Learning the Lessons of Market Transformation Programs

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Utilities and government have begun to alter the way they approach energy conservation and efficiency objectives, moving from rebates and regulations to strategic market interventions designed to effect sustainable shifts toward more efficient products and services. A number of these ‘‘market transformation’’ activities are now far enough along that it’s possible to examine both the shifts that have occurred in the market and the role of these activities in fostering those market changes. This paper reviews seven efforts currently underway and provides qualitative and, where possible, quantitative information on their progress in effecting market transformation.

With few exceptions, these efforts aim principally to change manufacturing practices by aggregating buyers or providing market differentiation or recognition. In certain cases, however, where high-efficiency products are available but have a small market share, a multi-pronged approach—combining manufacturer incentives; training for dealers, contractors or installers; and consumer education—has been used to increase the market. Once high-efficiency products have a substantial market share, codes or efficiency standards can be very effective in completing the transformation. For a few products, however, which have very low incremental cost, are highly cost-effective, or are heavily promoted, it appears that market transformation is possible without standards.

Although it is difficult to attribute particular market shifts to specific policies or programs, it seems that many of the market transformation approaches examined in this paper are having a positive market impact, as evidenced by increased sales of high-efficiency products and changes in manufacturer, dealer, and consumer behavior.

INTRODUCTION

In the last few years, utilities have sought alternatives to traditional demand-side management programs. Governments have assumed a market-stimulating role in energy efficiency. Both have sought to leverage private capital and ingenuity to improve the efficiency of energy-using products. And the concept of market transformation has been born and evolved.

While no single definition exists, in general market transformation refers to the process by which collective action, policies, and programs effect a positive, lasting change in the market for energy-efficient technologies and services, such that they are produced, recommended, and purchased in increasing quantity. The specific approaches that can contribute to market transformation range from traditional forms, such as information programs and rebates, to commercialization incentives, technology demonstrations, and market infrastructure developments. These approaches are used to achieve energy efficiency improvements at all levels in the distribution chain—from manufacturers through end users.

Market transformation activities can, for example, target consumers to induce changes in their attitudes toward energy efficiency and concomitant changes in their purchasing practices or strive to educate equipment dealers and contractors as well as building owners and operators about higher-end technologies and practices. Market transformation activities can also focus on the supply side, enticing manufacturers, through aggregate purchase commitments, energy labeling programs, or incentive payments, to produce more efficient products.

Several studies provide an overview of market transformation efforts in which government and utilities have encouraged more rapid improvements in, or accelerated adoption of, energy-efficient technologies (e.g., Flanigan & Fleming 1994; Geller & Nadel 1994; Nadel & Geller 1995; Schlegel & Prahl 1994). Some of these reviews assess the effectiveness of recent market transformation efforts. Increased interest in market transformation, however, has spurred several new initiatives, some of which are now far enough along that it’s possible to conduct a preliminary assessment of their effectiveness. This paper reviews seven current efforts and provides qualitative and, where possible, quantitative information on their progress in transforming the markets for energy-efficient products. It does not pretend to be a rigorous evaluation, but rather a status report, based in large part on interviews with program managers, manufacturers, and other stakeholders on the state of the art in market transformation programs. Information and insights gleaned from these efforts can improve the effectiveness of future market transformation programs.

PROCURING MORE EFFICIENT REFRIGERATORS

Coordinated mass-purchases of high-efficiency technologies (i.e., technology procurement) has been the market transformation strategy chosen by a number of organizations to move the refrigerator/freezer market to higher levels of efficiency. Two technology procurement efforts, in particular, are noteworthy: (1) the Super-Efficient Refrigerator Program (SERP); and (2) the New York Power Authority and Consortium for Energy Efficiency apartment-sized refrigerator initiative. Each of these efforts is described below.

The Super-Efficient Refrigerator Program (SERP)

In the early 1990s, both the U.S. Department of Energy (DOE) [for the initial National Appliance Energy Conservation Act (NAECA)] and the U.S. Environmental Protection Agency (EPA) conducted analyses on the feasibility of improving refrigerator energy efficiency. These analyses indicated that significant reductions in refrigerator energy consumption could be achieved with existing technologies. Recognizing the magnitude and potential for energy savings and capitalizing on changes in refrigerator designs that industry was expected to make to comply with a 1995 CFC phaseout, a number of interested parties (including EPA, the American Council for an Energy-Efficient Economy, the Natural Resources Defense Council, Pacific Gas and Electric Company, and the Washington State Energy Office) initiated discussions in 1990 on ways to encourage manufacturers to improve refrigerator efficiency. Negotiations and planning meetings involving an increasing number of utilities and other parties led to the founding of the Super Efficient Refrigerator Program, Inc. (SERP, Inc.) in September 1991. As an initial step, SERP drafted a detailed RFP calling for the development and commercialization of a ‘‘super-efficient’’ CFC-free refrigerator.

