Market Transformation Programs: Past Results, Future Directions

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Market transformation is a process whereby energy efficiency innovations are introduced into the marketplace and over time penetrate a large portion of the eligible market. In the past few years, many program planners and policy makers have begun discussing program and policy initiatives to encourage and accelerate the market transformation process. Instead of saving energy building-by-building, a market transformation approach seeks to change the entire market for particular products or services so that efficient products or services are the norm and do not need to be promoted with incentives. A market transformation strategy can be built from a combination of different program and policy initiatives ranging from R&D to utility incentives and voluntary commitments to building codes or equipment efficiency standards.

This paper reviews market transformation efforts that have occurred in recent years and the lessons they teach. Based on eight case studies we conclude that: (1) market transformation is feasible; (2) the preferred market transformation strategy varies from product to product, depending on characteristics of the technology and the market being served; (3) quality assurance is critical to the market transformation process; and (4) minimum efficiency standards and building codes often play a critical role in market transformation. However, developing and implementing a market transformation strategy is not easy, as such a strategy requires extensive coordination among, and long-term commitments by, many diverse parties.

This paper also examines future directions for market transformation including an analysis of promising market transformation targets. Eight high-priority targets for new market transformation initiatives are identified based on potential energy savings, cost-effectiveness, and likelihood intervention can make a difference. Policy strategies for each of these eight targets are presented. However, in order for these and other market transformation initiatives to succeed, there is a need to plan and implement more comprehensive long-term transformation strategies, develop evaluation procedures for market transformation, and design rewards for utilities that participate in successful market transformation ventures.

Introduction

Market transformation is a process whereby energy efficiency innovations are introduced into the market-place and over time penetrate a large portion of the eligible market. Market transformation can be visualized in terms of the classic S-shaped logistic diffusion curve (see Figure 1). Once a new product or other type of innovation is introduced, its penetration begins to rise through early adopters. Penetration then "takes off" as awareness of the technology and its advantages grows. The adoption process continues until market penetration levels off at "full market potential". Market transformation also implies lasting change such that the market does not regress to lower levels of efficiency at some later time.

In the past few years, many program planners and policy makers have begun discussing program and policy initiatives to encourage and accelerate the market transformation process. Instead of saving energy building-by-building, a market transformation approach would seek to change the entire market for particular products or services so that efficient products or services are the norm and do not need to be promoted with incentives. Relative to conventional program approaches, market transformation programs can potentially increase the amount of energy that is saved (because participation rates approach 100 %) while lowering long-term program costs per unit of energy saved (because transformed markets do not require incentives).

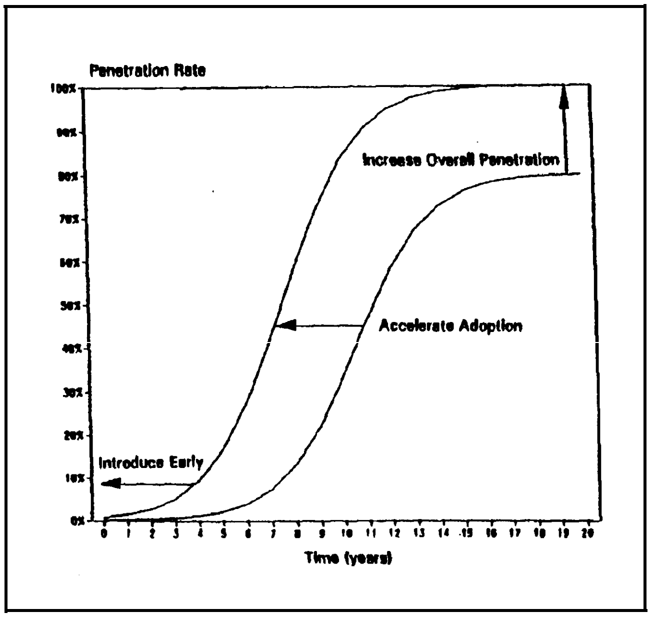

Figure 1. Approaches to Increasing Market Penetration (Nilsson 1992)

This paper addresses market transformation from several perspectives. The first section reviews the different program and policy elements that can be used to shape a market transformation strategy. The second section reviews market transformation efforts that have occurred in recent years and assesses the success of these efforts and the lessons they teach. The third section discusses the limitations of market transformation. The final section discusses future directions including an analysis of promising market transformation targets and policy strategies that could be used to facilitate market transformation.

