GAO

Report to the Chairman, Environment,

Subcommittee, Committee on Government Operations, House of Representatives

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ELECTRICITY SUPPLY

Utility Demand-Side Management Programs Can Reduce Electricity Use

GAO United States
General Accounting Office
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Resources, Community, and
Economic Development Division

B-245613

October 31, 1991

The Honorable Mike Synar
Chairman, Environment, Energy, and
Natural Resources Subcommittee
Committee on Government Operations
House of Representatives

Dear Mr. Chairman:

On December 21, 1990, you asked us to examine the potential electricity savings that could result from utility programs that are designed to increase the efficiency of electricity use, and to review the progress of states, utilities, and federal power agencies in encouraging more efficient electricity use. This report discusses these issues as well as some of the barriers faced by utilities and others in fostering further increases in efficiency.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to appropriate congressional committees, federal power marketing administrations, state regulatory agencies, and the Tennessee Valley Authority. We will also make copies available to others upon request.

This work was performed under the direction of Victor S. Rezendes, Director, Energy Issues, who can be reached at (202) 275-1441. Other major contributors are listed in appendix III.

Sincerely yours,

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

According to the Department of Energy (DOE), to meet electricity demand in 2000, the nation may need more than 100 new large power plants. Because utility-sponsored programs promoting more efficient electricity use, called "demand-side management" (DSM) programs, can help avoid the costs and environmental concerns associated with power plants, the Chairman, Environment, Energy, and Natural Resources Subcommittee, House Committee on Government Operations, asked GAO to examine (1) the potential for utility-sponsored DSM programs to reduce future electricity demand; (2) impediments to the effectiveness of DSM programs; and (3) efforts by utilities, states, and federal power marketing agencies to encourage efficient electricity use.

Background

DOE and others estimate that electricity use in the nation will increase by up to 2.4 percent annually through 2000, requiring new generating capacity. In addition to its dollar cost, new capacity often raises environmental concerns. In part to lessen new capacity needs, utilities have launched DSM programs that, among other things, encourage consumers to use less electricity by such actions as insulating their homes and businesses, and replacing appliances and other devices with more efficient models. The power thus "saved" is then available to serve new demand.

U.S. electric utilities typically operate without direct competitors in their service areas and are regulated at the state level. Generally, state regulators set retail electricity rates (prices) that allow utilities to earn an established rate of return on their investment. Historically, regulators set rates so that utilities increased their returns mostly by selling more power.

Results in Brief

Regulators and utilities in nine selected states, accounting for over one-third of U.S. electricity consumption, project that DSM programs will eliminate up to 15 percent of the total electricity demand that would otherwise exist in 2000. In some states, DSM programs are expected to avoid more than half of the growth in electricity demand that would otherwise occur by 2000.

Factors ranging from consumer behavior to regulatory disincentives inhibit the implementation of utility DSM programs. Consumers may be unwilling to accept more efficient devices that would reduce their electric bills because the purchase prices of the devices may be higher than prices for less efficient models. Under traditional rate regulation, utilities may be reluctant to implement aggressive DSM programs because, while utilities earn a return on approved investments in capacity, they earn no return on DSM programs. Moreover, because electricity demand reductions from DSM programs are hard to measure and estimate accurately, "saved" electricity is regarded as a less certain means of meeting electricity requirements than new power plants.

To counter these impediments, efforts are being made by (1) utilities, to aid customers financially in acquiring energy-efficient devices; (2) state regulators, to "decouple" utilities' profits from electricity sales and to provide financial DSM incentives for utilities; and (3) state regulators and others, to promote accurate and consistent measuring and reporting of DSM program costs and electricity savings.

Federal power marketing agencies' efforts to encourage DSM programs among their customer utilities vary significantly. For example, the Bonneville Power Administration conducts and funds comprehensive electricity conservation programs, while the Southwestern Power Administration primarily loans efficient equipment to its customer utilities and offers them information on how to promote energy efficiency to end-use customers. The agencies' programs differ in part because the agencies do not operate under the same statutory authorities.

Principal Findings

Potential for Electricity Demand Reductions

In the states GAO reviewed, state and utility officials estimated that DSM programs will reduce total electricity demand by up to 15 percent. These estimates are utilities' and regulators' best estimates of the extent to which DSM programs can be relied upon to satisfy demand for power. Other regional and/or national estimates of electricity savings that GAO found were in the same range. DSM programs are expected to avoid substantial portions of anticipated demand growth in the 1990s. For example, California DSM programs are expected to reduce the total electricity demand by about 15 percent in 2000; this is the equivalent of reducing about 61 percent of the additional demand that is expected by that year.

Impediments to Increased Efficiency

Studies by Oak Ridge National Laboratory and others suggest that consumers often demand greater rates of return on energy-efficiency investments than on other investments. Consumers may not adopt more efficient devices, even when doing so would be economically advantageous, because they lack information or funds or because of inadequate marketing channels for energy-efficient devices. For example, a cash-short consumer may buy a less expensive, but less energy-efficient refrigerator, although a more expensive, more efficient model would be more cost-effective over its life.

Moreover, typical electric rates do not reflect the environmental costs of producing electricity, and they are usually based on average production costs instead of the frequently higher marginal production costs associated with new capacity. Such rates may encourage the consumption of electricity.

Traditional regulatory approaches that link utility revenues and profits with electricity sales provide utilities with little incentive for DSM because DSM programs that reduce electricity sales can also reduce profits. Also, utilities have little incentive to reduce existing demand because doing so could idle capacity for which capital costs have already been incurred. Thus, the economic viability of DSM programs depends on whether the programs substitute for additional generating capacity or merely for increased use of existing generating facilities.

Uncertainty about DSM programs' effectiveness can also limit program implementation. Measuring or estimating the net demand reduction of DSM programs is difficult because (1) the level of demand that would exist without the programs is uncertain and (2) the programs can cause unintended changes in demand, such as consumers' raising a thermostat setting after installing a more efficient furnace. For example, because Illinois utilities could not show savings from pilot DSM programs, regulators were reluctant to implement the programs full-scale.

Efforts to Encourage Efficient Electricity Use

To overcome consumer reluctance, utilities have (1) provided financial incentives, such as rebates or discounts on monthly bills for the purchase of more energy-efficient devices; (2) installed efficient devices at customers' homes or businesses; and (3) provided information to customers about available energy-efficiency options and ways to lower their electric bills.

In several states, regulators have revised rate-making practices to provide utilities with DSM incentives. Approaches generally involve allowing utilities to collect (1) a financial return on DSM program investments and/or (2) increased revenues to offset lower sales because of DSM programs. State regulators and utilities are also adopting procedures to better assess and adjust for the impact of DSM programs. For example, New York regulators require utilities to annually adjust estimates of future DSM energy savings on the basis of recent experience.

Federal power agencies' DSM efforts vary considerably, in part reflecting differences in each agency's legislative mandate and authority to promote the efficient use of power. The Bonneville and Western Area Power Administrations, with the most extensive conservation programs, have been prompted by laws that (1) specifically direct them to encourage the efficient use of electricity and (2) allow them to link, or "condition," power allocations or power rates to their customer utilities' DSM efforts. In contrast, the statutory authorities of the other, smaller power agencies (the Southeastern, Southwestern, and Alaska Power Administrations) permit them to encourage, but not require, their customer utilities to implement DSM programs. However, according to power marketing agency and DOE officials, customer utilities are sometimes reluctant to implement DSM programs, and the smaller power marketing agencies cannot overcome such reluctance without specific statutory authority to link power allocations or power rates to customer utilities' DSM programs.

Matter for Congressional Consideration

The Congress may wish to consider enacting legislation that would authorize the Southeastern, Southwestern, and Alaska Power Administrations to link power allocations or power rates to customer utilities' DSM programs.

Agency Comments

As requested, we did not obtain written agency comments on this report. However, we discussed the factual information with DOE officials, who expressed general agreement with the facts and conclusions presented.

Contents

Abbreviations

ACEEE	American Council for an Energy Efficient Economy
CRS	Congressional Research Service
DSM	demand-side management
DOE	Department of Energy
EPRI	Electric Power Research Institute
GAO	General Accounting Office
GNP	gross national product
Kwh	kilowatt-hours
NORDAX	Northeastern Demand-Side Management Data Exchange
ORNL	Oak Ridge National Laboratory
TVA	Tennessee Valley Authority

Chapter 1

Introduction

Electricity production accounts for over one-third of all energy consumed in the United States. According to the Department of Energy (DOE), growing demand for electric power in the nation's homes, businesses, and industries indicates a need for up to 104,000 additional megawatts of generating capacity[1] —the equivalent of the output of about 104 large power plants—by the year 2000. More efficient use of electricity can help reduce demand and thereby reduce the need for expensive new power plants. By using more efficient machines, appliances, and other electrical devices, consumers can reduce their electricity consumption and thus make existing generating capacity go further. Many utilities sponsor programs to influence the efficiency of residential, commercial, and industrial electricity users. These efforts are known as demand-side management (DSM) programs because they are intended to reduce or stabilize customers' demand for electricity.[2]

The U.S. Electricity Market

Electric utilities supply power to the nation's homes, businesses, and industries. About 270 private utilities, known as investor-owned utilities, sell almost 80 percent of the nation's retail electricity. Public utilities and cooperatives account for about 20 percent of the sales to end customers. Consumers typically cannot choose to purchase from one utility instead of another. Retail market competition between utilities is generally not feasible in the electricity industry because it is uneconomic to develop rival power distribution systems in the same geographic areas. Consequently, a utility is granted a geographic service area within which it is the sole supplier. In exchange for being granted an exclusive franchise, a utility is obligated to serve all customers in the service area. Investor-owned utilities are regulated by state regulatory commissions, which set the retail electricity rates customers pay. State regulators usually estimate how much revenue the utility will need to meet its costs and earn a rate of return on investment. The electricity rates consumers pay are based on this revenue requirement. In contrast, public utilities are generally not regulated by state commissions because they are owned by the ratepayers.

