DEMAND-SIDE MANAGEMENT

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What is DSM?

Demand-side management (DSM) refers to active efforts by electric and gas utilities to assist customers in modifying their use of energy (Battelle-Columbus Division and Synergic Resources Corporation, 1984). DSM encompasses a variety of activities designed to change the level or timing of customers' energy consumption. Most discussion of DSM focus on programs that help customers save energy by encouraging them to adopt energy-efficient measures or practices (see categories one through five below), such as rebate programs that lower the first cost to customers of purchasing energy-efficient refrigerators. However, other DSM programs promote changes in the "shape" of a utility's load (see categories six and seven below), such as high electricity rates during times of the day when it is expensive for utilities to generate electricity to encourage customers to shift power consumption to other times of the day.

U.S. utility DSM programs can be divided into seven categories:

(1) general information to increase customers' awareness of their energy use patterns and opportunities to use energy more efficiently. Almost all utilities provide general information, ranging from educational brochures about subjects such as turning off gas-furnace pilot lights during warm months to bill inserts describing energy-efficient products and services. General information is also distributed through advertisements and by utility representatives.

(2) targeted technical information, including audits of customers' current energy use patterns, accompanied by recommendations for ways to use energy more efficiently. Audits have typically been offered free of charge; some utilities are now experimenting with charging fees.

(3) financial assistance -- loans or direct payments -- to lower the cost of purchasing energy-efficient technologies. Cash payments or rebates have been the most popular type of DSM program. Rebates reduce some or all of the cost of purchasing and installing an energy-efficient technology. Rebates can be fixed payments per unit (e.g., a $100 coupon to reduce the first cost of an energy efficient refrigerator) or payments that lower the initial cost of a technology to some predetermined level (e.g., to ensure that the energy saved will pay for the extra cost of buying a more energy-efficient refrigerator rather than one of standard efficiently within three years of purchase). Some utilities offer low-interest loans in place of or in conjunction with rebates. When given a choice, customers generally prefer rebates to loans. Utilities interested in achieving large impacts from their programs over a short period of time have therefore devoted a much larger share of DSM budgets to rebate programs than to loans (Nadel 1992).

(4) direct installation of energy-efficient technologies involves sending utility staff or utility-hired contractors to a customer's premises to provide energy audits and install pre-selected energy-saving technologies at no charge to the customer. Because utilities pay the full installation cost, these DSM programs are frequently the most expensive to operate, as measured by the cost of energy saved. Utilities have typically offered installation programs either as a last resort— for example, when there is an imminent threat of supply shortfall— or to serve particular market segments (e.g., low-income residential customers) that have proven difficult to reach with other DSM programs.

(5) performance contracting, in which a third party, often an energy service company (ESCO), contracts with both a utility and a customer to provide a guaranteed level of energy savings. Performance contracting programs have either involved competitive bidding, in which ESCOs and customers make proposals to the utility, or "standard offers," in which the utility agrees to pay for energy-saving projects at a fixed price per unit of energy saved. Payment is contingent on verification that the customer actually saves the amount of energy guaranteed in the contract. When an ESCO enters into a performance contract with a utility, the ESCO must recruit utility customers and form a separate contractual relationship with them so that the ESCO can finance and install energy-saving technologies and verify their performance. Performance contracting has mainly involved business (i.e., commercial) and industrial, rather than residential, customers.

(6) load control/load shifting, in which a utility offers payments or bill reductions in return for the ability to directly control a customer's use of certain energy-consuming devices or to assist the customer in installing a device, which alters the timing of demands on the electric system. In load control programs, utilities directly control some customer appliances during periods when demand for power is high, e.g. extremely warm days when increased cooling energy use causes heavy power system loads. Load-control programs rotate groups of appliances (typically water heaters or central air conditioners) on and off for short periods of time, reducing net loads on the power generation system. These programs have usually involved residential customers. Customers can also control loads by adopting load-shifting technologies (such as thermal storage, which allows a customer to use power when rates are low, e.g. at night, to generate and store heating or cooling to be used at other times of day when rates are high) that alter the timing of the customer's load. "Valley-filling" is used to describe programs that shift (or increase) customer loads to times of day when utility system loads and production costs are low.