Elements of Market Transformation Strategies

There are many specific policy and program approaches that can contribute to market transformation. These different approaches work in different ways to influence the technology diffusion curve, as discussed in the sections below. Many of these approaches can complement each other, either by design or by chance, to form a complete market transformation strategy. Among the approaches that can contribute to a market transformation strategy are:

1. Research and development (R&D)
2. Demonstrations and field tests
3. Commercialization incentives (e.g. "Golden Carrots™" such as the Super-Efficient Refrigerator Program)
4. Marketing and consumer education
5. Financial incentives
6. Voluntary commitments (e.g. Green Lights)
7. Bulk purchases
8. Building codes
9. Equipment efficiency standards

Explanations and examples of each of these approaches are discussed by Geller and Nadel (1994).

Examples of Market Transformation

A recent study reviewed eight end-uses where substantial energy efficiency improvements occurred during the past 15 years and market transformation took place to a moderate or high degree (Geller and Nadel 1994). These case studies illustrate that certain products and markets are relatively easy to transform to high efficiency, while other products and markets present a greater challenge.

Refrigerators, fluorescent lighting ballasts, and new residential construction in the Pacific Northwest are three examples of highly successful market transformation. The average electricity use of new refrigerators declined about 60% during the past 20 years. This dramatic improvement in efficiency was due in large part to state and then Federal efficiency standards, along with utility rebate programs. Refrigerator efficiency improvements are continuing as a result of these initiatives and "golden carrot" incentives to stimulate commercialization of advanced technologies.

Fluorescent ballasts were first transformed to higher efficiency magnetic types and are now being transformed to electronic types. These steps also were facilitated by state and Federal efficiency standards and utility incentive programs. In addition, government-funded research, development and demonstrations (RD&D), the U.S. Environmental Protection Agency's (EPA) Green Lights program and bulk purchases helped to perfect the technology and build the market for electronic ballasts.

The Northwest Power Planning Council (NWPPC) and the region's major electric utilities led a successful drive to transform residential construction practices in the Northwest. This effort involved development of Model Conservation Standards (MCS), demonstration projects, training and incentives for builders, and technical assistance and financial incentives to encourage local and then statewide adoption of MCS-based building codes. Most electrically-heated homes in the region now meet the MCS, with typical energy savings of 40% or more compared to previous construction practices.

Efforts to transform the market for windows, personal computers, compact fluorescent lamps (CFLs), adjustable speed drives (ASDs), and cars and light trucks have been moderately successful. Regarding windows, energy-efficient products with low-E films, argon gas fill, and improved frames have made major strides in the market, facilitated by government-funded RD&D, building codes, and availability of energy performance ratings. The energy performance of personal computers is being transformed through adoption of power management capabilities, prompted by the Energy Star recognition program. Sales of CFLs are rapidly rising due to technical improvements and utility incentives. Policy initiatives to promote ASDs have been limited, although demonstration and education projects have probably resulted in greater awareness and adoption.

Regarding vehicles, the average fuel economy of new cars doubled and that of light trucks increased by over 60% between 1973 and 1988. These advances were due largely to the Corporate Average Fuel Economy (CAFE) standards and the gas guzzler tax. Fuel economy improvements have stalled, however, as these policies have not been revised for many years and now have limited impact.

A number of conclusions can be drawn from these eight case studies.

Market Transformation Is Feasible

Our review shows that transformation of energy efficiency markets is possible. However, due to a wide range of barriers inhibiting the implementation of cost-effective energy efficiency measures, market penetration often occurs relatively slowly without policy intervention. In other words, it can be difficult to achieve widespread and lasting change in manufacturer, dealer and consumer behavior.

Market transformation can be greatly accelerated and expanded through the adoption of a combination of policies such as RD&D, stimulation of market entry, financial incentives, and efficiency codes and standards. These policy interventions can influence all phases of the diffusion process. Refrigerators, ballasts and new housing construction in the Pacific Northwest are good examples of the impact that comprehensive, integrated policies can have.

Interestingly, only in the case of new housing in the Northwest were these different program elements consciously planned as part of a comprehensive market transformation strategy. All of the other case studies involved ad hoc strategies in which the different policies were planned separately with relatively little coordination. With better integration, it should be possible to achieve more rapid market transformation and/or greater efficiency improvements.

Market transformation does not occur overnight. Many years are required to move from technology development and commercialization to widespread incorporation into new products or penetration of eligible markets. Also, policies and programs need to be sustained and periodically upgraded in order to prevent the market transformation process from stalling.