At the federal level, the Federal Energy Regulatory Commission regulates interstate power sales and wholesale electricity rates. Offices under DOE's Assistant Secretary for Conservation and Renewable Energy perform a variety of functions to promote efficiency, and several

[1]A megawatt is 1 million watts, a watt being the basic unit of measurement of electricity production.

[2]DSM programs have many purposes related to managing demand for electricity. For purposes of this report, we define DSM programs strictly as those that decrease total electricity demand.

national laboratories perform research on efficient technologies. The Tennessee Valley Authority (TVA) and DOE's power marketing administrations[3] sell power from federally owned generating plants at wholesale rates to customer utilities. Public utilities have priority over private utilities for power purchases from federal agencies.

Electricity Demand Is Expected to Grow

Electricity is becoming an increasingly important part of the nation's energy market. However, because forecasting remains an inexact science, it is not certain (1) how much demand will grow and (2) what electricity generating programs and DSM programs will be used to balance electricity supply and demand.

DOE estimates that nationwide demand for electricity will grow between 1.6 and 2.4 percent per year into the twenty-first century. While these growth rates are lower than those of the late-1980s, DOE estimates that electricity production will capture a larger share of the nation's energy use, up from about 35 percent of all energy consumed in 1989[4] to 41 percent by the year 2000. The rate of growth for electricity use is projected to be about 3 percent per year in the commercial sector; demand in the industrial and residential sectors is projected to grow more slowly.

This increase in demand will necessitate new generating capacity by the year 2000. Most of the nation's electricity is generated by utilities; however, according to DOE, as of 1990 utilities planned to build power plants to supply only about one-fourth of the additional megawatts that DOE estimates will be needed. According to the North American Electricity Reliability Council, about 75 percent of new capacity is projected to come from such sources as new, utility-owned oil, natural gas, coal, and nuclear power plants as well as hydropower, pumped storage, and other sources. An additional 25 percent will be supplied by nonutility generators.[5]

In 1990 only about 37 percent of the projected additions were actually under construction; of those under construction, about one-third were less than 50 percent complete. Experience indicates that it can take

[3]DOE's power marketing administrations are the Alaska, Bonneville, Southeastern, Southwestern, and Western Area Power Administrations.

[4]The most recent year for which data were available when we completed our field work.

[5]See Energy Policy: Developing Strategies for Energy Policies in the 1990s (GAO/RCED-90-85, June 19, 1990).

between 7 and 10 years or longer to plan, construct, and license large-scale power plants. In addition, increasing concerns about the environmental consequences of generating electricity and public opposition to siting and constructing nuclear power plants could slow, or even halt, the construction of many power plants.

Increasing the Efficiency of Electricity Use Can Help Balance Supply and Demand

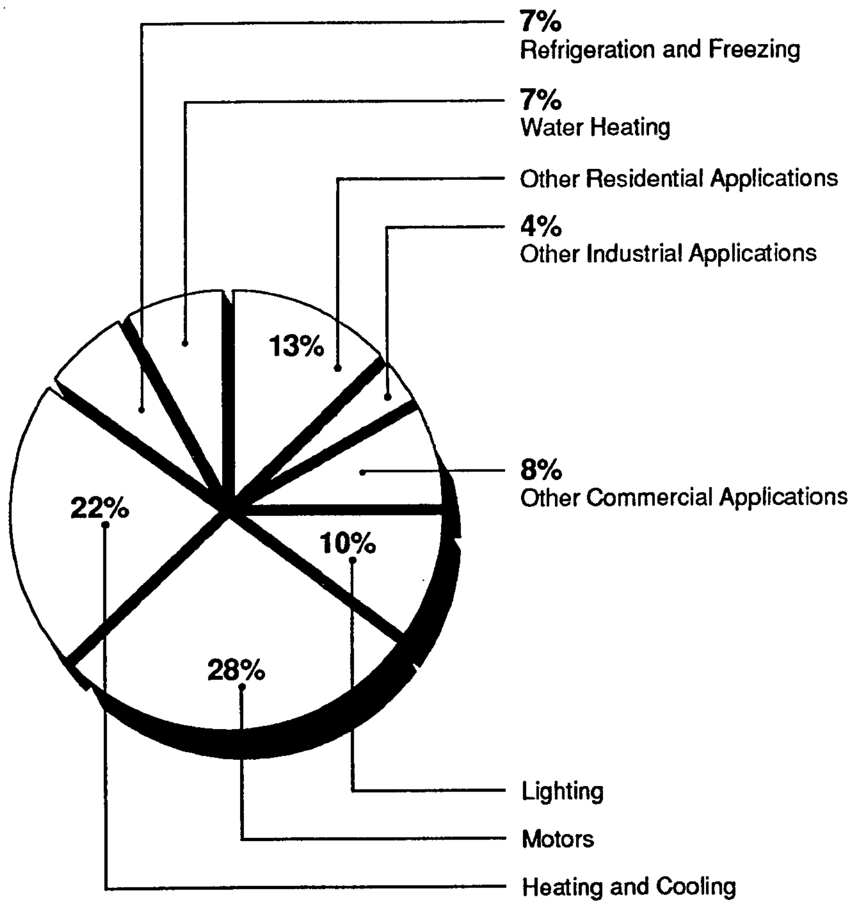
Replacing existing devices with more energy-efficient ones in the future can reduce the rate of growth in electricity demand. According to efficiency experts, the nation's greatest opportunities for saving electricity lie in motors, heating and cooling, lighting, and refrigeration equipment (see fig. 1.1). In these areas, new, commercially available technologies can create substantial electricity savings. For example, compact fluorescent lamps use only one-fourth of the electricity that regular incandescent lamps use to produce the same amount of light. Substituting compact fluorescent lamps for incandescent lamps could result in substantial savings because lighting accounts for one-fourth of the electricity consumed in the United States.

Several federal laws serve to promote efficient electricity use. For example, the Energy Conservation and Production Act (P.L. 94-385) authorized federal financial assistance for the implementation of efficiency improvements in existing buildings and industrial plants, and included provisions establishing efficiency standards for facilities that received this financial assistance. The National Energy Conservation Policy Act (P.L. 95-619) assisted in the financing of state energy conservation plans and authorized federal financial assistance for the installation of conservation measures in schools and hospitals. The National Appliance Energy Conservation Act of 1987, as amended, (P.L. 100-12) set efficiency standards and labeling requirements for 13 types of home appliances. In addition, the Pacific Northwest Electric Power Planning and Conservation Act (P.L. 96-501) calls for conservation to be an important way for the Bonneville Power Administration to balance electricity supply and demand. Also, the Hoover Power Plant Act of 1984 (P.L. 98-381) requires the Western Area Power Administration to insert provisions into its sales contracts that require customer utilities to implement conservation programs.

Dramatic Savings Are Estimated to Be Technically Feasible

Studies by the Electric Power Research Institute (EPRI) and the Rocky Mountain Institute have suggested that dramatic electricity savings, ranging from 24- to 75-percent reductions in electricity demand, are technologically possible through increased use of efficient, available

Figure 1.1: Distribution of Potential DSM Savings Through the Year 2000



Note: Figures do not add to 100 percent because of rounding.

Source: GAO calculation based on Electric Power Research Institute data.

technologies. However, these estimates of technically possible electricity savings are not attributable to DSM programs alone. Rather, they represent the potential savings that are possible through quick adoption of available technologies. These estimates do not necessarily assess the probability that technological substitutions will be made or the factors that would have to occur to make the substitutions a reality.

For example, EPRI estimated that substituting new efficient technologies for existing, less efficient ones could reduce total U.S. electricity demand by 24 percent to 44 percent in the year 2000. According to EPRI's analysis, the potential for electricity savings is almost equally distributed among the nation's residential, commercial, and industrial consumers.

However, the analysis excluded possible constraints, such as the purchase or installation costs of the new technologies. The EPRI study noted, "Only a fraction of the efficient technologies will be cost-effective at current prices of electricity and end-use equipment, however, and not all customers will implement cost-effective actions."[6]

On the high end, the EPRI estimate of 44 percent savings assumes that all lighting, electric motors, and other devices are replaced with the top 20 percent of the most energy-efficient available technologies. The lower estimate, 24 percent savings, represents a more conservative scenario, in which the number of technologies is constrained by such factors as limitations in the manufacturing infrastructure.

Another electricity savings estimate, prepared by the Rocky Mountain Institute, sets the savings potential at about 75 percent of present electricity use if the nation retrofits its capital stock using about 1,000 new electricity-saving technologies. The Institute considers these electricity savings to be technically feasible now, instead of at some future time, on the basis of current electricity demand and currently available technologies.

DSM Programs Promise Significant Benefits

Utility DSM programs incorporate end-use efficiency improvements into utility planning strategies. The programs are designed to improve electricity efficiency by encouraging utility customers—the nation's residences, businesses, and industries—to buy and use more efficient technologies. Electricity saved through these programs is then available to serve additional customers, lessening the need for new generating capacity. Consequently, potential conserved electricity can be viewed as a resource, just as a new power plant is viewed as a resource.

In DSM programs, utilities encourage greater efficiency in the use of electricity through such measures as (1) directly installing new, more efficient technologies; (2) rebating or subsidizing the purchase or installation costs of efficient technologies; and (3) providing information to customers about opportunities and benefits of using electricity more efficiently. Utilities are currently spending over $1 billion on DSM programs each year.

[6]Faruqui, A., M. Mauldin, S. Shick, et al., Efficient Electricity Use: Estimates of Maximum Energy Savings, Electric Power Research Institute, Report CU-6746 (Palo Alto, Calif.: Mar. 1990).

DSM programs can provide a variety of benefits, including improved economic efficiency. Economic efficiency improves when businesses, industries, and other consumers invest in less costly resources to obtain the same level of benefits. DSM becomes cost-effective when it is cheaper to conserve a kilowatt-hour than to generate one using resources such as coal, oil, or nuclear energy. However, cost-effectiveness can be perceived from differing viewpoints, including those of the sponsoring utility, program participants, program nonparticipants, and society at large. As discussed in appendix I, these differing viewpoints of the cost-effectiveness of DSM programs can affect whether, and under what conditions, DSM programs are implemented.

