recognized that capturing savings in electronics is an exceptional challenge due to the large diversity of products, efficiency levels, consumers, and market channels. Further, the relatively small energy savings achievable for each device demands significant market penetration for a cost-effective energy efficiency program. Emerging Technologies undertook an important next step in August 2007, partnering with QDI Strategies and MX Roads to develop effective program strategies. These strategies are now being evaluated in a 2008 California pilot program that provides upstream incentives to original equipment manufacturers and retailers. The scope of the program will be broadened in 2009 with additional elements such as Internet marketing and consumer education. This paper describes market research behind the program strategies and the activities being undertaken to implement the program. In February 2008, efficient electronics were included in the California Energy Efficiency Strategic Plan (Draft) for 2009–2020, insuring the long-term focus on this area.

Introduction

Human evolution, from hunter-gatherer to agriculture to industrialization to the information age, has included becoming more energy-intensive—and now, ever more dependent on information technologies. Considering office computers, cell phones, personal digital assistants, and televisions, many of us spend the majority of our waking hours interacting with electronics. While this may be good from the standpoint of economic productivity, it is less desirable from the standpoint of the resource demands associated with electronic energy consumption. The need to lower energy consumption to control costs, decrease use of energy and other resources, reduce waste, and mitigate global warming has arisen as critical to our well-being.

Nowhere have these issues become as public as in California, which has done an admirable job of maintaining energy consumption per capita at a constant level since 1976 (CEC 2007), primarily through its energy efficiency programs. Despite these successes, California faces a difficult challenge in controlling the growth—fueled by the unprecedented increase in the number, functionality, and size of these electronic devices—of electronics electricity consumption.

Consumer electronics and office equipment consume almost 8 percent of electricity used in the United States, according to industry and government estimates (CEE 2007; TIAX 2007). These organizations predict the annual growth of electronics' electricity use in the United States over the next decade to be close to 6 percent, quadruple the growth rate of electricity consumption overall. The growth of the U.S. electronics load is most rapid in the residential sector, rising from 11 percent of residential energy consumption in 2006 to an expected 18 percent in 2015. It is the only growing electric load (on a per capita basis) in California, and, without intervention, this trend is expected to continue for at least the next 10 years.

Energy efficiency is a societal benefit inherent in the economic sustainability of California and integral with the business of the state's utility companies. Pacific Gas and Electric Company (PG&E) has been in the energy efficiency business for more than 30 years, focused on curtailing the use of both electricity and natural gas. PG&E offers a wide range of energy efficiency programs—including rebate programs, energy audits, energy-savings programs for businesses and local governments, and online resources to inform and educate its customers. California's efficiency programs are administered on a three-year cycle by the investor-owned utilities (IOUs). The current program is in its third year (2008); PG&E's demand and electric savings goals for the current program cycle are as shown in Table 1 (PG&E 2005). A subsequent program with anticipated higher savings goals for 2009–2011 is being planned. And, in February 2008, efficient electronics were included in the *California Energy Efficiency Strategic Plan (Draft)* for 2009–2020 (CEC et al. 2008).

Table 1. Electric Demand and Energy Savings Goals for PG&E's 2006–2008 Program

	Demand (megawatts, MW)	Energy (gigawatt-hours, GWh)
2006	102	576
2007	114	668
2008	132	786
Total	348	2,030