Factors Affecting the Design of Transformation Strategies

The preferred market transformation strategy varies from product to product, depending on the characteristics of the technology and the market being served. For some products such as lamps or ballasts, efficiency is a prominent feature and consumers are relatively interested in energy efficiency. For other products such as refrigerators or personal computers, energy efficiency is a hidden attribute and consumers pay little attention to energy efficiency. Some products like refrigerators or lighting products are made primarily by large companies that can perform R&D on their own. Other products such as windows or buildings are made by a large number of smaller companies that conduct little R&D.

The preferred market transformation strategy for a particular product follows from these characteristics. As discussed below, minimum efficiency requirements are appropriate for some products but not for others. Public support for R&D and demonstration is critical for some products, such as energy-efficient windows and new construction practices, but not necessarily for others. Manufacturer-oriented commercialization incentives could be valuable for products such as appliances and windows where advanced technologies are ready to be introduced. Consumer, dealer, or manufacturer incentives, on the other hand, are important for products such as CFLs or adjustable speed drives where currently available efficiency measures are underutilized and first cost is a barrier to adoption.

With both new technologies and existing but underutilized technologies, a key objective is to establish a significant initial market; a market that is sizable enough to benefit from economies of scale and to support R&D to produce improved second- and third-generation products.

The appropriate scale for market transformation efforts depends on the type of technology and market. For mass-produced devices where climate does not affect performance to a significant degree (e.g., appliances, lighting products, computers and vehicles), a national approach is appropriate. It may even be helpful to develop coordinated international strategies for certain “world products” such as office equipment, lighting technologies, or cars. But for new construction or even certain building technologies such as windows, a regional approach is desirable so that policies and programs can take into account local conditions and target key actors such as local builders or architects.

The design of a market transformation strategy also depends on the range of impacts provided by energy efficiency improvements. In the case of personal computers and energy-efficient windows, efficiency improvements provide multiple benefits (e. g. reduced internal heat generation in efficient PCs and reduction in ultraviolet light transmission with low-E windows) and “sell themselves” to a large degree. For these products, a modest amount of policy intervention may be all that is required. In the case of refrigerators, ballasts, and vehicles, efficiency improvements primarily provide energy savings and are not widely adopted on their own. More aggressive policy initiatives, including minimum efficiency standards where appropriate, are required to transform energy efficiency.

In developing a transformation strategy, there is often an appropriate role for private industry, utilities, government agencies, and other organizations. Private industry usually leads R&D and marketing efforts. Government agencies can assist with R&D and demonstrations as well as participate in bulk purchases and promotion efforts (e.g. Green Lights). Government agencies also adopt efficiency standards and building codes. Utilities can offer conventional consumer incentives as well as less traditional commercialization incentives (e.g. “Golden Carrots”). Utilities can also participate in R&D and demonstrations (primarily through organizations like EPRI and GRI) and can sponsor training, education, and evaluation efforts. Other organizations, such as the Consortium for Energy Efficiency (discussed below), can help to combine the efforts of these different parties into an integrated market transformation strategy.

Quality Assurance

Quality assurance is critical to the market transformation process. Government agencies and utilities can help to assure that energy-efficient technologies meet broad performance requirements, are properly installed, and are used in ways that maximize consumer benefits. For example, some utilities adopted power quality and light output requirements in their rebate programs, thereby improving the performance of electronic ballasts and CFLs. In the case of power-managed PCs, EPA is taking steps to ensure that these features are enabled at the factory and explained to purchasers. And training and technical assistance for builders and code inspectors helped to improve compliance with the model construction standards in the Northwest.

The Importance of Efficiency Standards

The experience across a wide range of products and end uses shows that minimum efficiency standards and building codes can play a critical role in market transformation. For products where standards are appropriate, standards alone can result in market transformation by removing inefficient products from the marketplace. Standards can greatly shorten the diffusion cycle—the time between technology introduction and full utilization—and can prevent market penetration from reaching a plateau well below the full market potential.

Standards focus the attention and R&D efforts of manufacturers on energy efficiency. Appliance manufacturers, for example, are devoting the majority of their R&D budgets to energy performance and environmental issues (R. Holding, AHAM, personal communication). Efficiency standards can even force manufacturers to develop, commercialize and/or widely use new technologies. For example, the U.S. DOE proposed a new standard for electric water heaters in early 1994 which would essentially require all electric water heaters to include heat pumps, even though the market share of heat pump water heaters is presently less than 1% (USDOE 1994; B. Mittelstaedt, DEC, personal communication).

Minimum efficiency standards are not appropriate for all energy efficiency measures or products. The feasibility of certain technologies, such as CFLs and ASDs, is application specific. These technologies cannot be mandated across-the-board.