(7) innovative tariffs that make it cost effective for customers to reduce or change the timing of energy use. These tariffs include interruptible rates, time-of-use rates, and real-time pricing. An interruptible rate is similar to a load-control program; a customer pays a lower rate in return for agreeing to curtail loads whenever requested by the utility. The customer, rather than the utility, determines which loads to reduce when the request is made. Time-of-use rates set different prices for energy used during different times of day, based on the utility's costs of generating power at those times. Real-time pricing is a sophisticated form of time-of-use rates, in which a utility typically gives customers a forecast of hourly energy prices one day in advance. With both time-of-use rates and real-time pricing, customers respond by changing energy use to reduce their costs. Innovative pricing programs have targeted primarily industrial and large commercial customers.

History of U.S. Electric Utility DSM Programs

The history of DSM in the U.S. is dominated by the activities of electric utility companies. Historically, electricity service was considered a natural monopoly; it was thought that only one company in a geographic region could efficiently capture the economies of scale offered by electricity generation, transmission, and distribution technologies. In the U.S., two primary institutions arose to secure the public benefits associated with increased electrification: publicly owned municipal utilities were established in some large cities and governed by city councils; privately owned utilities were also formed, governed by state regulatory authorities. More than 80 percent of the electricity produced and sold in the U.S. comes from privately owned utility companies that generate, transport, and distribute power (EIA 1998).

For much of their history, U.S. electric utilities promoted new uses of power in order to increase their sales and thus their profits. However, during the 1970s, the dramatic rise in world oil prices and growing concern about the environmental impacts of electricity generation (especially those associated with reliance on nuclear power) led to a new emphasis on conserving energy.

In 1978, the federal government passed the National Energy Conservation Policy Act (NECPA). Among other things, NECPA required utilities to offer on-site energy audits to residential customers. This law was an acknowledgment that saving energy could be cheaper than producing it. We now recognize NECPA as the beginning of modern utility DSM programs.[1] NECPA encouraged utilities to create, staff, train, and maintain internal organizations devoted to helping customers reduce their electricity use. Prior to this time, utility staff efforts were focussed on serving customers and on promoting new uses for electricity.

After increasing modestly up through the mid-1980s, U.S. electric utility DSM programs began to increase dramatically during the late 1980s as a handful of states began to direct their regulated utilities to formally adopt least-cost or integrated resource planning principles. The term *least-cost planning* was introduced by energy-efficiency advocates to describe a planning process different from the one traditionally employed by utilities.

In the traditional process, utilities planned for and acquired new sources of power based on two presumptions: First, there were economies of scale in generation technology, such

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1 In fact, California and Wisconsin authorized utility DSM programs as early as 1975; these programs were the very first DSM programs, predating NECPA.

that new investments in ever-larger power plants resulted in lower costs for all (which had in fact been observed over the prior 40 years). Second, there were few opportunities to save electricity cost-effectively, so that the loads to be met by these new power plants could not be altered.

Least-cost planning, in contrast to both presumptions, was based on the realization that conserving energy could often be less expensive than building new power plants (Lovins 1976). The recognition that large-scale utility programs could measurably affect future electricity demands gave rise to the term *demand-side management*. Conceptually, least-cost planning differed from traditional planning by treating future load growth as an *outcome* of a planning process rather than as a fixed *input* to that process. Thus, planners had to give equal consideration to both supply- and demand-side options, as resource alternatives for meeting customer's energy needs (Krause and Eto 1988).

Regulatory efforts to encourage utilities to undertake DSM programs were bolstered by growing evidence of the low cost of technologies that could reduce electricity demand by increasing the efficiency with which energy was used. Energy-efficiency advocates conducted numerous technical analyses showing that substantial amounts of energy could be saved for much less than the cost of building new power plants with no change in the level of amenity provided to the customer (SERI 1981). Least-cost planning advocates argued that utilities should pursue these demand-side options whenever they were less expensive than supply-side alternatives they could displace (Cavanagh 1988). A number of "market barriers" to consumers choosing cost-effective energy-efficient technologies were identified (Blumstein, et. al. 1980). DSM programs overcame these barriers by providing information and financial incentives to assist customers in selecting energy-efficient technologies that would lower their energy costs.