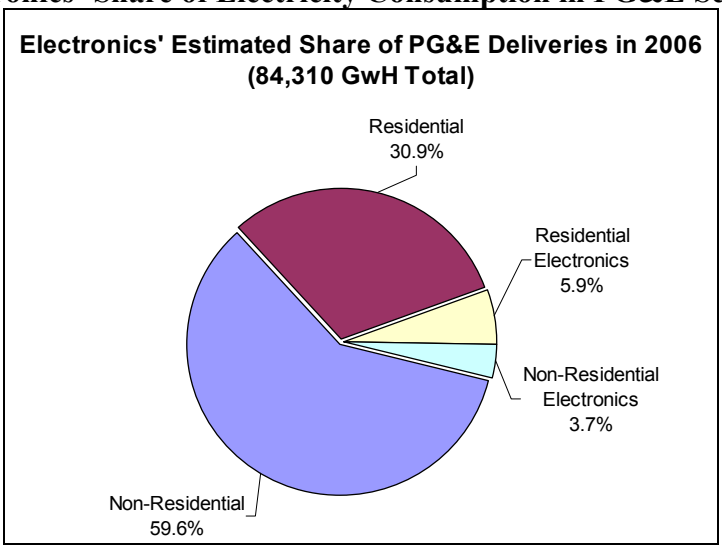
For PG&E customers, there is a potential savings of 2,600 million kilowatt-hours (kWh) between 2009 through 2011 in a highly diverse and fragmented electronics market with more than 50 product categories and multiple customer segments. Twenty million devices are sold in PG&E's service territory each year in the top product categories, and 3,000 retail stores sell electronics. Achieving energy savings in electronics, however, poses a number of challenges, due to the rapid evolution of technology, large number of different devices, large numbers of units sold, and relatively low energy savings potential per device. Electronics programs, therefore, require larger, non-traditional initiatives—with bolder strategies, including a greater focus on technology, aggressive market interventions, large scale, and sustainability.

This paper describes a market-focused strategy and a program designed to achieve significant penetration of this strategy. The program design is driven by the needs and requirements of market participants—manufacturers, distribution channels, and customers. Using manufacturers and distribution channels to deliver the benefits of high-efficiency electronics to PG&E customers is critical to overcoming challenges while meeting regulatory requirements for program measurement and verification.

The Energy Savings Opportunity

In PG&E's service territory, the electronics share of electricity demand is higher than the national average. In 2005, electronics represented 4550 million kilowatt-hours (kWh)—approximately 18 percent of PG&E's small business and residential consumption—according to an assessment by Energy Solutions (Chase et al. 2006). This share is expected to increase to 7130 million kWh by 2010 in the absence of energy-saving measures. According to a commercial energy use study for the California Energy Commission (CEC 2006), office equipment is 8.2 percent of commercial electricity consumption in the PG&E territory. Overall, electronics consume about 10 percent of PG&E's electricity sales, as shown in Figure 1.

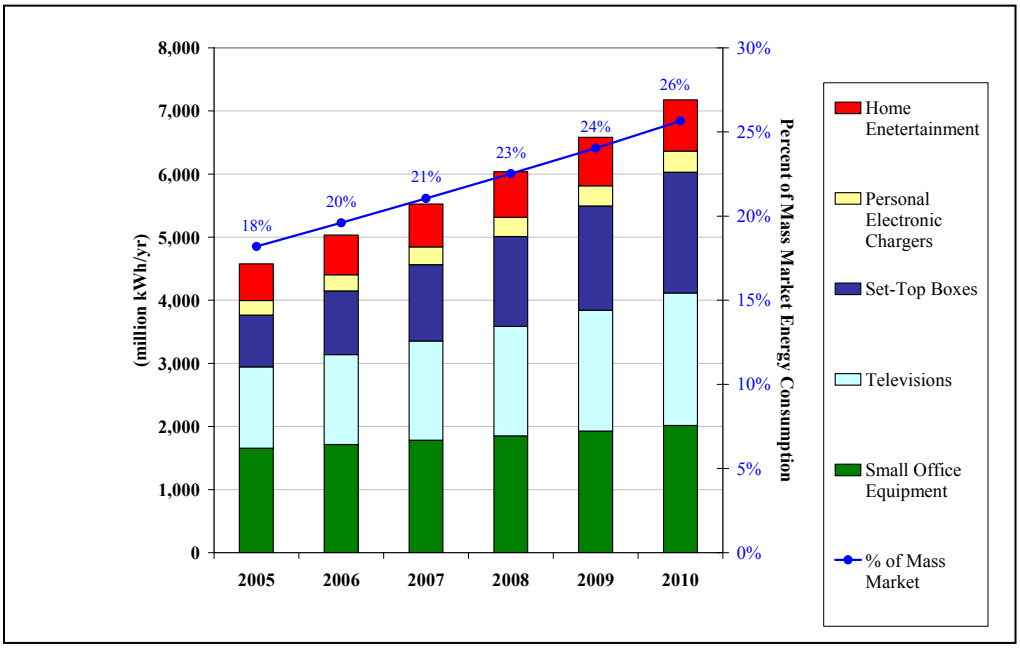
Figure 1. Electronics' Share of Electricity Consumption in PG&E Service Territory