Barriers and Limitations to Market Transformation

While past experiences with market transformation are encouraging, there are several barriers which must be overcome before market transformation efforts flourish. Also, a market transformation strategy is not appropriate for some applications.

Probably the biggest barrier to market transformation is that in order to transform markets, long-term efforts are needed that require coordination among many parties. At present, most efforts by utilities, government agencies, and other parties to promote energy efficiency do not take a long-term view. Also, coordination between utilities and agencies tends to be limited and often ad hoc. Instead each organization plans programs separately, budgets and program designs change frequently, and emphasis is placed on achieving savings in the short-term.

Utilities in particular are reluctant to make long-term commitments because of uncertainties about future regulatory policies and increasing competition in the utility industry. These issues are particularly acute for market transformation efforts because: (1) significant funds often need to be expended in the early years even though significant energy savings are not achieved until later, and (2) the success of market transformation efforts depends on long-term commitments by many parties, which increases the risks for the first utilities to commit to an effort and may allow some utilities to be "free riders" (utilities who receive the benefits of successful market transformation without contributing to the effort). Until regulatory commissions encourage and reward utilities for long-term market transformation efforts, many utilities will be reluctant to participate in such efforts.

The ability to transform energy efficiency varies among technologies and end-use markets. Of the successful market transformation efforts discussed above, all relied on a government mandate (efficiency standards, building codes, or fuel economy requirements) to complete the transformation process. For technologies that do not lend themselves to mandates, such as CFLs and ASDs, achieving the full market potential may be difficult or impossible. Furthermore, a long-term comprehensive market transformation strategy may be inappropriate for some technologies or industrial processes that are evolving rapidly and/or highly application-specific.

Future Directions for Market Transformation

Given the potential benefits of market transformation, many utilities and government agencies are interested in developing market transformation strategies for new products as well as for existing but underutilized products. For example, a recent NWPPC discussion paper suggested that demand-side management efforts in the Northwest should emphasize transforming new equipment and new construction markets (Watson and Eckman 1993). Similarly, the U.S. Climate Action Plan incorporates many initiatives to help transform markets including Golden Carrot and voluntary commitment programs and enhanced building codes and equipment efficiency standards (Clinton and Core 1993). In addition, a group of electric and gas utilities, government agencies, and public interest organizations formed the Consortium for Energy Efficiency (CEE), a non-profit organization dedicated to assisting in the development of markets for new super-efficient technologies (CEE 1994a).

Possible Targets for Future Market Transformation Efforts

Several dozen potential technologies have been suggested as possible market transformation targets. However, like any enterprise, developing market transformation strategies will take substantial time and effort, which will allow only a limited number of efforts to take shape in the early years. In an effort to help identify good targets for these initial efforts, the American Council for an Energy-Efficient Economy conducted an analysis for CEE which evaluated 31 different potential market transformation targets in terms of three factors: potential energy savings, likely cost-effectiveness, and likelihood that intervention can make a difference.

Potential energy savings were evaluated by estimating how much energy could be saved in 2010, if the markets for particular equipment or practices were successfully transformed by 2000. Under this scenario, energy is saved as new buildings and equipment incorporate specific efficiency measures. As a result, energy savings in 2010 depend on the amount of energy used in particular end-uses, the percentage by which energy use is reduced by a particular measure, the proportion of applications for which a technology is feasible, and the proportion of the equipment stock that turns over during the 2000-2010 period (no credit is taken for adoption prior to 2000). For most measures, the proportion of the equipment stock that turns over is a function of the estimated lifetime of the equipment; when the average lifetime is reached, the equipment is replaced. For a few measures where cost-effective retrofits are possible, full or partial retrofit of the existing equipment stock was also considered.

Cost-effectiveness was assessed by estimating a typical unit cost, unit energy savings, and measure life for each measure and then calculating the cost of saved energy (CSE), assuming a 5% real discount rate. The CSE can be compared to retail energy prices to estimate if a particular measure is likely to be cost-effective to consumers. Similarly, if a measure has a CSE of less than approximately $0.05/kWh for electricity or $4.00/MMBtu for natural gas, it is likely to be less expensive than the long-run marginal energy prices used by many utilities (see for example Nadel et al. 1994).

Responsiveness to market intervention was assessed qualitatively using an "excellent", "good" and "fair" scale. An "excellent" rating was assigned to technologies for which change is easy and low-cost, or for which the market is presently subject to standards or codes. A "good" rating was assigned to technologies for which the market is open to intervention or for which the U.S. Congress has authorized DOE to set efficiency standards. A "fair" rating was assigned to technologies for which the market has responded poorly to policy and program initiatives.