In 1992, SERP members proposed paying more than $30 million in financial incentives and offered this money on per-unit basis as a ‘‘Golden Carrot’’ in a contest for refrigerator manufacturers willing to develop and market a refrigerator that was: (1) full featured; (2) at least 25 percent more efficient than 1993 federal standards require; and (3) CFC free (in both refrigerant and insulation). After reviewing bids from 14 manufacturers, and testing prototypes from 2 semi-finalists, SERP selected Whirlpool as the winner of this competition in June 1993 (Fiest et al. 1994).

The original SERP refrigerator was a 22 cubic foot side-by-side unit that achieved energy savings of nearly 30 percent relative to the 1993 NAECA standard. In 1995, Whirlpool announced additional SERP models (including 25 and 27 cubic foot units) even more efficient than the original unit. Currently, Whirlpool’s SERP models exceed national efficiency standards by 38 to 41 percent. These SERP refrigerators are now available to consumers at retail outlets in the service territories of participating utilities. Whirlpool receives incentive payments from the utilities when it sells qualifying models in their service territories.

To what extent have the SERP units transformed the refrigerator market? Sales figures—one indicator of market transformation—suggest that SERP has had little impact. As of December 1995, sales of SERP units were below the scheduled rate laid out in Whirlpool’s proposal (Sandahl et al. 1995). Whirlpool attributes the slow sales primarily to the time and effort required of dealers to process the paperwork necessary to receive a rebate (Anderson 1996). This is in part a consequence of participating utilities’ requirements that the manufacturer tightly track and verify unit sales for each participating utility. Others believe that Whirlpool’s limited promotion and training for dealers and distributors have hurt unit sales (IRT 1994). In addition, the small niche market that the SERP units serve (in total, side-by-side units account for approximately 30 percent of the refrigerator/freezer market) may limit the potential for SERP to have broad market transforming impacts.

Despite relatively low sales and the narrow niche that the SERP program has targeted, SERP has made a number of significant contributions to moving the U.S. market for refrigerators toward greater levels of efficiency. First, SERP stimulated the introduction of a new highly efficient refrigerator in record time. By combining a number of ‘‘off-the-shelf’’ technologies, Whirlpool was able to produce a highly efficient refrigerator in about half the time that it typically takes to produce a new product. And some observers suggest that as a result of Whirlpool’s efforts other refrigerator manufacturers were able to accelerate the transition of their refrigerator lines away from CFCs a year before the scheduled phaseout (Lee 1996).

Second, the SERP contest is believed to have motivated other manufacturers to develop and test market similar high-efficiency products. Manufacturers, such as Amana and General Electric (GE), have entered the *national* market with efficient CFC-free refrigerators, and have plans to continue these lines. Shortly after SERP units became available, Amana offered a line of refrigerators 25 percent more efficient than the 1993 NAECA standard (Lee 1996). Further, Whirlpool elected to market the SERP units in non-SERP territories under its own ''Energy-Wise'' label. However, low initial sales of these units have led Whirlpool to stop producing and selling the Energy-Wise units (Anderson 1996).

Third, a recent Pacific Northwest National Laboratory (PNNL) study of the SERP process revealed that manufacturers, in general, believe that SERP had at least some influence on the proposed 1998 federal refrigerator standard (Sandahl et al. 1995). In November 1994, after nearly two years of negotiations, the Association of Home Appliance Manufacturers (AHAM) and a coalition of energy efficiency groups, state energy offices, and utilities announced an agreement on a new standard. While the technical details of the SERP model were not discussed in the negotiations, the SERP model was referenced as evidence that an energy-efficient, CFC-free refrigerator could be produced cost-effectively. Further, efficiency advocates, knowing SERP efficiency levels, were reluctant to drop below them in the negotiations. In July 1995, DOE issued a notice of proposed rulemaking (NOPR) that proposed a refrigerator standard nearly identical to this negotiated agreement. These standards reduce energy use of the most popular refrigerator/freezers by nearly 30 percent—similar to those of the winning SERP model.

Because SERP was the first program of its kind in the United States, manufacturers', utilities', and others' experience with SERP is likely to affect their willingness to participate in similar market transformation programs. According to PNNL, most utilities and manufacturers interviewed on the SERP process indicated that they might participate in future Golden Carrot programs, although their decision would be contingent on elements of the program's design, including the ''winner-takes-all'' approach and incentive levels, and the program's implementation (Sandahl et al. 1995). PNNL is currently conducting a formal impact evaluation of SERP that is anticipated to be completed in 1996.

Apartment-Sized Refrigerator Procurement

Apartment-sized refrigerators offer significant efficiency gains that are considered both feasible and cost-effective. To tap these potential energy savings, the New York Power Authority (NYPA) joined forces with the Consortium for Energy Efficiency (CEE) in a bulk purchase of highly efficient apartment-sized refrigerators. The impetus for the initiative was a localized effort by NYPA to procure more efficient refrigerators for public housing operated by the New York City Housing Authority (NYCHA).