Source: PG&E 10k; CEC, Mar. 2006; Energy Solutions, Dec. 2006; EIA

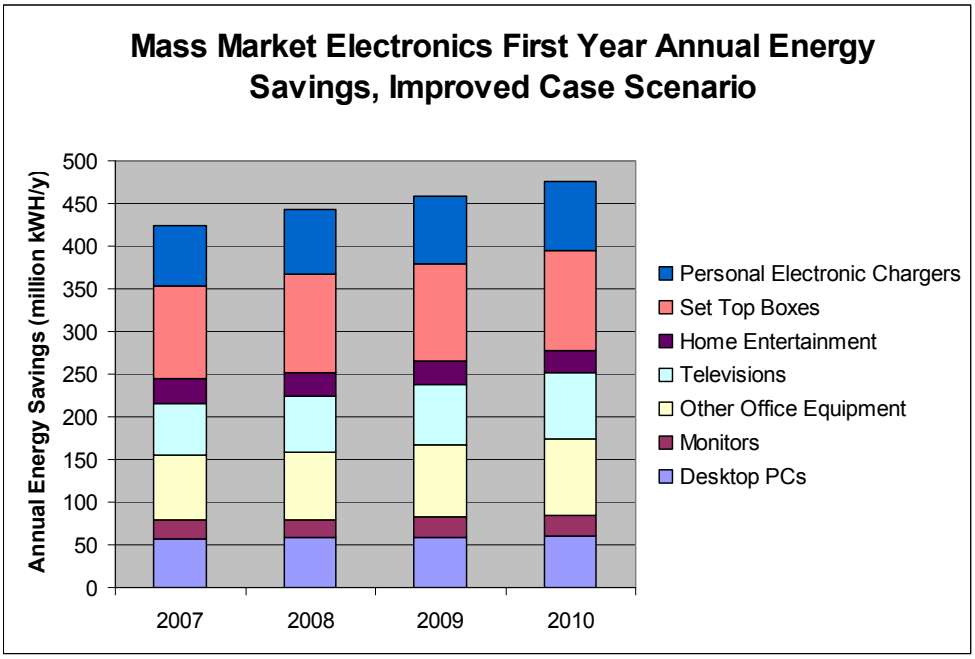
Figure 2 shows growth forecast by Energy Solutions—from 18% of PG&E's residential consumption in 2005 to 26% in 2010—for major *consumer* electronics, absent energy savings interventions. Figure 2 also shows the five major categories of electronics that fuel this growth.

Figure 2. Projected Growth of Major Consumer Electronic Categories in PG&E's Territory



The study projected that an "improved scenario" of interventions could save 470 million kWh per year by 2010 with 100% market penetration, as shown in Figure 3.

Figure 3. Annual Energy-Savings Potential for PG&E Mass Market Electronics



Source: Based on data from CEC et al. 2008.

A market opportunity model developed for PG&E by QDI Strategies Inc. (PG&E 2008) based on these data and likely market penetrations estimates the total potential energy savings

opportunity for a program conducted in 2009–2011 in PG&E's territory (Table 2). The model projects that perhaps 25% of the total energy savings potential can be captured assuming the implementation of a market-focused strategy.

Table 2. Market and Product Criteria for Energy Savings Opportunity for PG&E in 2009–2011

PG&E Energy Savings Opportunity 2009 – 2011 2,600 Million kWh/yr				
Markets	Product Families			
	Desktop Computers and Monitors	Other Office Equipment	Television and Home Entertainment	Set Top Boxes and Personal Electric Chargers
Residential / Home & Small Business	252	268	309	587
Large Commercial, Industrial & Agricultural	774	404		

Retail Channel | OEM/Distributor Channel | Not Addressed

The potential for savings is a significant fraction of the programmatic savings goals for PG&E, shown in Table 1. Detailed analysis of savings by product family and market timing suggest that an electronics program could contribute 25% of the energy savings goals in California.

Technology and Market Issues

In August 2007, PG&E contracted with QDI Strategies Inc. to understand market factors for efficient electronics, investigate ways to increase efficiency program effectiveness, and develop program strategies to capture significantly greater market share for efficient electronic products. Market understanding of customer and channel values was developed through personal interviews and resulted in a set of criteria used to develop effective program strategies. This section describes major market factors and their implications to program strategies recommended by QDI, discussed in the following section.