Results of the analysis are summarized in Table 1. Detailed assumptions and sources can be found in the complete analysis (Nadel 1994). Of the 32 products examined, potential energy savings varied from 0.03 quadrillion (10^{15}) Btu (Quads) to 1.41 Quads. By way of comparison, the Energy Information Administration projects 105 Quads of energy use in the U.S. in 2010 (EIA 1994). Savings total more than 7 Quads (allowing for some overlap between measures) if successful market transformation occurred for all of the technologies, which would reduce projected U.S. energy use in 2010 by approximately 7%. The CSE varies from $0.0-0.095/kWh and from $0.08-11.80/MMBtu. 91% of the measures have CSE's less than present residential and commercial retail energy prices (approximately $0.08/kWh or $6.00/MMBtu) and 78% meet the utility marginal cost criteria discussed above.

Based on these ratings, eight high priority technologies were identified which have: (1) an estimated energy-saving potential of more than 0.20 Quads; (2) a cost of saved energy less than $0.05/kWh or $4.00/MMBtu; and (3) a receptivity to intervention rating of good or excellent. These technologies are listed in Table 2. Of the technologies examined (see Table 1), the eight priority technologies are all among the ten largest energy savers. Two high-savings technologies—ASDs and gas engine-driven heat pumps are not included in the high priority list because of lower likelihood of success (for ASDs) and high cost of saved energy (for the gas-fired heat pump). For each of the high priority technologies, appropriate market transformation strategies differ. Possible strategies for each technology are summarized in Table 2. Recent efforts to develop strategies to promote market transformation for these high priority technologies are discussed below.

Heat pump water heaters have the largest potential savings of the priority technologies. Heat pump water heaters have been on the market for more than a decade but have not garnered significant market share due to high costs, reliability problems with early models, and lack of an installation and maintenance infrastructure. In the early 1990s, new heat pump water heaters were introduced to the market with installed costs significantly less than earlier models, and/or with improved designs to address reliability problems (CEE 1994b). Based on these promising developments, the U.S. Department of Energy proposed new efficiency standards for electric water heaters that would essentially mandate that as of about 1998, all electric water heaters must be heat pump water heaters. A final decision on this standard is expected in early 1995 (USDOE 1994). In addition, a group of electric utilities working through CEE has begun to investigate a coordinated utility program to promote heat pump water heaters. This program-which is likely to include bulk purchases, contractor training, and consumer financing and education (CEE 1994b)—could provide a bridge between the present situation and a nationwide minimum efficiency standard.

Research has found that leaks in duct systems can be a significant source of energy waste, increasing energy use for space heating and cooling by as much as 30%. Present remedies include leak detection using blower doors, pressure/flow sensors, and smoke sticks; and leak sealing using mesh tape and mastic. While these methods can be effective, they are also labor intensive and expensive, and can be impossible when ducts are inaccessible. To address this problem, researchers at Lawrence Berkeley Laboratory have developed aerosol compounds that are sprayed inside existing ducts. The technique is projected to reduce the cost of duct sealing to approximately $100 per home (Nadel et al. 1993). Field tests are scheduled for 1994, and discussions about commercialization have begun. Funding for this work is being provided by DOE, EPA, EPRI, and the California Institute for Energy Efficiency. The developers hope for commercialization by 1996 (M. Modera, LBL, personal communication). Assuming these efforts are successful, efforts will be needed to train HVAC contractors, educate consumers and promote duct sealing, and evaluate performance and assure quality when duct sealing is widely practiced.

As mentioned earlier, significant progress has been made in increasing sales of CFLs in the residential and commercial lighting markets. A number of initiatives are now taking shape that will further boost the CFL market. First, manufacturers continue to improve the product. For example, CFLs of equal size and light output of a 60 Watt incandescent lamp were commercialized in 1993 (Atkinson 1994). Manufacturers are now trying to develop products that are truly equivalent in size and light output to a 100 Watt incandescent lamp. Second, under a provision of the Energy Policy Act of 1992, the Federal Trade Commission has developed a labeling program for general service incandescent and compact fluorescent lamps. These labels, which will be on all product packages, will facilitate consumer comparisons between incandescent lamps and CFLs (FTC 1994). Third, CEE is working with EPA and a consortium of utilities and public interest groups to develop a program in which many utilities will pay incentives to manufacturers in order to reduce the cost of CFLs sold in local retail stores. Manufacturers will compete for the utility subsidies based on technical specifications such as product efficiency and size, and marketing factors such as cost reductions pledged by manufacturers and size of the local distribution network. This program is expected to include public education campaigns by EPA, local utilities, manufacturers, and local retailers (CEE 1994c).