With input from CEE, DOE, EPA, and others, NYPA developed a request for proposals (RFP) for a super-efficient apartment-sized refrigerator that was released for bid in May 1995. The initial RFP set target efficiency levels for four years, specifying that manufacturers deliver the best current technology for the first year of the program (1996), a unit that is 30 percent more efficient than the 1993 standard for the second year of the program, and units with even higher-efficiency levels for the third and fourth years of the program.

Four manufacturers expressed an interest in this RFP, however, none was willing to commit to the requirements of the third and fourth years. At the time that NYPA was negotiating with manufacturers on the scope and content of the RFP, Congress was taking action to limit DOE's ability to implement new appliance efficiency standards. The uncertainty over future standards translated into reluctance on the part of several manufacturers to invest in developing products that meet target efficiency levels far into the future (i.e., over the four year period specified in the RFP) (Brown 1996).

In response to these concerns, NYPA developed a second RFP that limited manufacturer requirements to those of the first two years. Three manufacturers bid on the second RFP. For some manufacturers, even committing to the second year savings was a stretch. Of the three that bid on the RFP, General Electric won the bid for the first year's savings, but only Maytag offered an apartment-sized refrigerator that met the second year's requirement. Historically, Maytag has not been a big player in the apartment-sized refrigerator market. Because the company had not yet invested in redesigning its products to meet the CFC phaseout schedule, however, it was ready to make the additional investment needed to simultaneously achieve the required energy efficiency improvements for the RFP. With its bid, which was very aggressively priced, the company enters this market niche in a very significant way. Some observers indicate that Maytag's bid has already spurred efficiency-based competition in the apartment-sized refrigerator market (Brown 1996).

NYPA and CEE are offering manufacturers a larger market and purchasers more reasonable prices by allowing housing authorities and utilities to piggyback on the NYPA contract with manufacturers. Preliminary marketing efforts by CEE indicate that the market transformation potential of the NYPA procurement is substantial. At Maytag's insistence, however, the maximum number of piggyback orders to the NYPA contract will be limited to 40,000 units. A number of housing authorities are strongly interested in the new product, and CEE anticipates that it can secure commitments to purchase at least 40,000 units each year (in addition to NYPA's order of 20,000 units annually for NYCHA) (Wisniewski 1996). With few exceptions, utilities have been less willing than housing authorities to commit resources to procuring energy-efficient apartment-sized refrigerators in the face of diminishing demand-side management dollars, although several proactive utilities have expressed an interest in large purchases.

TURNING CLOTHES WASHERS ON THEIR SIDE FOR GREATER ENERGY EFFICIENCY

Most clothes washers sold today have much in common with units sold 30 years ago. In fact, for some manufacturers, designs have changed little over this period. From an energy perspective, clothes washer efficiency was fairly stable in the 1980s and early 1990s, but the average energy consumption of new clothes washers dropped 17 percent in 1994 when new federal efficiency standards took effect. Much more efficient washers, however, that use less than half the energy and water of conventional models, are currently on the market. But these models use horizontal-axis designs that are very different from the vertical-axis designs that predominate in the U.S. market. The other major opportunity for efficiency gains in laundry equipment lies with increased washer spin-speeds, which decrease the water content of clothes at the end of the wash cycle and thereby reduce dryer energy use by 30 percent or more.

Historically, many market and non-market barriers have inhibited the spread of high-efficiency washers, with the result that the market share of these high-efficiency washers in 1994 was probably on the order of 1 percent. Price, in particular, has been cited as a key barrier. According to Vince Anderson of Whirlpool, ''despite the good payback available to the consumer, the historic price premium (roughly $200 or more) is at a level that significantly reduces sales potential'' (Anderson 1996). Another major barrier is Americans' past experience with high-efficiency designs. The one U.S.-built high-efficiency unit on the market in the past needed repair more often than the average washer. To overcome these barriers, a number of initiatives aimed at improving efficiency in the clothes washer market have come together in the 1990s, including:

- Announcements by DOE in 1991 and 1995 that they are very interested in horizontal-axis washer technology and are considering using this technology as the basis for setting new federal efficiency standards (DOE 1991; DOE 1994a).
- A joint R&D program by the Electric Power Research Institute and Maytag to develop a new, improved horizontal-axis design (EPRI 1995).
- Development of an initiative by CEE in which many utilities use the same efficiency specifications to provide significant and focused promotional activities for high-efficiency, high water extraction clothes washers (CEE 1995a).
- Formation of the utility consortium The High-Efficiency Laundry Metering and Marketing Analysis project (THELMA) to conduct market research, performance testing, and in-field metering on high-efficiency clothes washers in order to learn how to better promote these washers to consumers (Pope 1995).