The Growth in Utility DSM Programs

Regulators responded to this evidence by encouraging utilities to pursue energy efficiency aggressively by increasing the size and scope of their DSM programs whenever it could be shown that energy efficiency was a cheaper "resource" alternative than investments in new generating plants. While there had been little utility resistance to the original directives of NECPA, many utilities actively resisted suggestions by their regulators to pursue least-cost planning in general and DSM in particular.

As political pressure to pursue least-cost planning strategies grew, regulators began to recognize that utility resistance could be traced to long-standing regulatory approaches that had been developed to encourage sales of electricity when the (then) increasing economies of scale meant that increased consumption led to lower costs for all. As a result, utilities had had a powerful financial incentive to increase earnings by encouraging customers' consumption and constructing capital-intensive, new power plants to meet growing demand. These incentives made aggressive pursuit of activities that would reduce sales contrary to the business interests of the utility (Moskovitz 1989).

Two regulatory strategies were developed to overcome utilities' incentive to sell electricity and to insure that investment in programs to reduce customer demand would not represent a financial burden to utilities. The first strategy compensates utilities for sales "lost" as a result of cost-effective DSM programs (Baxter 1995). The second "decouples" revenue from sales by establishing a revenue target that is independent of the utility's sales and creating a balancing account to compensate for the difference between revenues actually collected and the revenue target (Eto, Stoft, and Belden 1994). By making total revenues are independent of actual sales volumes in the short-run, these approaches took away utilities' incentives to increase loads.

Some states created separate financial incentives for the delivery of superior DSM programs. Three types of incentives have been used (Stoft, Eto, and Kito 1995). In the first, utilities earn a percentage adder on money spent on DSM. In the second, utilities earn a bonus paid in \$/kWh or \$/kW based on the energy or capacity saved by a DSM program. In the third, utilities earn a percentage of the net resource value of a DSM program. Net resource value is measured as the difference between the electricity system production costs that the utility avoids because of the program(s) and the costs required to run the program(s). These new incentives were instrumental in stimulating growth of DSM energy-efficiency programs.

The effect of this efforts to re-align the financial interests of utilities with the public interest in pursuit of energy efficiency whenever it cost less than generating more electricity, was a dramatic increase in utility spending on DSM programs. Spending increased in significance to the point that U.S. Energy Information Administration began tracking DSM expenditures formally in their annual survey of utility operations. These surveys revealed that DSM spending by U.S. electric utilities had increased dramatically from \$0.9 billion in 1989 to \$2.7 billion in 1994[2] (see Figure 1). Electric utility DSM programs reached their largest size in 1993, accounting for more than \$2.7 billion of utility spending or about one percent of U.S. utility revenues.

The record of utility achievements demonstrated that DSM energy efficiency programs were able to save electricity cost effectively. In the most comprehensive analysis to date, an examination of the 40 largest energy efficiency programs targeted to the commercial sector (i.e., office buildings, retail establishments, schools, etc.) showed that these programs had saved energy at an average cost of 3.2 ¢/kWh and that they were highly cost effective when compared to cost of electricity generation they allowed the sponsoring utilities to avoid (Eto, Kito, Shown, and Sonnenblick 1995). However, not all utilities were equally effective in running energy-efficiency DSM programs. The study also found that some utilities, notably those with large DSM programs, had saved energy at cost of less than 2 ¢/kWh, while others had saved energy at a cost in excess of 10 ¢/kWh.

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2 1989 was the U.S. Energy Information Administration's first year of comprehensive data collection on utility DSM spending. Anecdotally, many believe spending in 1989 doubled from a relatively static level of spending throughout most of the 1980s.