Substituting DSM electricity savings for electricity generation can benefit the environment as well. Over two-thirds of the electricity generated in the United States is produced by burning fossil fuels: coal, oil, and natural gas. As a result, electricity generation is responsible for two-thirds of the sulfur dioxide, one-third of the nitrogen oxide, and one-third of the carbon dioxide emitted in the nation. Sulfur dioxide and nitrogen oxide are associated with acid rain, and mounting evidence connects carbon dioxide emissions with global warming. Recognizing the environmental benefits of utility conservation efforts, the Clean Air Act Amendments of 1990 (P.L. 101-549), for a limited period of time, permit utilities to earn "pollution allowances" (essentially, the right to emit a specified amount of pollutants) by demonstrating lower emissions resulting from DSM programs occurring under specified conditions.

Depending upon its capacity utilization, a utility may increase its production either by more fully utilizing existing generating capacity or by building new capacity. In general, the former is much cheaper because it requires no additional major capacity expenditures. Because DSM programs may be used as a substitute for additional electricity production, the economic viability of DSM programs depends critically on whether it alleviates the need to build new capacity.

Electric utilities and state regulators may view DSM more favorably in situations in which a utility is faced with the prospect of building more generating capacity than if the utility can increase its production just by increasing fuel use at existing plants. The economic decision to implement a DSM program frequently depends upon the amount of available excess capacity. In particular, DSM programs are more likely to be cost-effective when the amount of generating capacity above a utility's routine requirements is small, because the adoption of DSM could eliminate the need to invest in additional capacity.

Although more efficient use of electricity may improve the nation's international economic competitiveness, the significance of this benefit is uncertain. DSM programs can benefit U.S. exports by reducing the electricity and production costs of certain electric-intensive industries that are responsible for U.S. exports. However, if such an industry does not participate in a DSM program, then DSM may increase its electric rates and its costs of producing goods. Appendix II discusses ways in which electricity efficiency is related to the nation's international economic competitiveness.

Objectives, Scope, and Methodology

Because utility programs promoting more efficient electricity use, DSM programs, can help reduce electricity demand and provide cost and environmental advantages without sacrificing electricity's benefits, the Chairman, Environment, Energy, and Natural Resources Subcommittee, House Committee on Government Operations, asked GAO to examine

- the potential for utility DSM programs to reduce future electricity demand;
- impediments to the effectiveness of DSM programs; and
- efforts by utilities, states, and federal power agencies to address these impediments and encourage efficient use of electricity.

To meet these objectives, we first conducted a search of the available literature. A partial bibliography is included at the end of this report.

To assess the potential for DSM programs to aid in satisfying the nation's electricity needs, we reviewed projections of DSM electricity savings in state energy plans and utility resource plans in nine selected states—California, Florida, Illinois, Maine, Massachusetts, New York, Oregon, Texas, and Washington. These states collectively consumed about 38 percent of the electricity used in the United States in 1989, the last year for which data were available at the time we conducted our study. Electricity and DSM analysts referred us to these states, which we selected on the basis of (1) their acknowledged leadership in DSM or (2) their limited DSM experience and high consumption of electricity.

We also reviewed estimates and projections of DSM energy savings from the Electric Power Research Institute, the American Council for an Energy Efficient Economy, and the Rocky Mountain Institute. These organizations were selected because they provided estimates of the maximum electricity savings said to be possible if the most energy-efficient technologies replaced existing, relatively inefficient technologies. We did not, however, independently examine the validity of the methodologies used to make these estimates. We also interviewed officials of these organizations about the methods and assumptions associated with their electricity savings estimates, and consulted officials of DOE's Office of Conservation and Renewable Energy and Energy Information Administration about DOE's role in studying electricity conservation.

Our review of DSM programs excluded programs (known as "load management" or "load-shifting" programs) that are intended to shift electricity use from peak to off-peak periods. We also excluded "fuel-switching" programs, through which electric utilities encourage customers to switch from appliances and heaters that use oil and gas to those that use electricity and vice versa. State regulators have not yet determined whether to treat fuel-switching programs as DSM programs.

To identify impediments to greater electricity savings from DSM programs, we reviewed available literature and interviewed officials of state energy offices, state regulatory agencies, and electric utilities in the selected states. In addition, we reviewed studies and interviewed officials from DOE's Oak Ridge National Laboratory (ORNL) and Lawrence Berkeley Laboratory. DOE identified these two laboratories as being particularly active in energy efficiency research.

To examine efforts by utilities, states, and federal power agencies to address these identified impediments and encourage efficient use of electricity, we spoke with utility commissioners, regulatory staff, energy agency officials, and electric utility officials in the selected states. We also reviewed existing, and proposed revisions to, state electric utility regulations and the relevant proceedings of state regulatory commission meetings. In examining the federal role in promoting efficient use of electricity, we performed field work at DOE's Alaska, Bonneville, Southeastern, Southwestern, and Western Area Power Administrations as well as the independent Tennessee Valley Authority. At these agencies, we interviewed electricity resource planners and conservation specialists, and reviewed DSM program descriptions and evaluations as well as electricity resource plans. We also obtained expert opinions on efficient technologies from researchers at Lawrence Berkeley Laboratory and Oak Ridge National Laboratory. These laboratories, as well as electric utilities, the American Council for an Energy Efficient Economy, state agencies, and the Rocky Mountain Institute provided material on techniques for delivering efficient technologies to the consumer.

Our work was conducted from October 1990 to August 1991 in accordance with generally accepted government auditing standards. As requested, we did not obtain written agency comments. However, we discussed this report with various experts in the field and with DOE officials, who agreed with the facts and conclusions presented.

DSM Programs Are Expected to Reduce Electricity Demand Growth

Projected demand reductions attributed to DSM programs vary widely. For example, although regulators in California forecast that these programs could reduce electricity demand in the year 2000 by about 15 percent, regulators in Illinois forecast little or no impact from DSM programs. Other regional and utility estimates of DSM electricity savings were also between zero and 15 percent.

Although electricity savings from DSM programs are not intended primarily to replace existing capacity, they are expected to significantly reduce growth in electricity demand that would otherwise occur. In some states with relatively high estimates of DSM electricity savings, DSM programs are seen as the primary way to satisfy the demand growth that will occur between now and the year 2000. For example, in California, a state that consumes almost 8 percent of the nation's electricity, the predicted reduction in total electricity demand of about 15 percent by the year 2000 offsets over half of the demand growth that would otherwise occur.

Wide Range of Savings Projected for DSM Programs

Estimated reductions in total electricity demand as a result of DSM programs varied widely, ranging from almost zero to about 15 percent in the year 2000 in the nine states we reviewed. These estimates were obtained from state regulators, state energy offices, or regional planning entities as submitted by electric utilities. The estimates are based on the analyses utilities use to guide decisions on multimillion-dollar resource acquisitions concerning how to satisfy electricity demand. Table 2.1 shows the estimated DSM electricity reductions for the nine states we visited, which accounted for about 38 percent of the nation's electricity consumption in 1989.

Table 2.1: Estimated Electricity Demand Reductions Resulting From Utility DSM Programs in States Reviewed

State	Percent of U.S. electricity consumption in 1989	Percent reduction in electricity consumption in 2000
California	7.7	14.8
Florida	5.2	1.7
Illinois	4.1	[a]
Maine	0.4	1.9
Massachusetts	1.7	5.4
New York	4.8	6.6[b]
Oregon	1.6	5.4
Texas	8.7	[c]
Washington	3.3	5.4
Total	**37.5**	

[a]Illinois state officials indicated that DSM impacts for this period would be almost nonexistent.

[b]As reported by the New York Energy Office in its draft July 1991 state energy plan update.

[c]Annual energy forecasts prepared by the Texas Public Utility Commission project a reduction of peak electricity use of about 1,600 megawatts, or 2.4 percent, as a result of DSM.

Source: GAO calculations based on data from state regulatory and energy agencies and the New England Power Pool.

Other analyses estimate DSM electricity savings in the same range as those in the states we visited. For example, a February 1991 ORNL survey of 24 utilities found that plans for DSM electricity savings ranged from 0.1 to 13 percent of total electricity demand in the year 2000; the average reduction was over 4 percent of total electricity demand. The ORNL study included 24 utilities in all regions of the nation except the North Central states, representing about one-third of the nation's electricity generation. Similarly, the Electric Power Research Institute (EPRI), a utility-funded research and development organization, estimated in 1990 that DSM programs would reduce electricity consumption by 3 percent of total demand in the year 2000. EPRI based its estimate, in part, on an analysis of savings plans that were associated with 70 DSM programs nationwide. Furthermore, the Northwest Power Planning Council, responsible for regional power planning in four northwestern states, issued energy plans that included DSM electricity reductions of 5.4 percent of total demand in the year 2000.

Estimates for future electricity supply and demand can be volatile. For example, a New England Power Pool official cautioned that the need for additional sources of electricity, including DSM electricity savings, could be reduced if economic conditions in New England worsen.

DSM Programs Will Offset Demand Growth, Not Existing Demand

DSM program savings are projected to satisfy system growth needs rather than to displace existing generating plants. Their contribution to balancing electricity demand and supply can be significant, especially in areas expecting demand increases. In locations with more active DSM programs, including Massachusetts, California, and the Pacific Northwest states, estimates are that DSM programs can satisfy over half of new electricity demand. For example, as shown in table 2.2, in California programs may satisfy about 61 percent of the state's new requirements for electric power between 1990 and the year 2000.

Table 2.2: DSM's Role in California Through the Year 2000

Changes in electricity use	2000
Increase in electricity use between 1990 and 2000 without DSM, in gigawatt-hours[a]	70,148
Projected electricity use avoided as a result of DSM between 1990 and 2000, in gigawatt-hours	42,565
DSM savings as a percentage of growth	60.7%

[a]A gigawatt-hour is a unit of electricity consumption equal to 1-million kilowatt-hours.

Source: GAO estimates based on historical and projected electricity consumption data from the California Energy Commission.