These efforts have been proceeding steadily and often in coordination with each other but face some barriers. Sixteen energy utilities and many water agencies, for example, have signed up for the CEE initiative and many of these utilities as well as EPRI and DOE are also part of the THELMA consortium (CEE 1995b). However, limited availability of high-efficiency washers has made it difficult to enroll additional utilities in the CEE program. And opposition by some manufacturers to stringent clothes washer efficiency standards has contributed to a Congressional moratorium on new appliance efficiency standards in 1996.

Overall, these different initiatives appear to be affecting some shifts in the U.S. clothes washer market. In 1991 only one U.S. manufacturer produced washers meeting the CEE specifications and imports of complying models were very limited. By 1994, one small U.S. manufacturer began producing a new high-efficiency, high-spin-speed washer and three out of the four major U.S. manufacturers had announced their intention to introduce new high-efficiency models, with the new units expected to reach the market place in 1996 and 1997 (CEE 1995a). Also, imports of high-efficiency washers appear to have picked up significantly, with several European manufacturers actively marketing their washers throughout the United States (deLaski 1996; Pope 1996).

What has contributed to manufacturer and importer decisions to market new high-efficiency models? First and foremost, U.S. manufacturers appear to be motivated by the possibility of new federal efficiency standards. Second, the new high-efficiency washers have the added marketing benefits of improved cleaning performance and less wear and tear on clothes. Third, the consumer appeal of substantial energy and water savings from these washers, combined with demonstrated utility and government interest in promoting and providing incentives for high-efficiency washers, has influenced manufacturers and importers. In spite of the uncertainty concerning new federal efficiency standards, U.S. manufacturers are continuing their efforts to develop and commercialize new high-efficiency clothes washers.

Still, the market share of these high-efficiency machines is very low and likely to remain low until units are mass-marketed by major U.S. manufacturers. Also, even when models are widely available, it is uncertain how consumers will respond to the new models and the different marketing initiatives. It is also unclear whether DOE will proceed with new clothes washer efficiency standards. Thus, while significant progress has been made, it will probably be several years before we will know whether these initiatives were successful in their goal of transforming the U.S. clothes washer market.

TAKING A BYTE OUT OF OFFICE EQUIPMENT ENERGY USE

In the early 1990s, several forces came together to effect efficiency improvements in office equipment, beginning with personal computing equipment. First, as a result of initial studies of the magnitude of office equipment power loads and the trends in power consumption, a group of utilities, government agencies (including EPA and DOE), and energy efficiency advocates, led by the Electric Power Research Institute (EPRI), formed the Office Technology Efficiency Consortium. This Consortium strives to increase office equipment energy efficiency and improve load characteristics, power quality, and tolerance to power line disturbances without compromising either competitive features or user productivity. To achieve these goals, the Consortium has emphasized the need for, and has contributed to the development of, more reliable data, government or corporate purchasing specifications, and utility-sponsored information programs to create a market for efficient office equipment.

Growing interest in office equipment efficiency led EPA to query manufacturers about the technical feasibility of incorporating power management features into personal computers (PCs). Based on positive manufacturer responses, EPA worked with manufacturers to develop the ENERGY STAR Computers Program—a voluntary labeling program designed to encourage the development, production, and sale of energy-efficient, power-managed office equipment.

EPA launched the program in June 1992, by announcing it at a Consortium-sponsored workshop to heighten awareness of the importance of more efficient office equipment. Later that year, in October 1992, the Energy Policy Act of 1992 (EPAct) was signed into law, and with it DOE was required to oversee the development of a manufacturer-centered voluntary information program to encourage the marketing and purchasing of more efficient office equipment products. Consortium members were instrumental in suggesting this provision to Congress. Office equipment efficiency was on the agenda of manufacturers, government agencies, and utilities, and the ENERGY STAR specification provided an efficiency requirement around which these players could rally.

The initial phase of the ENERGY STAR program required manufacturers to produce PCs and monitors capable of switching to a low power mode [i.e., at or below 30 watts (W)] when not in active use. Participating manufacturers, in turn, were entitled to use the ENERGY STAR label in promoting their products. In 1993, EPA expanded its ENERGY STAR program to include printers (with requirements similar to those of PCs) and signed partnership agreements with printer manufacturers that comprised more than 95 percent of all printers on the market.

In the wake of these efforts, on Earth Day 1993, President Clinton signed Executive Order #12845 into law, requiring federal agencies to purchase ENERGY STAR PCs, monitors, and printers. The Executive Order delivered to manufacturers the promise of the largest office equipment market in the world and, together with the relatively low cost of adding power management capability to office equipment, helped mobilize rapid manufacturer participation in the ENERGY STAR program. During the 1994 fiscal year alone, federal agencies purchased at least 292,000 compliant PCs, 167,000 monitors, and nearly 65,000 printers. These purchases save the federal government an estimated $5 million in energy costs annually (Dolin 1996; EPA 1995). Overall, EPA estimates that in 1995 ENERGY STAR PCs comprised approximately 70 percent of new sales; and ENERGY STAR-compliant power-managed monitors comprised 80 to 85 percent of those on the market; and ENERGY STAR printers, which didn't appear on the market until June 1993, comprised more than 95 percent of the printers on the market. Data validating these estimates should be available as of June 1996 (Fanara 1996; Latham 1996).