Product Diversity and Number

The accelerating functionality and adoption of electronics creates challenges for energy efficiency programs. The sheer breadth of products alone is a considerable issue. Consumer electronic categories include computing and home office equipment, video (such as CRT and flat-panel television sets, videocassette and DVD players and recorders, camcorders, digital cameras, and set-top boxes); audio (hi-fi systems, cassette, CD, and MP3 recorders and players, personal stereos, and radios); games consoles; and telecommunication products designed primarily for domestic use. Business electronics include computer hardware—personal computers, servers, mainframes, workstations, and peripherals and imaging equipment—presentation products, videoconferencing equipment, and other office equipment. Not only are electronics exceptionally diverse, but they are sold by the millions.

Further, each individual device uses a relatively small amount of energy (in comparison to common energy users in the home, such as refrigerators or washers). The average electronic device consumes around 70 kWh per unit per year, ranging from just 12 kWh/y for electronic chargers to almost 300 kWh/y for a plasma TV. For office equipment, the average consumption per year is about 100 kWh in the home and approaches 200 kWh in business offices, where the duty cycles are substantially longer (Chase et al. 2006). More than 40 percent of office equipment energy use is by PCs and monitors (Roth et al. 2002), making computers a major energy-savings target. Similarly, televisions and personal computers consume the most electricity among home electronics. The fastest growing consumer market segment is set-top boxes, and this segment's electricity consumption is anticipated to surpass that of computers and monitors over the next five years.

The relatively small amount of energy used by each device also makes the potential energy savings from each device small. Therefore, capturing significant energy savings in California requires attention to tens of millions of devices. Finally, electronic devices have relatively short life cycles, usually becoming obsolete due to the availability of newer devices with higher functionality about every three to five years. Thus, energy efficiency programs must adapt quickly to changing market trends.

Efficiency Levels

The various electronic product families often show a wide range of energy consumption and variations in energy use over the various operation modes, as well as in idle and off modes. An electronic product is therefore determined to be energy efficient according to a complex set of regulated and voluntary standards. A regulated efficiency program, such as the programs administered by the IOUs in California, must identify a baseline energy efficiency above which incentives can be justified to change the market and a level of efficiency above the baseline that can be achieved through market interventions.

At the national level in the United States, the ENERGY STAR® label is the primary voluntary standard that designates compliance with energy efficiency goals developed by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) (ENERGY STAR., n.d.). ENERGY STAR standards have been created for home electronics and office equipment. The current home electronic standards are designed to reduce electricity consumption when the products are "off" (but still powering features such as clock displays and remote controls). The following product categories have standards: battery charging systems, digital-to-analog converter boxes, cordless phones, DVD products, external power adapters, home audio, televisions, and VCRs. ENERGY STAR office equipment standards, which are more rigorous than those for home electronics, have been designed for computers, copiers and fax machines, external power adapters, notebook PCs, monitors, printers, scanners, and multi-function devices. These devices are required to use less energy to perform regular tasks, and when not in use, to enter a low-power mode automatically. ENERGY STAR specifications are periodically revised to move the market toward more energy-saving products. Revisions are underway for a number of electronics products, including computers, external power adapters, imaging equipment, monitors, set-top boxes, and TVs.

At the state level, the California Energy Commission has a continuing program to develop standards for a range of energy-using devices, such as external power supplies and audio and video equipment. These regulations may present additional requirements beyond the voluntary standards set by ENERGY STAR.

Energy programs often use newly introduced ENERGY STAR standards as the efficiency level to be achieved by the program. As devices that meet ENERGY STAR standards become common in the market, programs will often shift to a higher level of efficiency. Thus, efficiency programs need to be coordinated with both the timing of and the efficiency levels of standards-setting bodies.