DSM programs primarily offset future demand growth, rather than displacing existing demand, for various reasons. Displacing demand implies idling existing electric generating capacity, which may not be a cost-effective option. Idling capacity reduces operating costs but does not change the fixed costs that the utility bears whether a power plant is operating or idle. DSM program costs may not be offset by savings in operating costs alone. Furthermore, utilities may be reluctant to idle existing capacity because doing so can decrease the "rate base" on which the utility earns its financial returns.

State regulators have sometimes been reluctant to force utilities to close down existing power plants and replace that capacity through DSM programs. In Massachusetts, for example, in DSM rate proceedings, state regulators wrote that in order to promote least-cost planning, they needed the active cooperation of utilities. Thus, the regulators decided to protect existing capacity by implementing rules that keep existing and planned capacity from being replaced by new DSM electricity savings.

Furthermore, shutting down an existing plant in favor of DSM programs may not always save costs. Utilities may have fixed costs,[1] such as debt repayments, associated with existing capacity that would have to be repaid whether or not the capacity was operating. In some cases, the financial savings to the utility and to consumers from satisfying demand through a DSM program may not be enough to offset these fixed costs. The state of Massachusetts, for example, bases its policy of protecting existing capacity from being replaced by DSM programs partially on this factor.

[1]Fixed costs refer to costs incurred by utilities that must be paid regardless of the amount of electricity being generated and sold. For example, even if a plant is completely idled because of lower demand, the utility still incurs depreciation costs on it.

Overcoming DSM Impediments Challenges Utilities and Regulators

Utilities and regulators face formidable impediments to realizing increased electricity savings through DSM programs. These impediments include (1) factors that limit the consumers' willingness to buy electricity-saving appliances, (2) a regulatory process that can discourage utilities from choosing to implement DSM programs instead of producing and selling electricity, and (3) the difficulty of measuring and estimating DSM programs' electricity savings accurately.

Utilities and regulators have taken actions to address these impediments. To help overcome consumer reluctance to buy energy-efficient appliances, utilities are financing customer purchases of more energy-efficient appliances, directly installing such equipment, and educating customers about the benefits of purchasing and using energy-efficient devices. To resolve the problems caused by regulations that link utilities' profits to electricity sales, state regulators are implementing rate-setting approaches that financially reward utilities for implementing DSM programs. Also, utilities and regulators are taking steps to improve measurement of the electricity saved through DSM programs.

Overcoming Consumer Reluctance to Purchase Efficient Technologies

For various reasons, consumers are often reluctant to buy more energy-efficient devices, even when the expected returns from doing so compare favorably with returns from other possible investments. Studies indicate that consumers may, in effect, discount expected savings from energy-efficiency investments more than they discount expected returns from other investments. These studies also find that consumers may not purchase more efficient models because consumers do not know about the electricity and monetary savings these models provide. To address consumers' reluctance to purchase and use energy-efficient models, utilities have implemented DSM programs that help finance consumer purchases of efficient appliances and provide consumers with information about the benefits of making such purchases.

A Number of Factors Limit Consumers' Willingness to Purchase Efficient Devices

Electricity-efficient devices, such as refrigerators, lights, and air conditioners, can often cost more than their less efficient counterparts. Economically rational consumers should be willing to purchase more expensive, energy-efficient devices if such devices can save them enough money on their electricity bills to offset the higher purchase costs. Purchasing a more expensive but more energy-efficient device rather than a less expensive but less energy-efficient model can be viewed as an investment. The expected rate of return on such an investment will depend on how the present value of future savings on electricity bills compares with the additional purchase price of the more energy-efficient model. In this way, consumers can make decisions about investing in increased energy efficiency by comparing the expected returns on such investments with the expected returns on other investments (such as stocks or bonds).

Studies by the National Resources Defense Council and ORNL have generally found that consumers will buy energy-efficient appliances if the higher purchase costs can be offset through reduced monthly electricity bills within 2 years. Consumers are less likely to purchase the more expensive model if the payback period is longer than 2 years. For example, consumers may not purchase high-efficiency fluorescent light bulbs because these bulbs are more expensive than low-efficiency incandescent bulbs and because consumers may not recoup the added cost through reduced electricity bills for up to about 5 years. This relatively short payback period shows that consumers, in effect, demand a much higher rate of return on energy-efficiency investments than they do on other investments.

Similarly, a DOE study described a consumer's decision to buy a new, top-mount, automatic defrost refrigerator-freezer. The consumer had to choose between a new, less efficient model that cost $440 (in 1987 dollars) and used 1,010 kilowatt-hours of electricity per year, and a new, more efficient model costing about $94 more but using only 485 kilowatt-hours per year. According to this study, at the national average electricity rate of about 7 cents per kilowatt-hour, the energy savings of the more efficient model was projected to be about $34 per year, making the payback period about 2.8 years.

In addition, a consumer may consider the payback period to be much longer if the choice is not between two new refrigerators, but between keeping an existing, inefficient model and buying a new model. In such a case, the consumer is likely to view the cost differential as the full price of the new model, although the old refrigerator is partly depreciated. In the case of the refrigerator-freezer, the payback period would then be seen as 15.7 years.

The way the consumer gets paid back—by relatively small decreases in monthly electricity bills—may add to consumer reluctance to purchase efficient technologies. These small monetary savings may not provide a large enough incentive for customers to buy more efficient but more expensive appliances. In the refrigerator-freezer example discussed above, the $34 annual electricity savings reduces the monthly electricity bill by less than $3.00. This savings is not only small but can be hidden from consumers because they have no way of tracing electricity savings to specific pieces of equipment in electricity bills.

Consumers' existing and planned residential arrangements can affect their views of the expected returns from energy-efficiency investments. For example, home buyers may be unwilling to buy more expensive energy-efficient homes if doing so would decrease their electric bills for 30 years but they plan to sell their homes in 6 years. (While the home owners theoretically could recoup the unrealized benefit by selling the house at a slightly higher price, it may be difficult to demonstrate such effects in practice.) Also, apartment dwellers who pay a fixed fee for utilities, or whose electric bills are included in rent payments, have little incentive to reduce electricity consumption.

Even when consumers realize that purchasing a more expensive electricity-saving appliance can save money in the long run, their budgets may not allow them to make the purchase. If consumers have only limited or nonexistent access to credit, they may have to pass up opportunities to save electricity and money. Consumers may also have limited information about the potential benefits of energy-efficient devices. According to ORNL, consumers lack information about which devices are the most efficient or about how much electricity and money could be saved by acquiring them. In addition, until recently, many efficient devices were not widely available in many areas of the country.

Utilities Have Established Incentives to Overcome Consumer Reluctance

Utilities are experimenting with several types of incentives to overcome consumer reluctance to buy more energy-efficient products. These include providing consumers with (1) rebates to help them pay the costs of acquiring more efficient products, (2) discounts on monthly electricity bills if consumers install efficient devices, and (3) energy-efficient devices installed directly by the utility. Utilities have also taken steps to address consumers' lack of information about the benefits of purchasing energy-efficient devices. Such information can be provided through mailings to consumers, free energy audits, and appliance labels that contain information on the appliances' electricity use.

The efforts of Massachusetts electric utilities to overcome consumer resistance were typical of those we found in several states. For example, to promote more efficient residential water heating, a Massachusetts utility encouraged some residential customers to improve the efficiency of their water heaters by paying the additional costs of wrapping the water heaters in its service area. This same utility proposed the use of energy audits to promote efficiency at area farms by identifying opportunities to improve energy-efficiency and ways to realize such improvements. The utility paid rebates equaling 50 percent of the installation costs of efficiency devices to overcome farmers' concerns about high acquisition costs. Another Massachusetts utility installed efficient lighting and water heaters free to willing low-income customers in its service area.

Regulators Are Experimenting With Incentives for Efficient Use of Electricity

The traditional regulatory system for pricing electricity may discourage utilities and consumers from choosing DSM as an alternative to producing and using electricity. Potential disincentives include (1) rate designs that allow for increased returns primarily through increased sales of kilowatt-hours; (2) regulations that allow returns on investments to utilities only for electricity-generating projects, not for DSM programs; and (3) pricing electricity on the basis of utilities' average cost of supplying power, rather than on the sometimes higher marginal or incremental cost of generating each additional kilowatt-hour. State regulators are continuing to experiment with nontraditional approaches to overcome impediments to choosing DSM.

Some Factors Encourage Utilities to Market More Kilowatt-Hours

Except in nine states, as of 1990 utility profits were linked almost exclusively to generating and selling kilowatt-hours.[1] Under traditional regulatory methods, electric rates are set to cover the average costs of supplying power over a period of several years, including a reasonable rate of return on capital invested in the electricity-generating system. A utility that met increased demand by investing in new capacity would seek rates enabling it to cover its additional costs, including a return on the investment. Under regulation that does not provide a return on DSM program investments, the DSM programs would be less attractive.

Capacity Surpluses

Utilities with surplus capacity have less incentive to implement DSM programs than utilities without such surpluses, because DSM programs may reduce sales revenues while fixed costs remain the same. A utility with

[1] According to the Congressional Research Service, as of 1990 nine states had revised their electric rate-making rules to provide electric utilities with revenues above and beyond program costs for conserving electricity.

a surplus capacity margin[2] may have little incentive to adopt a DSM program, because it does not face the need to add capacity or otherwise seek additional sources of electricity. The utility, which must pay the costs associated with operating and maintaining its power plants even if all the generating capacity is not being used, would have even less revenue available to cover these costs and provide its authorized rate of return.

DSM programs have not flourished in areas of the country where capacity margins have been as large as 30 to 40 percent. In Illinois, for instance, state energy officials cited capacity margins exceeding 30 percent as one important obstacle to implementing full-scale DSM programs in the state.

Regulatory Cost Treatment

Another disincentive to utilities' implementation of DSM programs is that in many states rate-making rules do not allow utilities to recover a financial return on DSM investments. In these states, utilities only recover program costs. At the same time, these states allow utilities to collect a financial return on investments for building new generating plants. In this situation, utilities may find DSM programs less financially advantageous than building and operating power plants.