Some program design problems as well as technical incompatibilities, however, have eroded the potential energy savings from Energy Star products. Early in the program, for example, EPA did not require computer manufacturers to ship their PC models with the power-management feature already ''enabled.'' Thus, even though the equipment was capable of powering down, it did not unless the user intervened and set up the feature. A recent study by Lawrence Berkeley National Laboratory reveals that only 10 percent of Energy Star PCs currently in the field are enabled (Koomey et al. 1995). In October 1995, EPA addressed this problem by modifying the Energy Star program to explicitly require manufacturers to ship PCs with the sleep feature enabled. Additionally, local area network (LAN) activity and compatibility issues can limit the energy savings from PC power management features. For example, for certain high-end computers intended for network use, network ''polling'' functions can keep the PC awake, thereby limiting the effectiveness of the Energy Star features. Further, computers not generally intended for network use can disconnect from the network upon entering the low-power mode. To respond to this problem, EPA now requires manufacturers to specify in their product literature if a product is not intended for network use (Latham 1996; McMahon, Piette & Kollar 1995).

Despite these problems, a recent study by LBNL indicates that the Energy Star program has already saved about 3 billion kWh annually in the United States. Together with new fax machine and copier specifications (finalized in 1994 and 1995, respectively), which rounded out the suite of office equipment programs, Energy Star is projected to save about 17 billion kWh per year in the United States by the year 2010 (Koomey et al. 1995).

Fueled by manufacturer interest, the EPA Energy Star program has effected considerable change in the supply of efficient office equipment. To expand its programs' effectiveness, however, EPA recognizes the need to motivate consumers as well. A survey conducted in 1993 indicated that only nine percent of respondents were familiar with the Energy Star label (COPEE 1994). As a result, EPA intends to launch a significant media education campaign on the benefits of energy-efficient equipment in late 1996. Further, EPA, in October 1995, made considerable progress toward an international set of Energy Star criteria by negotiating an agreement with the Japanese government to implement an International Energy Star Office Equipment Program. EPA is also working with the European Commission to further develop a common internationally recognized set of Energy Star criteria.

COOLING DOWN AIR CONDITIONER ELECTRICITY USE

Residential Central Air Conditioner Initiatives

Air conditioner energy use generally coincides with periods of peak electricity demand. As a result, improving air conditioning energy efficiency is of particular interest to electric utilities. As of 1994, electric utilities offered more than 300 programs to promote high-efficiency electric space heating and cooling to their residential customers, with the most common incentive being a cash rebate (EPRI 1995b). These incentive programs, however, tend to be extremely diverse, targeting varied efficiency levels and generally focusing on seasonal and not peak performance metrics. The Consortium for Energy Efficiency (CEE) sought to remedy these problems by developing residential air conditioner program guidelines for utility incentive and promotional programs. In doing so, CEE aimed to minimize the confusion generated by diverse utility programs, send a clear market signal to high-efficiency products manufacturers, and increase high-efficiency equipment availability.

The CEE initiative, which covers single-phase unitary and split system air conditioners and heat pumps up to 65,000 Btu per hour of cooling capacity (i.e., 5 tons), has two components:

- First, the equipment efficiency component consists of multiple efficiency tiers with eligibility determined on the basis of SEER (a measure of average seasonal performance) and EER (a measure of peak load performance) for cooling performance and also HSPF for heating performance. The initial efficiency tiers are based on equipment that is approximately 15 percent more efficient than average equipment being sold today (e.g., a tier 1 SEER level of 12 relative to a 1994 sales-weighted average air conditioner SEER of 10.6). A series of higher tiers (e.g., tier 2 at SEER 13, tier 3 at SEER 14, and advanced tiers of 15 and above) are based on additional efficiency improvements, for which higher incentives are recommended.

- Second is an installation component that includes a set of installation guidelines for contractors to follow. Few utility programs focus any effort on improving installation practices—a critical component in ensuring efficient system performance. CEE recommends that utilities incorporate the installation guidelines in their programs to maximize actual energy savings, but utilities are not required to adopt this component to participate in the initiative.

To date, eight utilities have signed on to participate in CEE's residential air conditioner and heat pump initiative. These utilities serve about 15 percent of the residential customer base in the United States (CEE 1995c).

CEE has encountered some difficulties in marketing the program to utilities, and in particular, in determining whether programs that either include some but not all of the CEE efficiency tiers or offer promotions but not financial incentives should qualify. In these areas, CEE has tended to be fairly conservative and has appeared overly restrictive to some potential participants. In late 1995, CEE approved a set of program modifications that clarify and simplify the program to address many of these issues. These modifications include requiring that utilities support only tier 1 efficiency levels, and expanding the methods of participation to include not only financial incentives but also ''significant and focused promotional/educational activity.'' Furthermore, as the electric utility industry restructures, CEE has had to adapt to a changing perspective in the industry regarding energy-saving programs (Marge 1996).