Efficiency Programs and Incentives

Financial incentives to end users have long been the primary energy efficiency program tool for changing purchasing behavior. Since 2006, PG&E has offered various end-user and channel incentives for high efficiency electronics. These programs include three independent energy-savings measures delivered to two distinct market segments through three different channels:

- LCD monitor incentive: This measure provides mass-market (i.e., residential and small commercial) customers incentives to purchase high-efficiency LCD units from dozens of manufacturers, and relies on retail channels to promote the incentives and pass on the savings.
- The 80 PLUS program (80 PLUS, n.d.): This multi-utility effort conducted by Ecos Consulting aims to develop and market high efficiency power supplies within desktop PCs. Specifications for 80 PLUS power supplies have been adopted by ENERGY STAR for their latest computer specification 4.0. Dell and HP have computer models that meet ENERGY STAR 4.0 / 80 PLUS specifications and receive incentives to provide these computers to the market.
- PC power-management software: This measure provides end-user rebates to businesses when they install qualifying software products that automatically control the power settings of networked PCs from the server level.

The low incentive amounts that can be justified in these individual measures relative to the product prices for electronics, and the low redemption rates experienced in consumer rebate programs, limit their effectiveness. Therefore, program strategies that focus on an "upstream" marketing delivery system that focuses on manufacturers, distributors, and retailers has distinct advantages. Upstream incentives increase availability of efficient products from manufacturers, and they encourage channels to increase market presence, negotiate with vendors for better prices, and promote the efficient options.

Energy efficiency programs in California are also subject to evaluation, measurement and verification (EM&V), post-program studies that determine the effectiveness of the program's market intervention. Critical criteria to quantifying program energy savings include numbers of efficient devices sold, whether the devices actually reached the target market (or were taken out of California, for example), and whether the program was the determining factor in changing the market. End-user rebate programs in California have relied heavily on contacting individual

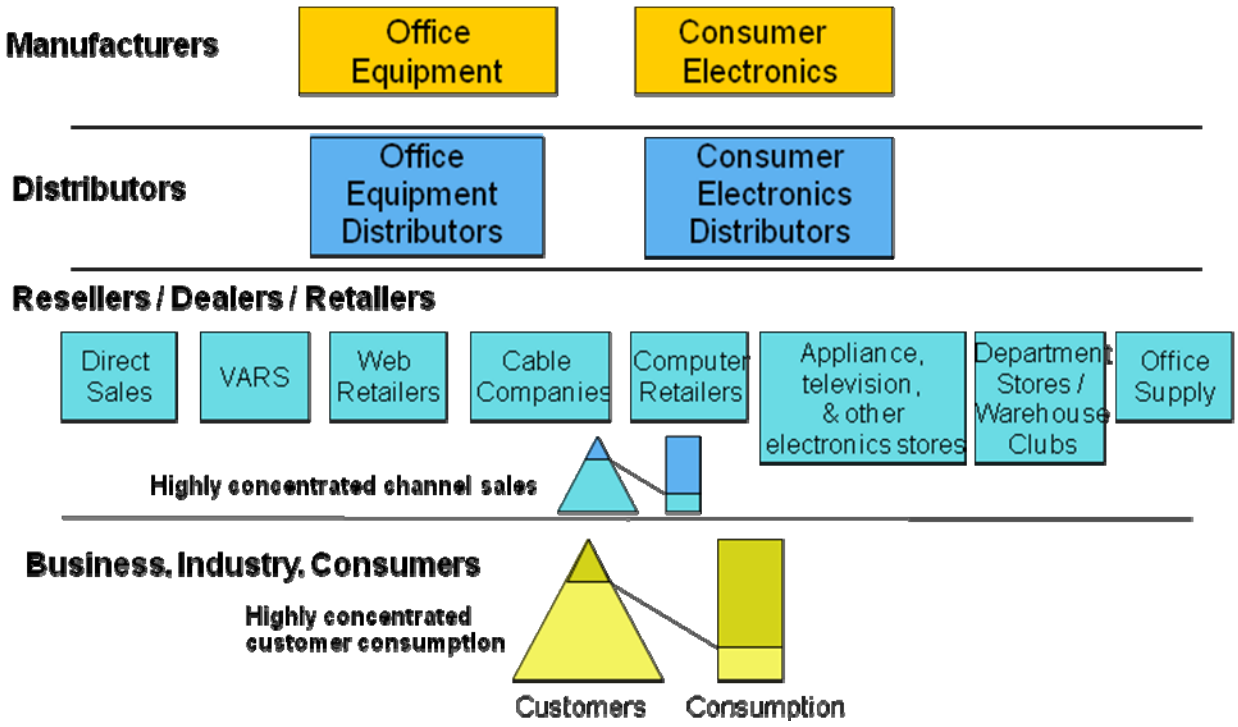
consumers to determine these criteria. A large-scale electronics program presents major challenges to this evaluation methodology and requires additional evaluation strategies to effectively change the market.