Electricity Pricing

Electricity prices that do not reflect the financial costs of generating each kilowatt-hour of electricity and electricity's environmental costs tend to encourage electricity consumption, not efficiency. For example, electricity rates are generally based on the average cost of supplying electricity. This practice tends to hide the often higher marginal cost of electricity—the cost of supplying each additional unit of power. Today, the marginal cost of electricity is frequently higher than the average cost; that is, each kilowatt-hour of electricity produced by a new base-load or peak-load power plant generally costs more than a kilowatt-hour produced by the older, existing system. Thus, electric rates based on average costs tend to be lower than rates based on marginal costs. This pricing practice may encourage more electricity consumption than would occur if consumers had to pay higher rates based on marginal costs.

In addition, electricity rates in the past have generally excluded the costs of avoiding environmental damages and cleaning up pollution that

[2]The capacity margin is the difference between a utility's peak demand forecast and the maximum amount of power it can generate from existing capacity. According to utility analysts, the ideal capacity margin is around 20 percent, which allows the utility to meet unscheduled outages and other contingencies while minimizing the cost of unused capacity.

stem from generating power. For example, in Massachusetts such costs for electricity from a coal-fired power plant have been estimated at up to 4.7 cents per kilowatt-hour, a significant amount compared with the 1989 national average price for electricity of 6.7 cents per kilowatt-hour. Comparing the cost of electricity made available through DSM programs with the cost of electricity from coal-fired generators without recognizing the environmental cost of the latter could make DSM programs appear less advantageous.

State Regulators Are Acting to Reduce Disincentives

Increasingly, state regulators are taking actions to respond to regulatory disincentives. In 1990, according to the Congressional Research Service (CRS), at least nine states had implemented regulations to (1) reduce the revenues that utilities lose as a result of DSM programs and (2) provide financial returns for utilities' DSM investments. At least 14 other states were actively considering such proposals.[3] Regulators are also taking steps to address issues of overcapacity and to consider fully the cost of generating electricity in electricity rates.

"Decoupling" Electricity Sales and Utility Revenues

Some state regulators are "decoupling" utilities' revenues from electricity sales by allowing utilities to recover some portion of the revenues lost when DSM programs successfully reduce energy consumption.

- In California, regulators use utility-prepared estimates of future electricity sales to project future revenues. Regulators then adjust electric rates so that utilities collect the forecasted revenue amounts, regardless of whether sales of kilowatt-hours go up or down (provided the deviations from projected sales are caused by DSM programs, depressed economic conditions, or weather changes, and not by utility errors in managing its power program). New York regulatory officials said they are considering this approach.
- Massachusetts regulators allowed a utility to forecast revenues lost through its DSM programs at the beginning of each calendar quarter. The utility was then allowed to recover these amounts through rate increases the next year. In 1991 this adjustment increased the utility's revenue by $1.1 million.

[3]According to CRS, in addition to California, Illinois, Maine, Massachusetts, New York, Oregon, and Washington—which were included in our review—Connecticut, Colorado, Idaho, Iowa, Maryland, Minnesota, Nevada, New Hampshire, New Jersey, North Carolina, Pennsylvania, Rhode Island, Vermont, and Wisconsin have revised or are considering revising their regulations in order to encourage DSM.

Some states have adopted a "shared savings" approach involving consumers and utilities. California adopted such an approach for one utility so that ratepayers "keep" 85 percent of the savings attributable to DSM programs through lower electricity bills, and the utility "keeps" the remaining 15 percent through increased revenues. New York regulators also used this approach, allowing utilities to retain from 5 to 20 percent of the savings.

Decoupling utility revenues from kilowatt-hours can also decrease the impact of DSM programs on utility revenues, even in overcapacity situations. For example, because California utilities collect preapproved revenue levels even in overcapacity situations, overcapacity does not serve as a meaningful disincentive to DSM programs.

Allowing Returns on DSM Investments

Some state regulators are allowing utilities to earn a return on DSM investments rather than recovering only program costs. These financial returns are sometimes allowed only when the utility demonstrates to state regulators that it has satisfied specific electricity savings targets. Monetary awards to utilities are sometimes based on a rate of return for each kilowatt-hour not generated. For example, Massachusetts regulators allow a utility to earn a financial bonus for electricity not sold once the utility demonstrates that it has achieved 50 percent of its DSM program's electricity savings goal. At the 50-percent mark, this bonus equals a 1-percent return on the utility's DSM program investment, and the bonus increases if the company satisfies larger portions of its electricity-savings target.

Some states are implementing a related DSM incentive—allowing utilities to recover DSM program costs in the way that best suits their needs. In New York and Massachusetts, for instance, utilities can choose to recover program costs either as operating expenses on a quarterly basis or by amortizing the costs and recovering them over many years.

Addressing Other Pricing Impediments

Some states are acting to price electricity in a way that reflects the external costs associated with generating electricity. For example, to reflect the environmental costs of removing residual sulfur dioxide from power plant emissions, Massachusetts and New York regulators may add a predetermined amount, ranging from about 1 to about 4.7 cents per kilowatt-hour, to the estimated cost of electricity from coal-fired power plants. Such cost adjustments make DSM, as well as less polluting electricity-generating resources like solar and hydropower energy, more competitive with traditional coal-fired power options in utility resource planning and acquisition decisions.

Utilities and regulators have also implemented rates that reflect the increased costs of generating electricity during high-demand, peak periods. For example, during the summer, one utility institutes seasonal rates of 8.37 cents per kilowatt-hour for electricity consumption exceeding 800 kilowatt-hours, compared with a rate of 6.76 cents per kilowatt-hour during the rest of the year. While not necessarily equal to the marginal cost of generating each additional unit of power, such alternative rates may encourage consumers to use less power during high-demand periods. In addition, the Northwest Power Plan, prepared by the Pacific Northwest Electric Power and Conservation Planning Council,[4] suggests that if the Bonneville Power Administration and its customers have difficulty achieving DSM electricity savings goals, marginal cost pricing of electricity sales should be instituted to encourage more efficient use of electricity.

Improving Measures of DSM Program Effects May Help Expand Efforts

Making sure that estimates of DSM energy savings are reasonable is an important factor in assuring regulators and utilities that DSM programs are a cost-effective and reliable way to balance electricity supply and demand. Without evidence confirming the accuracy of such estimates, regulators and utility officials sometimes view DSM programs as a risky option for satisfying electricity requirements. An official in Illinois, for example, noted that the inability to demonstrate savings from pilot DSM programs contributed to the state's reluctance to expand or perpetuate the programs. Because DSM electricity savings are hard to measure, utilities and regulators are experimenting with a variety of techniques to ensure a higher level of accuracy in DSM electricity savings estimates.

DSM Savings Are Difficult to Measure

DSM energy savings are hard to measure for two basic reasons:

- Because DSM electricity savings cannot be directly observed, they must be estimated, and estimating methods are susceptible to error.
- Estimates also depend on analysts' ability to predict and measure human behavior—a task fraught with uncertainties.

[4]The Pacific Northwest Electric Power and Conservation Planning Council was established under P.L. 96-501 to serve as Bonneville's regional energy planning body. Its members are appointed by the governors of the regional states, and the council establishes regional electricity plans, including regional electricity saving goals for the Bonneville Power Administration.

To estimate electricity saved through a DSM program, utilities can use a variety of techniques. Such techniques include estimating the energy-saving effect per installation of an energy-efficient device (like a compact fluorescent light bulb), monitoring electricity use for selected customers before and after participation in a DSM program, and contrasting electricity use of sample groups of DSM program participants and non-participants. However, these methods may yield inaccurate or atypical results. For example, engineering estimates may yield inaccurate results if devices fail to perform as expected, or monitoring electricity use may yield atypical results if measurements are taken during times of unusual energy use (such as extreme weather).

Changes in human responses to DSM programs are complex and difficult to assess. For example, in order to avoid attributing too great a level of savings to a DSM program, regulators and utilities must estimate "free riders"—people who would have purchased an energy-efficient device or practiced energy conservation even without the existence of the utility-sponsored DSM program. According to some estimates, free riders can account for between 40 and 89 percent of the participants in a DSM program in extreme cases, especially in programs that encourage customers to buy more efficient appliances. But identifying and quantifying such persons can be difficult. If regulators have approved financial returns to utilities on the basis of electricity savings attributable to a DSM program, failure to correctly estimate free riders and to adjust DSM electricity savings downward can result in financial returns to utilities that are too high.

Regulators in states we selected expressed limited confidence in the accuracy of utilities' estimates of DSM electricity savings. Regulators need to be confident in the reasonableness of estimated electricity savings in order to determine that a program will be cost-effective before they approve its implementation. Evaluating a DSM program's cost-effectiveness accurately depends upon the ability of the utility to accurately forecast the electricity demand reduction that will result from the DSM program. Accurate estimates of DSM electricity savings are also important because state regulators are beginning to provide financial returns to utilities for implementing successful DSM programs. These returns are sometimes based on the utilities' estimates of DSM electricity savings.

Utilities are also concerned about the accuracy of DSM electricity savings estimates. Utilities want to be sure that these estimates are reliable because they use these estimates to decide how much additional capacity they need to construct or how much electricity they need to buy from other sources.

The lack of confidence in estimates of DSM electricity savings contributes to regulators' and utilities' perceptions that, as a way to help balance future electricity supply and demand, DSM programs are more risky than generating and selling electricity. Such perceptions can reduce reliance on DSM programs for this purpose.

Measurement difficulties have impeded DSM programs. Officials in two of the states we visited gave the following examples:

- In Illinois, a state energy agency official cited doubts about the cost-effectiveness of DSM programs and the ability of utilities to properly measure DSM electricity savings as important reasons for not allowing utilities to implement DSM programs full-scale. According to the official, as of May 1991, utilities had not demonstrated that their pilot programs were cost-effective or that they could measure the energy savings of DSM programs with a high degree of accuracy.
- In Florida, a utility official cited a lack of assurance about the accuracy of estimated DSM electricity savings as an important reason for not pursuing DSM programs more vigorously. He wanted to be confident that DSM programs could displace specific amounts of capacity in order to plan how much future demand would have to be satisfied.