Table 1. Analysis of Potential Technologies to Target for Future Market Transformation Initiatives

	Technology	End-Use Energy Use 2010		Base Effic.	New Effic.		Equipment Life (years)	Potential Energy Savings in 2010 (Quads)	Cost of Saved Energy	Units	Likelihood Intervention Could Make A Difference
1.	Non-residential ASDs*	1675	TWh	--	25	% svgs	15	1.41	$.01-.05	/kWh	Fair
2.	Res. heat pump water heater	134	TWh	0.88	1.89	EF	10	0.68	$0.034	/kWh	Excellent
3.	Res. gas engine-driven heat pump	4.02	Quads	0.80	1.29	AFUE	23	0.66	$7.74	/MMBtu	Good
4.	Res. retrofit duct sealants*	6.30	Quads	--	15	% svgs	15	0.47	$1.32	/MMBtu	Good
5.	Res. compact fluorescent lamps	121	TWh	16	60	lpw	9	0.46	$0.023	/kWh	Good
6.	Low-e argon wood/vinyl windows**	4.51	Quads	0.58	0.36	U-value	40+	0.41	$2.41	/MMBtu	Excellent
7.	Res. clothes washers	1.14	Quads	1508	783	kWh/yr	14	0.39	$0.038	/kWh	Excellent
8.	Res. coated filament lamp	121	TWh	16	50	lpw	3.5	0.34	$0.018	/kWh	Good
9.	Res. central air-cooled A/C & hp	140	TWh	10.5	14.0	SEER	12	0.31	$0.050	/kWh	Excellent
10.	Comm'l packaged A/C	135	TWh	10	14	IPLV	15	0.24	$0.048	/kWh	Excellent
11.	Super-effic. refrigerator (SERP)	114	TWh	704	493	kWh/yr	19	0.19	$0.039	/kWh	Excellent
12.	Ind'l fractional & 1-phase motors	129	TWh	55	75	% effic	10	0.18	NA	/kWh	Good
13.	Comm'l packaged refrigeration	45	TWh	--	48	% svgs	10	0.18	Low	/kWh	Good
14.	Comm'l hi-effic luminaires	296	TWh	68	80	% effic	20	0.18	$0.051	/kWh	Fair
15.	Res. showerheads	0.74	Quads	2.5	1.5	gpm	20	0.15	$0.08	/MMBtu	Excellent
16.	Res. luminaires for CFLs	121	TWh	16	60	lpw	20	0.14	$0.058	/kWh	Fair
17.	Res. clothes dryers	0.32	Quads	3.01	8.61	EF	17	0.12	$0.095	/kWh	Excellent
18.	Res. halogen IR lamp	121	TWh	16	21	lpw	2	0.12	$0.064	/kWh	Good
19.	Res. hi-effic gas water heaters	1.32	Quads	0.55	0.63	EF	14	0.12	$3.82	/MMBtu	Excellent
20.	Post-SERP refrigerator	80	TWh	493	361	kWh/yr	19	0.12	$0.060	/kWh	Excellent
21.	3-glaz. low-e argon vinyl windows**	1.74	Quads	0.36	0.20	U-value	40+	0.11	$5.57	/MMBtu	Good
22.	Comm'l daylight dimming	229	TWh	--	30	% svgs	20	0.11	$0.019	/kWh	Good
23.	Res. elec ground source hp**	113	TWh	1.74	3.92	Avg.COP	20	0.09	$0.045	/kWh	Good
24.	Ind'l air compressors	73	TWh	--	15	% svgs	10	0.09	$.01-.03	/kWh	Good
25.	Res. tight duct fittings	6.30	Quads	--	20	% svgs	25	0.09	$1.46	/MMBtu	Excellent
26.	Comm'l heat pump water heaters	14	TWh	98	300	% effic	10	0.08	$0.04	/kWh	Excellent
27.	Low-energy copiers	13.51	TWh	--	50	%savgs	5	0.07	$0.00	/kWh	Good
28.	Chillers	83	TWh	0.64	0.53	kW/T	22	0.06	$0.020	/kWh	Good
29.	Res. dishwashers	0.28	Quads	0.46	0.61	EF	13	0.05	$0.016	/kWh	Excellent
30.	Ind'l pumps	131	TWh	--	8	% svgs	15	0.05	$.02-.03	/kWh	Fair
31.	Ind'l integral horsepower motors	515	TWh	90.0	91.7	% effic	15	0.04	$0.000	/kWh	Excellent
32.	Ind'l fans	62	TWh	--	10	% svgs	15	0.03	Low	/kWh	Fair

Notes:

* Retrofit measures -- 100% penetration in 2010 is assumed.