Market Channel and Customer Behaviors

The electronics industry comprises a highly diverse set of companies, from large multi-national corporations to small specialty firms. Major manufacturers are global firms that serve consumer, business, and industrial markets. The manufacture of electronics equipment generally involves the assembly of components from different companies. Because manufacturing is a relatively simple process, it is extremely price-competitive. In addition, manufacturers typically operate on a one-year product cycle that responds to consumer's behavior of concentrating their purchases in the five months between August's back-to-school sales through January's Super Bowl.

In general, two distribution steps separate the manufacturer and either the business purchaser or consumer, as shown in Figure 4. (However, manufacturer-direct or warehouse sales sometimes are used and eliminate one or both of these steps, essentially bringing these channel functions in-house.) Medium and large businesses, institutional, and government customers buy their electronics through original equipment manufacturer (OEM) channels, where manufacturers sell directly to customers using their own distribution network—through independent distributors or through value-added resellers (VARs).

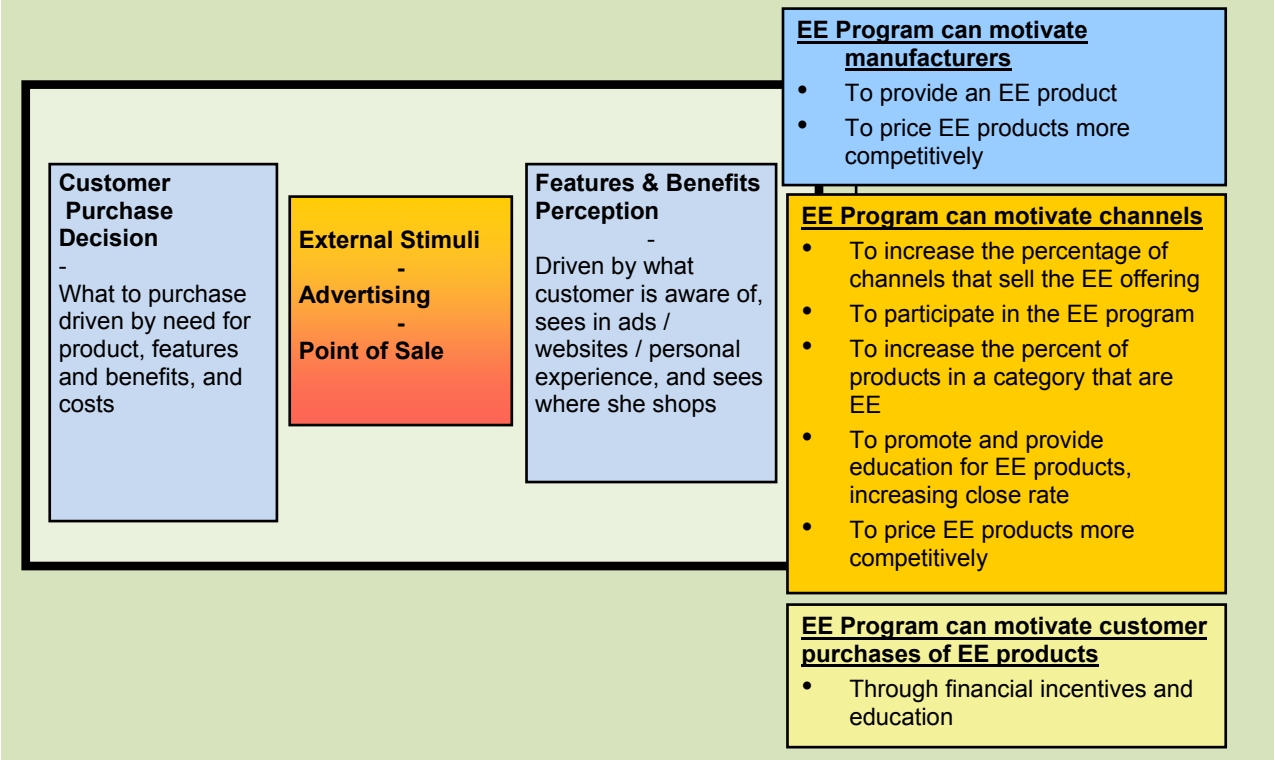
Figure 4. Electronics Channels



For consumer electronics, the retail channel connects product to the mass market first through distributors and then retail stores, such as specialty electronics stores, department stores, and office-supply stores. In some cases, manufacturers bypass the distributors and sell directly to retailers through their own sales organizations or directly to end-users through Internet sales. Among channels, there is a concentration of the top few sales organizations serving the majority of the market, and among customers, there are ones such as large businesses that purchase large numbers of some product types. These concentrations tend to drive market penetration strategies toward major channel players and major customers.

Consumers will buy energy efficient products, providing the overall value proposition offered by the channels is acceptable. It is the market channels' functions to influence customers to purchase product, driven by perceived needs and the features and benefits offered by the equipment manufacturer, the channel, and in the case of efficient electronics, the energy efficiency program offering. Channels can influence customers' electronics purchases with advertising, brand loyalty, customer service, and distribution. These influences are shown in Figure 5, and of particular significance is the impact (right side of figure) that the efficiency program can have on buyer decisions through motivation of the channels.

Figure 5. Market Behavior Model