Actions to Promote Greater Certainty in DSM Energy Savings

State regulators and others are testing a variety of methods to promote greater certainty about DSM electricity savings. These include methods that allow regulators to validate utilities' calculations of energy savings, efforts to improve the techniques used to estimate DSM electricity savings, and more consistent collection of data. For example, when disagreements about the uncertainty of residential electricity savings estimates were raised in the Northwest, the Bonneville Power Administration, a customer utility, and an environmental group jointly sponsored a citywide test to demonstrate the potential for electricity efficiency. The $20-million test, called the Hood River Conservation Project, collected actual DSM electricity savings data for energy-efficient technologies and tested ways to encourage home owners to take part in DSM programs. The experiment showed that DSM programs sustained for 1 to 3 years or more can achieve over 80-percent enrollment of eligible customers.

Regulators in other states we selected also have efforts underway. To continuously upgrade the accuracy of DSM energy savings estimates, the New York Public Service Commission required a utility to revise its estimates of future DSM program energy savings on the basis of actual data from the previous year. According to a commission official, utilities are required to spend 10 percent of their DSM budgets developing new evaluation techniques in order to improve measurement and estimating techniques for DSM programs.

The state of California also promotes accurate and consistent estimating of DSM energy impacts. The state has a comprehensive method to ensure consistent data collection and to monitor the progress these programs make in satisfying stated energy reduction goals. To collect DSM program monetary returns beyond a third year, a utility must implement a measurement plan that satisfies the state regulators. For the first 3 years, the utilities can collect financial returns based on specified and constant estimated DSM program electricity savings. However, from the fourth year on, financial returns will be based on actual DSM electricity savings calculated by implementing the utility's measurement plan. Guidelines for data collection are detailed and comprehensive.

Ongoing efforts to promote consistent definitions of DSM concepts, and hence consistent reporting of DSM electricity savings, include the DOE-initiated, utility-funded, Northeast Demand-Side Management Data Exchange (NORDAX) Project. The project collects information on DSM program costs and electricity savings from 123 utilities. To date, NORDAX has focused primarily on developing and testing a standardized data collection form and promoting its use by utility staff. Also, the Oak Ridge National Laboratory has undertaken a project, sponsored by DOE and EPRI, that has identified ways to standardize DSM program definitions, reporting methods, and measurement techniques. To assist in this process, the laboratory has drafted a handbook that offers standardized definitions and reporting formats for DSM energy savings and program costs. Furthermore, DOE's Energy Information Administration has developed a form to annually collect standardized data on each utility's overall DSM program energy savings, plans, and costs.

Observations

Utilities and regulators are counting on DSM programs to help balance electricity supply and demand at a time when the nation is becoming increasingly dependent on electricity to satisfy its energy needs. Because of the high stakes associated with the success or failure of DSM programs in filling new demand, it is important to address two issues that, in our view, are key to realizing the potentially significant contributions of utility-sponsored DSM programs. These two issues are (1) developing cost-effective means of measuring DSM program impacts and (2) establishing regulatory strategies for encouraging a sustained commitment to DSM programs.

Measures to determine whether DSM programs achieve their planned energy savings are essential because (1) utilities are scheduled to invest billions of dollars in DSM programs, (2) utilities are counting on the "saved" electricity as one source of supply to meet expected increases in future electricity demand, (3) state regulators are increasingly allowing utilities to collect financial returns based on the results of DSM programs, and (4) utilities and regulators need to know what mix of DSM technologies and techniques yields the most cost-effective energy savings. Unless consistent and accurate data regarding DSM electricity savings are collected and reported, widespread reliance on DSM savings could be delayed.

In addition, DSM programs will fulfill their potential only if they are sustained over time and become standard elements of utility strategies for balancing electricity supply and demand. Maintaining the momentum of DSM programs in the face of short-term obstacles such as temporary periods of utility surplus capacity or economic downturns is, in the words of one utility commissioner, one of the most difficult regulatory challenges.

DOE has begun efforts to encourage utilities and state regulators to collect consistent and accurate data on DSM program costs and impacts, and to incorporate efficiency programs as strategic elements for balancing electricity supply and demand. In addition, the National Energy Strategy calls for the Federal Energy Regulatory Commission to encourage consideration of efficiency measures through its regulation of wholesale electricity markets. We are reviewing these efforts and plan to issue a report on them in early 1992.

Federal Power Agencies' Role in Encouraging Efficiency Varies Widely

Federal power agencies consist of DOE's five power marketing administrations—Bonneville, Western, Southeastern, Southwestern, and Alaska—and the Tennessee Valley Authority, an independent agency. These agencies are in a key position to encourage efficient electricity use because of the large number of customers they affect. However, the present role of these agencies in promoting efficiency varies widely. For example, with an explicit legislative mandate to encourage conservation and with the legislated ability to charge more for its power unless customer utilities implement DSM programs, the Bonneville Power Administration (Bonneville) is a recognized DSM program authority, and has operated DSM programs for more than a decade. In contrast, the much smaller Southeastern Power Administration, without similar legislative authority, is just beginning to consider DSM as a tool for meeting power needs.

Encouraging More Efficient Electricity Use Provides Benefits

Because federal power sales touch a significant percentage of the U.S. electricity supply, the agencies are in a key position to promote the efficient use of electricity on a widespread basis. Collectively, the federal power agencies generate and/or distribute over 12 percent of the nation's electricity. Customer utilities—municipal electric systems, electric cooperatives, and investor-owned utilities—that buy this power, in turn, sell about 29 percent of the nation's electricity supply to consumers.

Increased efficiency in the use of federal power can reduce agency costs. For example, drought conditions have caused the Western Area Power Administration (Western) to buy power from other sources in order to meet its supply obligations to customer utilities. In 1990 these drought-related purchases amounted to some $267 million in additional expenditures that were passed on to Western's customers. Western officials said that they had decided to purchase power instead of expanding Western's DSM programs because they thought the drought was only temporary. In another example, according to an analyst from the Pacific Northwest Electric Power and Conservation Planning Council, if regional DSM efforts do not save enough electricity to reduce capacity requirements by about 350 average megawatts per year, Bonneville and the region's utilities will have to spend about $2 billion more by the year 2000 to meet electricity demand.

In addition, reducing hydroelectricity demand could favorably affect power agencies' ability to satisfy the multiple uses of the river systems that are used to generate federal hydropower. River systems such as the

Columbia are used not only to generate power but also for such purposes as recreation, irrigation, and supporting fish and wildlife. Federal power agencies are called upon to accommodate these multiple uses. To the extent that they reduce demand for hydroelectricity, DSM programs can facilitate the use of the rivers for purposes other than generating hydropower. For example, since 1981 Bonneville has limited power production from the Columbia River hydroelectric system in order to protect fish and wildlife, at a cost of $300 million in lost power sales.

Recently, the National Energy Strategy recognized the important role that federal power agencies can play in encouraging the efficient use of electricity. The strategy—the Administration's proposed energy policy, intended to promote more efficient, environmentally benign energy use—noted that encouraging energy efficiency will help stretch the use of federally generated electricity.

Existing DSM Efforts Vary Widely Among Federal Power Agencies

Current efforts to promote conservation programs by customer utilities vary considerably among the federal power agencies, reflecting differences in the extent to which these agencies' statutory authority encourages electricity conservation and efficiency. Such statutory authority also allows these agencies to link their customer utilities' power allocations or power rates to the implementation of DSM programs.[1]

Bonneville Power Administration

Bonneville supplies about half of the electricity used in the Pacific Northwest, primarily from hydroelectric dams owned and operated by federal agencies. Bonneville also owns about 80 percent of the region's transmission network and coordinates electricity flow throughout the area. The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) directs Bonneville to use conservation to the extent possible.

The efforts of Bonneville to promote conservation include (1) providing financial and technical assistance to electricity consumers, (2) encouraging states and local jurisdictions within its service area to develop energy-efficient building codes, and (3) transferring energy-efficient technologies. As a financial incentive, Bonneville pays part of the cost to weatherize electrically heated homes through customer utilities. Bonneville provides technical assistance by, for example, funding a hotline to

[1] 1The authority to link power allocations or power rates to customer utilities' implementation of DSM programs is called "conditioning authority."

provide information about efficient technologies to commercial and industrial customers. In order to support more efficient building codes, Bonneville promotes model building standards and offers financial incentives to jurisdictions that adopt and enforce the codes, to builders who construct buildings to these standards, and to parties who buy these buildings. Washington and Oregon have adopted state building codes similar to the model conservation standards supported by Bonneville. To provide technology transfer assistance, Bonneville conducted a residential construction demonstration to promote innovative technologies.

In addition to its own conservation efforts, Bonneville's explicit legislative authority enables it to promote DSM programs among customer utilities. The Pacific Northwest Electric Power Planning and Conservation Act of 1980

- requires the Northwest Power Planning and Conservation Council to develop a regional conservation and electricity plan that Bonneville should follow;
- designates electricity conservation as the principal priority for the regional plan;
- authorizes Bonneville, when recommended by the council, to place a 10- to 50-percent surcharge on power sales to customer utilities unless they implement effective DSM programs; and
- directs Bonneville to use revenues obtained as a result of the surcharge to promote conservation efforts.

Western Area Power Administration

The Western Area Power Administration supplies over 10 percent of the power in its vast territory, stretching from Kansas to California. Western is statutorily directed to encourage the efficient use of electricity and has legally explicit conditioning authority for the federal power it markets. Specifically, under the 1984 Hoover Power Plant Act (42 U.S.C. 7275-76), Western must include in sales contracts a provision requiring customer utilities to undertake certain conservation efforts. The act also authorizes Western to withhold part of a customer utility's power allocation if the customer utility fails to take such steps. In an April 1991 Federal Register notice, Western proposed an energy planning and management program that would link power allocations to customer utilities' adoption of long-term energy planning mechanisms and efficient customer electricity use.

Tennessee Valley Authority

TVA is unique among the federal power agencies in that it supplies nearly all of the electricity within its designated service area. In this regard, TVA is similar to a private utility. Thus, if its sales declined as a result of DSM programs (or for any other reason), TVA's rates would probably increase as fixed costs were allocated to a shrinking number of kilowatt-hour sales. Such a situation could induce some municipal and/or large industrial customers to leave the TVA system and buy power from neighboring utilities instead.