** Measures for both new construction and retrofit -- analysis assumes 100% penetration in new construction for 2000-2010 period plus replacement sales equal to new construction sales.

Table 2. Prime Targets for Market Transformation Strategies

Product	Possible Mechanisms
Heat pump water heaters	Bulk purchases, incentives, contractor training, standards
Duct sealants	R&D, demonstrations, contractor training and quality control, consumer education, incentives
Compact fluorescent lamps	Continued product improvements, incentives, consumer education, develop retail infrastructure
Low-E, argon-filled wood/vinyl-framed windows	Labeling, builder education, utility incentives, building codes, perhaps standards
Clothes washers	R&D, demonstrations, incentives, standards
Incandescent lamps	R&D, "Golden Carrot" incentives, standards
Residential central A/C & heat pumps (air source)	Incentives and standards
Commercial packaged A/C	Demonstration projects, incentives, standards

Low-emissivity (low-E) windows have been steadily gaining in market share as costs decline, improved performance testing and information programs are introduced, and building code requirements are tightened. The National Fenestration Rating Council (NFRC) has begun a rating and labeling program which allows builders and consumers to compare the energy performance of windows (NFRC 1993). Some utilities now provide incentives for use of low-E windows in new construction. In addition, recently commercialized “southern low-E” film reduces the amount of solar heat gain through windows, providing substantial cooling energy savings in hotter climates (EDU 1994). Due to the success of these efforts, low-E windows are cost-effective in most climates and should be incorporated into local and state building codes, as well as national voluntary codes upon which many state and local codes are based. For example, Oregon has adopted performance-based requirements for window U-value that effectively requires low-E windows in new homes (J. Rivera, National Fenestration Rating Council, personal communication). In some states, utility incentives may be needed to lay the groundwork for building code requirements as well as to stimulate adoption of energy-efficient windows in the replacement market. In addition, LBL has begun to research the feasibility of window efficiency standards (S. Selkowitz, Lawrence Berkeley Laboratory, personal communication).

Two clothes washer efficiency improvements—horizontal-axis designs (which reduce hot water use) and high spin speeds (which extract more water from clothes, reducing dryer energy use), can reduce energy use for home laundering by nearly 50%. These high-efficiency washers are widely sold in Europe, but U.S. consumers and manufacturers have been resistant to the changes. However, three efforts are beginning to change this picture. First, EPRI and a major manufacturer are developing a new high efficiency horizontal-axis washer (J. Kesselring, EPRI, personal communication). Other major manufacturers also report that they are developing new horizontal-axis models (HFD 1993). Second, CEE has developed a utility incentive program to stimulate commercialization and sales of high efficiency washers under which participating utilities will use similar rebate eligibility levels (CEE 1993). Third, DOE has announced that it is considering requiring efficiencies achieved only with horizontal-axis designs when it sets new efficiency standards (due to be published in 1996, and to take effect in 1999). Washer spin speed will also be an important issue during the process to set this standard (USDOE 1990). The success of the first two efforts could influence DOE’s decision on new standards.

While improved CFLs are introduced each year, which increase the number of applications where CFLs can be successfully used, there remain many applications where general service incandescent lamps must be used due to their size, price, color, and other attributes. Researchers have been striving for many years to develop new incandescent products that are much more efficient than standard incandescent lamps; among the ideas being pursued in the laboratory are halogen infrared-reflective lamps, hafnium carbide single-whisker filament lamps, and coated filament lamps. Research on these and other technologies is now being conducted by manufacturers, DOE, and EPRI (Nadel et al. 1993). As a complement to ongoing

R&D, CEE is considering sponsoring a "Golden Carrot[SM]" contest to encourage manufacturers to develop and commercialize an incandescent lamp that is up to twice as efficient as standard incandescent lamps.