The Future of DSM

Currently, the U.S. electric utility industry is in the midst of changes that have and will continue to affect the future of DSM. Starting in 1994, states began actively discussing restructuring their electricity industry to allow customers to choose their supplier of electricity and to increase competition among electricity generators. Utilities responded predictably to this threat of competition. First, they have actively sought regulatory protection for assets whose book value was in excess of current market prices. They also began aggressively cutting costs in all areas, including DSM. According to EIA, total DSM spending in 1997 had declined to $1.6 billion (from a high of $2.7 billion in 1993). By 1998, several states had restructured their electricity industry and many other states are expected to follow this trend.

In a fully restructured industry, utilities become essentially regulated power distribution companies with only an obligation to connect all customers to the power grid but with no obligation to plan and acquire generation to serve all customers. When utilities are relieved of the obligation to serve certain customers, they are also relieved of the obligation to use least-cost planning principles to acquire resources (including demand-side energy efficiency improvements) on behalf of these customers.

Although electricity industry restructuring renders the traditional utility monopoly franchise obsolete, the public purposes that are served by utility DSM programs remain whenever market barriers prevent cost-effective energy efficiency decisions from being made. Restructuring offers the promise that reliance on market forces to set electricity prices will better reflect the true value of electricity than will continued reliance on regulatory authorities to fix prices. If successful, elimination of regulatory mis-pricing would address an important historic market barrier to energy efficiency. However, it is unlikely that restructuring will address all the market barriers that prevent cost-effective energy efficiency actions from being taken. For example, the environmental consequences of electricity generation in particular, which are not currently reflected in the market prices paid for electricity, remain a strong argument for continuing energy-efficiency programs.

In the past, utilities were in a unique position to promote public interest in energy efficiency through DSM programs; they had: (1) access to low-cost capital; (2) name recognition among customers and acknowledged technical expertise; (3) lack of direct financial interest in promoting particular energy-efficiency products or services; (4) access to detailed information on customer energy-use patterns; and (5) a system for billing customers for services. Whether utilities will retain these desirable features following restructuring is not known because it will depend on decisions that yet to be made by regulators on the organization and rules governing the firms operating in the market.

For example, it is clear that many utilities plan to offer DSM programs as a feature to keep and attract customers. Non-utility energy service providers have become concerned that ratepayer funding for DSM programs will be used unfairly to subsidize utility development of business opportunities that will be pursued as unregulated profit-making activities.

They argue that utility managers already face conflicts of interest when delivering ratepayer-funded DSM programs that historically served broad public interests, while at the same time attempting to maximize shareholder returns by using these programs to keep utility customers from switching to other suppliers or to increase the utility's dominance in local energy-efficiency service markets.

In a restructured electricity industry, utilities are concerned that including DSM program costs in their regulated rates puts them at a competitive disadvantage compare to other power providers, which are not also required to charge for DSM. A surcharge to recover DSM program costs levied on all electricity users regardless of their suppliers eliminates this concern. As of 1998, 12 states had adopted these surcharges to continue funding for DSM programs as well as, in some cases, funding for other "public purpose" activities, such as research and development or promotion of renewable energy.

Some states are expected to rely on utilities with good past records to continue to administer DSM programs if the utilities can mitigate conflicts of interest. If local utilities have had poor past performance with DSM or cannot mitigate conflicts of interest, states may consider: (1) administration by an existing or newly created government agency, and (2) administration by an independent, possibly nonprofit entity (Eto, Goldman, Nadel 1998). Both alternatives raise questions of governance and accountability for the administration of funds.

Summary

Demand-side management programs have been a bold experiment in the active promotion of energy efficiency by U.S. electric and gas utilities. By and large, they have demonstrated that market barriers, which constrain consumers' abilities to lower their energy costs, can be successfully and cost-effectively addressed by well-designed and targeted programs. To date, these programs have represented billions of dollars in utility investments that have allowed utilities to avoid even more costly and environmentally damaging power plants. As the utility industry is restructured, many are hopeful that regulators will continue to enact policies that successfully align utility interests with pursuit of cost-effective energy efficiency opportunities.

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