TVA operates under general authorities established in the Tennessee Valley Authority Act of 1933; it is not statutorily required to promote energy conservation, and it is an independent federal corporation. Before the late 1980s, TVA operated one of the nation's most aggressive DSM programs, saving an estimated annual average of 205 megawatts per year from home weatherization programs alone. However, since 1988 TVA has largely dismantled its DSM programs.

TVA officials explained that the programs were discontinued for two reasons. First, in the late 1980s TVA decided to hold rates steady for 3 years in order to maintain customers and preserve the integrity of the system. Second, according to its analysis, the agency had exhausted the readily available, cost-effective conservation options within its service area. In the agency's view, it was more cost-effective to meet future electricity demand by completing several partially built nuclear power plants.

We recognize that DSM programs sometimes cause customers' electric rates to increase as utilities' fixed costs are allocated to a decreased number of kilowatt-hours sold. Although we did not verify the accuracy of TVA's analysis, we cite numerous examples in this report in which active DSM programs are being counted on to achieve total electricity savings of 5 to 15 percent, sometimes offsetting over 50 percent of new demand growth.

Other Federal Power Agencies

The Alaska, Southeastern, and Southwestern Power Administrations account for less than 10 percent of the electricity used in their service areas. Alaska operates the generating facilities from which it markets power. Southeastern and Southwestern do not operate any hydropower facilities; they market power primarily from U.S. Army Corps of Engineers hydroelectric facilities.

The smaller power administrations have undertaken modest DSM efforts for several years, or are proposing to institute such measures in the near future. For example, the Alaska Power Administration has worked for several years with the Juneau utility, evaluating and testing demand-side measures as well as supply options. The Southwestern Power Administration has maintained a loan program of energy-efficient equipment and has conducted technical workshops for its customers. Beginning in January 1992, Southeastern may provide energy-efficiency training programs for its generation and transmission cooperatives and for its municipal power agency customers.

Southeastern, Southwestern, and Alaska operate under enabling legislation that implicitly allows them to encourage or persuade their customer utilities to implement DSM programs. However, unlike Bonneville and Western, the smaller power administrations' legal authorities do not allow them to exercise conditioning authority to encourage electricity conservation.

Without explicit mandates or conditioning authority, the smaller power marketing administrations may be hampered in their ability to promote electricity conservation. For example, according to Southwestern and DOE officials, customer utilities may be able to mount successful legal challenges to power marketing agencies' attempts to implement DSM programs. Such challenges may come from customer utilities that face generating capacity surpluses; these utilities may wish to increase sales, not limit them through DSM programs.

Southwestern has attempted to gain clarification regarding its legal authority to mandate DSM programs. According to Southwestern and DOE officials, in 1990 Southwestern requested a statement of authority from DOE to enable it to engage in more active DSM efforts. In January 1991 DOE's Assistant Secretary for Conservation and Renewable Energy informed the Administrator of the Southwestern Power Administration that Southwestern (1) had implicit (not explicit) authority under section 5 of the Flood Control Act of 1944 to encourage conservation programs among customer utilities and (2) could propose, in the absence of more explicit legislative authority, conservation programs through rule-making actions, subject to departmental approval.[2] The legislation does not allow the smaller power marketing administrations to condition power allocations or power rates on a customer utility's DSM efforts, as

[2]The Southeastern Power Administration also operates under the general authority of the Flood Control Act of 1944. The Alaska Power Administration operates under legislation that enables it to operate its two projects. This legislation includes the Eklutna Project Act of 1950 as amended (64 Stat. 382 and 67 Stat. 574) and the Snettisham Project Authorization of the 1962 Flood Control Act, as amended (76 Stat. 1194).

Bonneville and Western's legislative authorities do. DOE and Southwestern officials said that any attempts by Southwestern to implement DSM programs could be challenged in court by customer utilities. As of July 1991 none of the three smaller administrations had initiated rule-makings or taken steps to link power allocations to customer utilities' DSM programs.

Conclusion

Although they supply less than 10 percent of the power in their service areas, the Alaska, Southeastern, and Southwestern Power Administrations can encourage more efficient use of federal electricity resources by encouraging the implementation of DSM programs. To date, these agencies' DSM efforts may have been hampered because, unlike Bonneville and Western, the smaller agencies lack an explicit legislative mandate to encourage efficiency as well as conditioning authority to require DSM efforts by customer utilities. DOE and power agency officials stated that they would welcome additional conditioning authority for the smaller power marketing agencies as long as use of such authority remained discretionary for these power agencies.

Although the percentages of power they provide in their service areas are relatively small, the smaller power administrations have important opportunities to use conditioning power to encourage efficiency in their areas. For instance, customer utilities may consider federal power desirable because it is very inexpensive, frequently costing 2 cents or less per kilowatt-hour. At the same time, some customer utilities may be very dependent upon federal power, buying over half of their total electricity from the federal power administrations.

Matter for Consideration by the Congress

In order to encourage the efficient use of federal electric resources and to maximize the role of federal power agencies in promoting the efficient use of electricity, the Congress may wish to consider enacting legislation that would authorize the Southeastern, Southwestern, and Alaska Power Administrations to link power allocations or power rates to customer utilities' DSM programs.

Assessing the Cost-Effectiveness and Pricing of DSM Programs

Utility demand-side management (DSM) programs are an alternative to increasing electric power supply (the "supply option") for utilities facing expected growth in demand. Evaluating the economics of DSM programs, comparing them with the supply option, and determining how to adjust traditional regulatory methods of setting electric rates to incorporate DSM programs are difficult tasks and are subject to some debate. Decisions that utilities and state regulators make regarding cost-effectiveness and pricing factors can affect whether DSM programs are implemented and to what extent they may displace additional supply sources.

As a general principle, the prime conservation goal of utility DSM programs is to improve energy efficiency; that is, to increase the level of electricity services or benefits—lighting, heating and cooling, and others—per unit of electricity consumed. However, there are costs associated with such gains, such as the cost of developing and deploying more efficient technologies. To maintain economic efficiency, these costs should not exceed the benefits of increased energy efficiency.

DSM Costs and Benefits Can Be Measured From Different Viewpoints

Whether DSM programs should be chosen as an alternative to the supply option depends on a comparison of their economic impacts on the electric utility company in question, its customers, and the economy in general. Because participation in DSM programs is generally voluntary among utility customers, only those programs that result in net economic gains to participants are likely to be implemented. However, making DSM program participants better off than they would be under the supply option does not necessarily ensure that everyone affected by the DSM program will also be better off. Nonparticipating utility customers may end up with higher bills; the utility company's costs may be higher; and the economy in general may incur higher costs to balance electricity supply and demand. An economic comparison also depends on whether "external" effects are considered, such as the environmental effects of supplying electricity from fossil-fueled power plants.

DSM Program Cost-Effectiveness Tests

As DSM programs have evolved, benefit-cost tests have been developed to evaluate the economics of DSM programs. Each test looks at the benefits and costs from a different perspective.[1]

[1]The tests as described in this appendix have been adapted by us to allow comparisons between proposed DSM programs and a utility's alternative of meeting demand increases through "supply options."

- The participant's test measures DSM program benefits and costs solely from the viewpoint of a program's participants. Among the participant's expected benefits are lower electric bills (due to less electricity use).[2] On the cost side, the participant may have to assume all or part of the cost of increasing electric efficiency, such as the cost of replacing a refrigerator with a more energy-efficient model. In a DSM program, the participant's costs may be subsidized directly by the utility, or indirectly through a third-party DSM provider who is paid by the utility.[3]
- The ratepayer impact test[4] adopts the perspective of all the utility's ratepayers. This test measures the DSM program's effects on electricity rates and compares these effects with the rate effects that could be expected without the DSM program. For example, a DSM program may result in higher electric rates than the supply option would. Thus, while participants have lower bills (see footnote 2), nonparticipants may end up paying higher bills than they would under the supply option case.
- The utility revenue requirements test views DSM program costs from the sponsoring utility's standpoint. A utility's revenue requirement is the total dollar amount that regulators use when approving rates; it is the estimated amount the utility needs to cover allowable costs. To pass this test, a DSM program's impact on revenue requirements should be smaller than the impact of the supply option. In the supply option, revenue requirements increase to cover the costs of providing additional electricity. These costs would be avoided if a DSM program resulted in enough conservation to eliminate the need for new supplies. However, the DSM program would impose its own costs, such as the cost of information dissemination, subsidies to induce participation, and/or payments to third-party DSM providers.[5]
- The total resource cost, or societal, test measures the impact of a DSM program on the economy in general. In its broadest definition, this test considers nonmarket, or "external," costs and benefits, such as environmental effects. The total resource cost of a supply option is the cost of supplying kilowatt-hours most economically. The resource cost of a DSM

[2]DSM programs may cause electricity rates (the price per kilowatt-hour) to increase. However, it is assumed that the electricity bills of participants—in the aggregate—will be lower than rates under the supply option. Lower electric bills are the underlying motive for voluntary participation in DSM programs.

[3]If the utility subsidizes the DSM program, the utility is likely to increase electric rates, effectively passing along the cost of the subsidy to both participating and nonparticipating ratepayers. In effect, therefore, nonparticipants would be subsidizing participants.

[4]Also known as the nonparticipants test.

[5]For example, a utility may pay a DSM provider a dollar amount higher than the DSM program's resource cost. In this case, the utility's revenue requirements would exceed the total resource cost of meeting demand for electricity in its service area.

program is, likewise, the cost of the most economic way of conserving the kilowatt-hours.

Benefit/Cost Tests Incorporate Equity as Well as Efficiency Considerations

Utility officials and regulators do not always agree on which tests should be emphasized when measuring the cost-effectiveness of DSM programs. Although efficiency considerations are inherent in the total resource cost test, there may be concerns about equity among ratepayers. The challenge is to balance the interests of utility companies, the customers who participate in DSM programs, the customers who do not participate, and the economy in general.