Achieving significant electricity savings requires a strategy that addresses both consumer and business markets, covers a range of electronics products, and works effectively with channels that influence electronics customers' purchases. The key criteria for an effective electronics program are as follows:

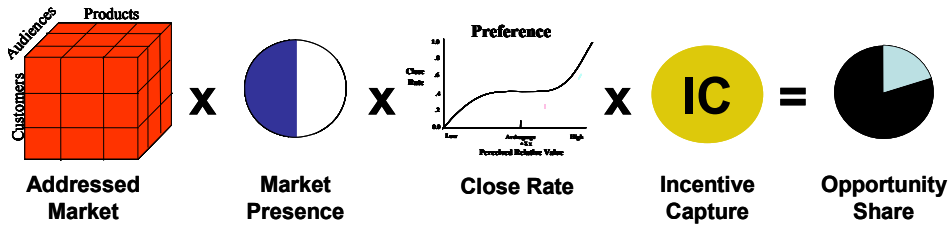
1. A large number of electronics products must be included to achieve sufficient market share to ensure a cost-effective program. The program needs to integrate products into groups and use consistent market channels.
2. Manufacturers and distribution and sales channels prefer as wide a geographic program as possible to capture economics of scale and operational consistency in their product delivery.
3. More program leverage exists among the channels, and channel-based programs will yield the greatest energy savings per dollar invested (PG&E 2008). Therefore, programs must sustain channel management capabilities.
4. Energy efficiency program measures must be carefully timed to complement national and local efficiency standard activities and manufacturing design and sale cycles.
5. Programs must be designed based on the values most important to customers and marketing channels.

The following section describes how these criteria were used to develop the strategies for both near-term and longer sustainable programs to deliver electronics energy savings in California.

Program Strategies and Design

QDI used a market-opportunity model to maximize program effectiveness based on the identified program criteria (PG&E 2008). This model defines opportunity share, i.e., market penetration, according to Figure 6, where the elements and desired program influences are

Figure 6. QDI's Market Opportunity Model



- Addressed Market = fraction of the market opportunity that is realistically achievable, defined by a targeted set of customers for a set of products or services. Programs should maximize addressed market by motivating manufacturers to produce and promote energy efficient products.
- Market Presence = portion of the time the high efficiency product is available where and when the customer wants to buy. It is influenced primarily by channel behavior. Programs should increase the frequency at which the high-efficiency product is available by motivating channels to advertise the energy efficient products and to increase the visibility of the products to consumers.
- Close Rate = frequency that the customer selects the high efficiency product versus the alternatives. Customer and channel behavior both impact close rate. Programs should increase how often the customer selects the high efficiency product versus the

alternatives by motivating stores to increase the percentage of shelf space allocated to efficient products, engage in educational activities (for example, store signage, and sales-associate training), and pass along a portion of the incentives they receive to customers in the form of lower prices or rebates.