Complementing the CEE initiative is EPA's new Energy Star program for heat pumps and air conditioners, which was unveiled in April 1995. The primary thrust of the program is to improve manufacturer product offerings and market share for high-efficiency products. The Energy Star Heat Pump and Air Conditioner Program requires that manufacturers produce units with a minimum SEER of 12 and a minimum HSPF of 7. These criteria were based on the CEE tier 1 requirement. However, unlike CEE, EPA does not require that manufacturers also meet a peak-load cooling performance requirement. Thus far, 11 manufacturers have signed on to the program. In addition to the manufacturer component of the program, EPA has initiated a marketing campaign and has begun a series of pilot distributor and contractor training activities. Through this latter effort, EPA hopes to educate dealers and distributors on the benefits of high-efficiency equipment and improve the likelihood that they will stock and install ENERGY STAR compliant products.

In addition, DOE has also begun a rulemaking to determine new efficiency standards for central air conditioners and heat pumps (DOE 1993). The standard-setting process is proceeding slowly and at the earliest will be completed in late 1997. The new standards will probably take effect in the first few years of the next century. The initial analysis prepared for the rulemaking indicated that, depending on equipment size and characteristics, efficiency levels of SEER 13 to 15 can be cost-effective for consumers (DOE 1994b). However, some important issues, which have not been addressed in the analysis thus far, may reduce the final standard to somewhat lower efficiency levels. Still, electricity and peak demand savings of approximately 20 percent or more relative to the current SEER 10 standard are likely as a result of these new standards. The success of the CEE and EPA programs may affect this rulemaking.

Improved sales of tier 1 equipment and increased availability of high-efficiency equipment across the board may evidence the effectiveness of the CEE and EPA initiatives. First, air conditioner and heat pump sales data for 1993 and 1994 show that, in 1994, 16.1 percent of air conditioner and heat pump shipments had a SEER of 12 or more, up from 12.7 percent in 1993. On the other hand, the proportion of units with SEER of 14 or more was the same in 1993 and 1994 (0.4 percent) (Martz 1995). As of 1995, the Air-Conditioning and Refrigeration Institute (ARI) no longer provides this data to the public. However, several industry observers suggest that SEER 12 equipment accounted for approximately 25 percent of sales in 1995, while sales of SEER 13 and higher equipment remained low. Second, a database of available models shows that, in early 1994, 23 percent, 10 percent, 1.4 percent, and 0.1 percent of models met CEE tiers 0, 1, 2, and 3, respectively (tier 0 was a temporary tier with a SEER of 11). By late-1995 these percentages had increased to 43 percent, 27 percent, 7 percent, and 2 percent (CEE 1995c; CEC 1995).

Results of interviews with manufacturers and distributors indicate that the CEE and EPA initiatives have contributed to helping to improve uniformity among programs, which has helped to solidify manufacturer interest in developing products at the tier 1 level (i.e., SEER 12). They also point out other factors, namely higher profit margins, marketing opportunities in the replacement market, and the potential to differentiate their products from their competitors in the marketplace, that contribute to manufacturers' decisions to produce high-efficiency products.

However, at least one manufacturer competing at the highest efficiency levels feels that the CEE program has not been a factor in his company's success in marketing existing products or in new product development decisions. Nonetheless, manufacturers that have not tended to produce high-efficiency equipment have entered the market for tier 1 equipment and are slowly building interest in developing products that meet higher efficiency tiers. At the 1996 International Air Conditioning, Heating, and Refrigeration Exposition, for example, several manufacturers announced new SEER 12, 13, and 14 units and a number of other manufacturers expressed an interest in finding out which utilities were promoting products at the higher-efficiency levels.

New federal efficiency standards, if enacted, could complete the transformation of the residential central air conditioner and heat pump markets to at least the tier 1 level. In fact, the significant and growing market share of tier 1 products is likely to make a standard based on tier 1 relatively uncontroversial. Transformation to higher-efficiency levels has barely begun, although a few utilities (e.g., Florida Power & Light and Pacific Gas & Electric) in regions with significant market acceptance of tier 1 levels have begun to successfully emphasize higher-efficiency levels in their programs (Marge 1996).

Commercial Air Conditioning Initiatives

CEE's residential air conditioner and heat pump initiative is complemented on the commercial side by its High Efficiency Commercial Air Conditioning (HECAC) initiative, which covers unitary, three-phase equipment (CEE 1994). Historically the commercial unitary air conditioning market has been dominated by first cost considerations and there has been little effort to promote high-efficiency equipment in the market. In 1989, in an effort to improve the efficiency of commercial unitary air conditioners and heat pumps, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) developed a set of recommended practices for new commercial construction that includes efficiency levels for unitary air conditioners. Since 1989, many states have adopted this ASHRAE standard as part of their state building codes. In 1992, the U.S. Congress established minimum efficiency standards for unitary commercial air conditioners and heat pumps up to 240,000 Btu per hour cooling capacity based on the ASHRAE standard. The CEE program was designed to promote commercial air conditioning equipment that is more efficient than this standard.