Residential central air conditioners presently on the market range in efficiency from SEER 10 to more than 16. In areas with utility rebates, units with SEERS of 11 and 12 are widely sold. However, few units are sold with SEERS of 14 or more, due to high unit costs, limited availability, and modest utility incentives for these very efficient units. To address these problems, CEE has developed a program under which participating utilities would use similar rebate eligibility levels, just like in the CEE clothes washer program. An important component of the proposed program is that eligibility is determined on the basis of both SEER (a measure of average seasonal performance) and EER (a measure of performance at peak load). By focusing on EER as well as SEER, significant peak savings should result with very high efficiency units, allowing utilities to afford higher rebates for units of SEER 14 or more (CEE 1994c). In addition, the U.S. Department of Energy is presently conducting a proceeding to determine new efficiency standards for central air conditioners and heat pumps. The new standards, if released on schedule, will take effect in 1999 (USDOE 1993). Utility incentive programs may influence this proceeding.

Approximately two-thirds of commercial cooling loads are served by packaged systems (assembled in a factory and shipped to the construction site ready to install). These systems tend to be the least costly commercial cooling system, and there is intense price competition between manufacturers. As a result, efforts to improve unit efficiency have been limited. This situation has begun to change. In 1992 the U.S. Congress established minimum efficiency standards for packaged commercial air conditioners and heat pumps up to 240,000 Btu/hour cooling capacity. In 1994 CEE developed a program to promote commercial packaged cooling systems at least 10% more efficient than the Federal standard. The centerpiece of this program is a two-tier rebate eligibility scheme. In part due to this program, several major manufacturers brought new units to market in 1993 and 1994 that meet CEE's first threshold. Research and demonstration projects are underway to develop and test units meeting CEE's second threshold (CEE 1994d). In addition, ASHRAE has begun to develop new efficiency standards for packaged commercial air conditioners as part of its model building code. Once ASHRAE's work is completed, DOE will establish revised efficiency standards for these products. These standards are likely to equal or exceed CEE's first tier, but expanded efforts to promote CEE's second tier are probably needed before manufacturers introduce qualifying high efficiency units.

In addition, work has begun to develop strategies for some of the other technologies listed in Table 1 including next generation refrigerators, packaged commercial refrigeration equipment, showerheads, ground source heat pumps, and industrial fans, pumps and compressors (CEE 1994a). Thus, considerable progress has been made toward developing market transformation strategies for many of the highest-rated technologies. However, extensive work is still needed to complete the development of these strategies and then successfully implement them.

Generic Policy Issues

In order for some of the market transformation efforts now in the planning stages to succeed, additional actions are needed to address some of the barriers to market transformation discussed above. First, for each technology target, there is a need to develop a coherent long-term market transformation strategy. The efforts discussed above generally involve coordinated efforts among multiple organizations, and a several year commitment, but many fall short of a true integrated long-term strategy. In some cases, such strategies could be developed now, based on a series of meeting among interested parties including utilities, manufacturers, and government agencies. In other cases, proceeding to a long-term strategy will be a gradual effort, and can only take place as the different organizations become comfortable working together and making long-term commitments.

Second, evaluation approaches need to be developed to assess the success of market transformation initiatives. If utilities and government agencies are going to invest substantial resources in transformation of end-use energy efficiency markets, they need to determine if their investments are delivering the desired results. Such determinations are typically made by evaluating the impacts of programs and policies retrospectively. Evaluations of successful past programs provide some assurance that similar investments will be productive in the future. While evaluation of traditional energy efficiency programs (e.g., grants or utility DSM programs) is commonplace, relatively little information is available on the success of market transformation efforts. In particular, methods need to be developed and tested to estimate what would have happened to markets if transformation strategies were not employed and to estimate the number of consumers who purchase efficient equipment but do not participate in a formal program such as a utility rebate program. In 1993, evaluation professionals began to address these issues (Prahl and Schlegel 1993, Kitchine 1993). Further work is needed so that policy makers can determine whether market transformation strategies are working and how they can be improved.

Third, since utilities are likely to play a pivotal role in most transformation initiatives, and since potential changes in the utility industry make utilities leery of making long-term DSM commitments, utility commissions and other government agencies need to support and reward utilities for participating in successful market transformation efforts. Rewards can range from public recognition, along the lines of EPA's Green Lights program, to financial incentives, just like many utilities now receive financial incentives for successfully implementing conventional DSM programs. Financial rewards for market transformation should be based on evaluation results, and should be proportionate to the risks utilities incur and the benefits that are produced for society.

Developing and implementing market transformation efforts will require extensive coordination and commitment on the part of many organizations. However, given the success of several past market transformation efforts, further implementation of comprehensive market transformation strategies is likely to be amply rewarded in terms of energy savings, economic gains, and environmental protection. Through effective market transformation, society can realize the large-scale and broad benefits offered by greater energy efficiency.

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