- Incentive Capture = rate at which the benefits of energy-savings programs are achieved. This rate depends on channel or customer behavior and regulatory policy. Programs should increase how often credit is received for the customer's purchase by motivating stores to track and report sales, provide historic sales data for comparison to sales with efficiency programs in place, and provide customers with the information necessary to participate in follow-up surveys.

Having a sufficient addressed market size is critical to the success of the program. The three key ways to increase the size of the addressed market are to have a wide range of products in the portfolio (such as within the product families of Table 1), link the timing of product incentives to accepted energy efficiency standards, industry milestones (such as analog-to-digital conversion), and product cycles, and develop an ongoing pipeline of energy efficient products from manufacturers. Thus, product unit sales, growth, and energy-saving potential are criteria for selecting products to add to the portfolio.

When incentives are paid directly to purchasers, the program only influences the close rate. Furthermore, incentive capture with mail-in rebates that accompany consumer-direct incentives is typically low because of lack of response. Retailer and manufacturer incentives, on the other hand, can affect every factor in the opportunity model. Additionally, a well-designed channel program will produce opportunity shares substantially higher than with purchaser incentives. As this work evaluated various scenarios of the opportunity share, the results showed that upstream rebate programs were likely to be eight times as effective in achieving energy savings as by providing incentives to end-use purchasers (PG&E 2008). The design of an effective channel-based program is essential.

Based on the developed program criteria and strategies for obtaining market penetration, the following recommendations were made:

- Develop a statewide program that covers all California IOU ratepayers.
- Conduct a pilot program in 2008 to begin to capture energy and demand savings and plan elements of a larger program in 2009–2011.
- Build the organization, operating capabilities, and experience necessary to implement a larger scale program in early 2009.

These activities were undertaken by PG&E in January 2008, and the status of the program is described below.

California Business and Consumer Electronics Program

PG&E's Mass Market Program began the 2008 pilot program with a focus on integrating its existing programs for ENERGY STAR 4.0 / 80 PLUS desktop computers, computer monitors, and PC network power-save software and new incentives for bundled computer and monitors and for televisions through a common set of retailers and manufacturers. Thus designed, the program aims to substantially increase both market presence and close rates. The pilot program

and strategy for a larger-scale program (both in product and geography, to begin in early 2009) were approved by San Diego Gas and Electric, Southern California Edison, and PG&E—such that the program now addresses approximately 80% of the California market.

The 2008 pilot program's savings opportunity is expected to be 4 gigawatt-hours (GWh) of energy and 0.8 megawatt (MW) of demand. By 2011, the annual savings potential in California is projected to be 230 GWh and 48 MW.

The pilot program also has an ambitious schedule—to launch an OEM program of PCs, monitors, and bundled PCs and monitors in late June 2008 and to launch a retail program in early September 2008. Critical program activities now in progress are as follows:

1. Identifying products to be included in the program
2. Aligning California's IOUs through an advisory body, to coordinate relationship management, program objectives, and implementation processes
3. Building partnered relationships with standards groups, state agencies, industry groups, and consultants
4. Building manufacturer and retailer participation agreements
5. Designing and implementing educational, marketing, and point-of-sale materials
6. Establishing incentive allocations that maximize market penetration and satisfy IOU cost-effectiveness criteria
7. Building organizational capabilities needed to manage the IOU program and its management requirements with channels, accounts, implementers, and detailers,
8. Developing program capabilities to track sales, pay incentives, and insure acceptable EM&V processes.

These activities address the channel-based strategies identified in this research. As the program develops, it will also address electronic user education and behavior in energy efficiency, which will become inherently more important to energy savings as electronic devices become more efficient. PG&E is currently evaluating emerging technologies such as power management, efficient chargers, smart strips, and energy displays that are external to electronic devices and are more user-dependent as well as emerging technologies for future integration into products. And, communication plans for influencing consumer use are now in development.

Conclusions

This research has identified the energy savings opportunities of, the strategies for, and the elements of an integrated product and channel large scale energy efficiency program for business and consumer electronics. A California 2008 pilot program is in progress to implement and test these concepts prior to full-scale program implementation in 2009. Program success will depend on and benefit from as wide a covered territory as possible. Therefore, we welcome inquiries regarding the program details, and updates will be available to interested parties throughout program development and implementation.

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