Like CEE's residential air conditioning program, HECAC consists of multiple efficiency tiers: an initial tier based on equipment approximately 10 percent more efficient than average equipment being sold today; and a higher tier, based on additional efficiency improvements, for which higher incentives are recommended. For example, for a 10 ton cooling capacity unit, the federal standard requires an 8.9 EER, and CEE's first and second tiers are 10.0 and 12.0 EER respectively. Participants in the HECAC initiative include 16 utilities that serve about 20 percent of U.S. electric utility customers (CEE 1994; CEE 1995b).

A number of activities have worked in concert with the CEE initiative to move the market toward high-efficiency commercial air conditioning equipment. First, concurrent with the development of the CEE initiative, EPRI and Lennox engaged in a cooperative research and development effort to develop a line of very high-efficiency unitary equipment, with the objective of trying to meet CEE's second tier (Blatt 1992). The results of this effort, the Lennox L-series, is gradually being commercialized over the 1995-1996 period (Stockwell 1995). Second, EPA has funded the California Institute for Energy Efficiency to develop a prototype 10 ton commercial air conditioner that exceeds CEE's second tier. Through this effort a prototype was designed, built, and underwent field testing. Preliminary results indicate that the efficiency of this prototype falls short of their goal of 12.9 EER due to problems caused by the hurried construction of the prototype, but that the unit is still more efficient than any product now on the market and achievement of the original goal should be possible with more careful construction (O'Neal & Davis 1995). Finally, ASHRAE has begun to develop a new set of efficiency standards for packaged commercial air conditioners as part of its model building code. The initial draft ASHRAE standard is similar in stringency to the CEE tier 1 level (ASHRAE 1996).

Assessing the effectiveness of these efforts is difficult because data on the sales-weighted efficiency of commercial packaged air conditioners is not publicly available. What are available are various analyses of the percent of units on the market that meet certain efficiency targets. For example, a June 1993 analysis by the Air Conditioning and Refrigeration Institute (ARI) prepared for CEE found that approximately 14 percent of the units then on the market met CEE tier 1 while no models met CEE tier 2 (Wethje 1993). During 1994 and 1995 the proportion of models meeting CEE tier 1 grew substantially. An analysis comparing the early 1994 California Energy Commission database on commercial packaged air conditioners and heat pumps with the updated November 1995 version revealed that nearly half of the new models added to the database during 1994 and 1995 met CEE tier 1 (Suozzo 1995). As of early 1996, an analysis of the ARI database indicate that a total of 23 percent of models met tier 1 (Marge 1996).

Based on discussions with manufacturers, increased utility and consumer interest in high-efficiency equipment prompted many of the major manufacturers to introduce new high-efficiency product lines to complement their existing standard efficiency lines in 1993 and 1994. To the extent that CEE spurred more uniformity among utility programs at the tier 1 level, the CEE initiative contributed to this market shift. In addition, by 1994 preliminary drafts of the new ASHRAE standard were available to manufacturers and these drafts have had an impact on product development efforts since, under federal law, development of a new ASHRAE standard triggers, and forms the basis for, a new set of federal standards.

Manufacturers, however, have shown little interest in CEE's second tier. For example, the Lennox L-Series generally falls midway between CEE tiers 1 and 2, and none of the units meet tier 2. It appears that this is due to several factors including the costs associated with research and development needed to achieve tier 2 levels, changes in utility focus away from energy efficiency to customer service programs, and the larger size and higher price of tier 2 equipment relative to tier 1 equipment, which make it difficult for tier 2 equipment to compete in the marketplace. To address this issue, in early 1996 CEE proposed lowering the tier 2 efficiency requirements to levels 10 percent above the new ASHRAE level. With these new levels, the high-efficiency Lennox series will generally achieve tier 2 levels (CEE 1996).

Furthermore, while tier 1 units are now widely available, they still represent a relatively small portion of equipment sales. One utility involved in the CEE program estimated that about 10 percent of commercial unitary equipment sales in its territory met CEE tier 1 in 1995. On the other hand, the various efforts to promote this equipment have increased manufacturer comfort with these efficiency levels and, as a result, most if not all major manufacturers are supporting the efficiency levels in the draft ASHRAE standard. When this standard and its companion federal standard are completed, the transformation of the market to tier 1 will be complete.

HEATING UP THE MARKET FOR HIGH-EFFICIENCY FURNACES

Wisconsin's cold northern climate together with the natural gas emergencies of the late 1970s prompted a number of groups, including the state, the public utility commission, utilities, and community action agencies, to promote energy conservation and weatherization. In 1982, the Public Service

Commission (PSC) issued a directive requiring certain utilities in the state to offer programs to weatherize the homes of low-income rate payers. Under this directive, the major gas and electric utilities were required to provide weatherization services to low income customers free of charge and to install energy conservation measures, including high-efficiency gas furnaces, that met a 5-year simple payback (Airriess et al. 1985; Schlegel, McBride & Thomas 1990). Utilities performed an audit—including a heating equipment evaluation—then took bids from local contractors for the installation of the measures recommended in the audit. Because installing high-efficiency furnaces (e.g., AFUE of 90 percent), particularly as replacements for existing units, garnered significant energy savings and was easily delivered through local contractors, many utilities began offering not only low-income services, but also high-efficiency gas furnace rebates to other customers. By the mid-1980s, utility rebate programs to promote high-efficiency heating equipment, and furnaces in particular, were fairly widespread.

From 1982 through 1991 almost half of all furnaces were replaced with high-efficiency furnaces and more than 90 percent of the furnaces replaced in the early 1990s were replaced with high-efficiency systems. This compares with significantly lower high-efficiency furnace penetrations in nearby states. In Michigan, for example, only a third to a half of new gas furnaces sold in the state are high-efficiency models (HBRS, Inc. 1995).

In response to an increasing demand for high-efficiency gas furnaces, prices declined, such that the costs of full condensing furnaces are now substantially less in Wisconsin than in most other northern states. A study comparing the markets for gas furnaces in Michigan and Wisconsin, indicates that the incremental cost of moving from standard efficiency furnace (e.g., AFUE of 80 percent) to a high-efficiency model for a 1600-square-foot home is approximately $70 less in Wisconsin (e.g., $390 in Wisconsin compared to $460 in Michigan) (HBRS, Inc. 1995).

As the saturation of high-efficiency gas furnaces increased and the market for these products appeared ‘‘sustainable,’’ many utilities and the PSC withdrew rebates for high-efficiency furnaces in 1988 and 1989. Through nearly five years of utility programs, Wisconsin succeeded in making high-efficiency gas furnaces the norm. Schlegel and Prahl (1994) believe that the key to the success of the transformation of the furnace market in Wisconsin was contractor education. Their theory suggests that together, low income weatherization and utility rebate programs enabled, and in some cases even required, contractors to become familiar with high-efficiency gas furnaces. Contractors thus recognized that full-condensing furnaces were often more reliable than standard furnaces, could generate higher than average profit margins, and were more likely to be specified by competitors. These factors, together with the fact that contractors in this largely ‘‘replace-on-failure’’ market play a key role in consumer purchasing decisions, were critical in shifting purchasing patterns toward high-efficiency in Wisconsin (Schlegel & Prahl 1994). Additionally, a number of studies, suggest that in Wisconsin, more so than in other states, participants in all levels in the equipment distribution system value energy efficiency, making high-efficiency products an easier sell (Van Liere, Vig & Feldman 1994).

CONCLUSIONS

The examples presented in this paper provide evidence of shifts in the markets for key products, including increased availability of models, increased sales of high-efficiency products, and changes in manufacturer, dealer, and consumer behavior. Although it is difficult to attribute particular market shifts to specific policies or programs, it appears that many of the market transformation approaches examined in this paper are having a positive market impact.

With few exceptions, these efforts aim principally to change manufacturing practices by aggregating buyers or providing market differentiation or recognition. Where the desired technology is not presently on the market or only available in limited quantities and at very high cost, technology procurement (e.g., like SERP or the apartment-sized refrigerator initiative) can develop a large enough market so that availability increases and first cost increments decline. (Although lack of simultaneous promotion to buyers may result in market shifts that are not sustainable.) Manufacturers interest in introducing new products may be heightened in cases where high-efficiency products provide additional benefits besides energy savings (e.g., better performance) or when new efficiency standards are likely and market transformation programs help provide a large initial market.

Where high-efficiency products are available but have a small market share, efforts to develop a substantial market share can be difficult if major market barriers exist. In these situations a multi-pronged approach is often needed, combining incentives, training for dealers, contractors or installers, and consumer education. A successful example of such an effort is the case of condensing furnaces in Wisconsin where the actions of manufacturers, utilities, state and local officials, and trade allies put these different program elements into place.

Where high-efficiency products have a substantial market share, mandatory codes or efficiency standards can be very effective at completing the transformation process, as shown by likely new refrigerator efficiency standards and possible new efficiency standards for clothes washers and air conditioners. Standards may not be needed, however, if the incremental costs of high-efficiency are very modest (e.g., as with power-managed office equipment) or extensive supplier and/or purchaser interest has been developed through other means such as years of utility and government incentives (e.g., as with furnaces in Wisconsin).

Given the diversity of products and initiatives, there are likely to be exceptions to each of these ''rules.'' However, there is one conclusion that will generally hold true: market transformation takes a long time. In all of the case studies, at least five years and sometimes as much as ten years are likely to elapse before a market is significantly transformed. Parties involved in the process need to sustain their commitments for many years before seeing the full benefits of successful market transformation.

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