A DSM program may "fail" the ratepayer impact test on equity grounds, even if it passes all the other tests. For example, even if the total resource cost and the utility's revenue requirements are lower for a DSM program than they are for the supply option, the average cost per kilowatt-hour sold—and therefore electric rates—may be higher. DSM program participants would still pay lower bills than under the supply option because they would consume less electricity (see footnote 2), but nonparticipants would pay higher bills. Proponents of the ratepayer impact test argue that it is unfair for nonparticipants to subsidize participants in this manner.

Pricing and Design of DSM Programs Can Affect Cost-Effectiveness Measures

When consumers anticipate that they can save enough money through reduced electric bills to warrant purchasing more efficient but more expensive devices, they may be expected to do so without any involvement on the part of the utility. However, because of certain anomalies associated with conservation investment decisions (see ch. 3), many DSM advocates believe that utility participation is necessary to achieve the potential efficiency benefits of conservation. As a result, some regulators may consider requiring utilities to subsidize DSM investments when such investments are less costly to the utilities than building additional capacity.

Utility-Subsidized DSM Programs Can Pose Equity and Efficiency Concerns

Utility-subsidized DSM programs present two potential problems. The first is related to equity: If utilities are allowed to pass along their DSM costs to ratepayers, then nonparticipating customers may end up paying higher electric rates than they would under the supply option, without realizing the benefits of reduced electricity use. This may result in nonparticipants' subsidizing participants.

Under traditional cost-of-service electric utility regulation, utilities are allowed to recover the costs of providing electricity and to earn a regulator-approved return on capital investment for their stockholders. The regulated electricity rate (price) is based on the average cost of providing power—that is, the total cost (approved by regulators) of providing electricity divided by the number of kilowatt-hours sold. In comparison, the utility's marginal cost is the incremental cost of supplying an additional kilowatt-hour (by purchasing or generating). Most observers agree that the marginal cost of power supplies today is higher than the average cost. That is, a kilowatt-hour of electricity produced from newly added capacity generally costs more than the existing electric rate.

The second problem is related to economic efficiency: Participants may be willing to contribute to the cost of a DSM program because they will benefit from lower electric bills (even at higher rates) due to reduced consumption. If bills are lower, and if nonparticipants also bear part of the cost, then some investment in conservation might occur even when such investment is more expensive to the economy as a whole than increasing supply.

One way to address both these problems is to require utilities to limit their subsidies for DSM programs so that nonparticipants pay no more than they would pay if, instead of reducing demand through a DSM program, the utility increased electricity supply. This requirement poses the risk, however, of resulting in insufficient investment in conservation if participants prove unwilling to spend more at the beginning for increased energy efficiency even when it would be economically advantageous for them to do so. Therefore, some economists have proposed changing the states' regulatory structures to give utilities additional financial incentives to implement DSM programs that require no direct contribution from participants.

A simplified hypothetical example illustrates how regulatory treatment can affect whether a utility DSM program meets the cost-effectiveness tests for equity and efficiency presented above. An important assumption we make is that the quantity of electricity demanded in the various DSM scenarios below does not change from one scenario to the other, although the rate charged by the utility per kilowatt-hour may be different across scenarios.[6] The example consists of the following scenario:

- The Electric Utility Company's (Electrico) existing load (total demand) is 1,000 kilowatt-hours, supplied at a total cost of $50, or 5,000 cents,[7] including returns to investors. Thus, the average cost is 5 cents per kilowatt-hour, and this is the rate that Electrico charges its customers.
- Electrico expects a growth in load (demand) of 100 kilowatt-hours, absent any DSM programs. It determines that adding capacity to meet this load will require it to receive an additional 800 cents, or 8 cents per kilowatt-hour, from its customers to cover its costs and provide a return to investors. This is the marginal cost of meeting increased demand through additional supplies.
- A DSM provider offers a program to conserve 100 kilowatt-hours. The actual cost of achieving this conservation is 600 cents, or 6 cents per kilowatt-hour saved.
- All of Electrico's customers pay the same rate for electricity (that is, there is only one customer class).

Under a traditional regulatory structure, Electrico would have little incentive to implement the DSM program: Although the DSM program would cost less than building and operating additional capacity, Electrico would have to forego the return it could earn on the capital it would invest in additional capacity.[8]

Although Electrico's customers would have an economic incentive to contract with the DSM provider, regulators may decide that participation, for the reasons discussed in chapter 3, would not be sufficient to capture many of the economic efficiency benefits of DSM. Therefore, the regulators might consider requiring the utility to contract with the DSM provider. If so, and if participants do not contribute directly to the program's cost, the price Electrico will pay might range from 600 cents, the

[6]This assumption greatly simplifies the discussion. DSM programs are usually viewed as a means of slowing outward shifts in demand (resulting from, for example, population growth). The price that a utility pays per unit of electricity conserved affects how much electricity is saved, and thus may be viewed as a factor that shifts the demand curve to the left. The price paid per unit saved also affects the price that the utility charges to its customers per kilowatt-hour generated and sold. Accounting for these changes would complicate the discussion considerably and unnecessarily for our purpose.

[7]Because electric rates are measured in cents per kilowatt-hour, for ease of illustration all values are expressed in cents.

[8]Largely because of risks associated with building new power plants, utilities often meet increased demand by purchasing wholesale power rather than by adding capacity, even though they generally do not earn a return on purchased power. For simplification, our example does not consider purchased power.

actual cost to the DSM provider, to 800 cents, the cost of building additional capacity. (Competition among DSM providers, bargaining skill, and other factors would determine the actual price.)

Table I.1 compares electric rates and societal resource costs under the supply option with their values under a utility-financed DSM program. The two DSM prices represent the lower and upper bounds of the price range as defined above.

Table I.1: Effects of DSM on Electric Rates and Resource Costs

Scenario	Kilowatt-hours demanded and supplied[a]	Effects on Electrico: Supply cost[b]	DSM price	Revenue required[c]	Average cost[d]	Economy's resource cost[e]
Existing situation	1,000	5,000¢	[f]	5,000¢	5.00¢	5,000¢
Supply option	1,100	5,800	[f]	5,800	5.27	5,800
Utility-financed DSM program:						
Price is 6¢ per kilowatt-hour avoided	1,000	5,000	600¢	5,600	5.60	5,600
Price is 8¢ per kilowatt-hour avoided	1,000	5,000	800	5,800	5.80	5,600

[a]The quantity of electricity the utility must supply to meet demand.

[b]The total cost to the utility of supplying the electricity.

[c]The total revenue required to cover the utility's costs, equal to the total costs of supplying power, plus any payments for DSM.

[d]The average cost to the utility per kilowatt-hour. This is equal to the revenue required divided by the number of kilowatt-hours supplied. It is also the rate the utility charges customers.

[e]The economy's total resource cost, equal to the cost of supplying power plus the actual cost of the DSM program.

[f]Not applicable.

Equity

Under a DSM program at either end of the price range, Electrico's electric rates are higher than the rate resulting from the supply option (from 5.6 cents to 5.8 cents, compared with 5.27 cents). Higher rates occur because Electrico's revenue requirements, although no greater than under the supply option, are divided by a smaller number of kilowatt-hours sold than in the supply option (1,000 instead of 1,100). As a result, if not all of Electrico's customers are participants in the DSM program, then nonparticipants will be paying higher rates (without receiving the benefit of reduced electricity use) than they would under the supply option.

Efficiency

For the particular example above, the economy's resource cost is lower with the DSM program, regardless of whether the utility pays 5,600 cents or 5,800 cents. This is because the resource cost of the DSM program, at 600 cents, is lower than the utility's supply option, at 800 cents. In fact, no matter what the utility pays for the DSM program, it would be economically efficient as long as its resource cost is less than that of the supply option.

However, if utilities are not limited in how much they are allowed to pay for DSM, there may be incentives that result in a DSM option that is not economically efficient. If a utility's payment for DSM will be recovered through increases in electric rates, there is an effective subsidy from nonparticipants to participants. Such a subsidy can create a financial incentive for conservation when conservation is more costly, from a societal standpoint, than increasing electricity supplies. This can be illustrated by changing the above example as follows:

- Assume that the actual cost of conserving the 100 kilowatt-hours is 900 cents, or 9 cents per kilowatt-hour saved.
- The DSM provider anticipates charging each participant 4 cents per kilowatt-hour avoided. In theory, participants should be willing to spend up to 5.27 cents per kilowatt-hour to conserve electricity. As table I.1 shows, this is the amount participants would have to pay if Electrico chose to increase supply instead of reducing demand.
- The DSM provider offers to provide the DSM program to the utility for 6 cents per kilowatt-hour. The DSM provider will thus receive a total of 10 cents per kilowatt-hour: 4 cents per kilowatt-hour directly from participants plus 6 cents per kilowatt-hour from Electrico. The provider will earn a profit of 1 cent per kilowatt-hour.
- Electrico recoups its DSM program costs of 600 cents by raising the rates for both its participating and nonparticipating customers. That is, the rate is adjusted to 5.6 cents per kilowatt-hour, as shown in table I.1.

If Electrico was required to implement a DSM program under these circumstances, economic inefficiency would result. The total resource cost of the DSM program would be 5,900 cents (the actual DSM cost of 900 cents, plus the 5,000 cents for supplying the existing 1,000 kilowatt-hours of electricity). This exceeds the 5,800-cent total resource cost of building additional capacity. (This is true even though the cost to Electrico for DSM would be less than the cost of the supply option).

Financial Incentives Can Address Equity and Efficiency Concerns

Some economists favor limiting utility payments for DSM to an amount that is based on the difference between the cost of an additional kilowatt-hour (marginal cost) and the rate that would result under the supply option. This would eliminate subsidies from nonparticipants to participants and the incentive to invest in more conservation than is economically efficient.

As shown in table I.2, nonparticipants are left as well off as they would be under the supply option when Electrico's DSM payment is limited to 2.73 cents per kilowatt-hour, or 273 cents for 100 kilowatt-hours of conservation. This 2.73 cents per kilowatt-hour payment equals the difference between (1) the cost of an additional kilowatt-hour under the supply option (8 cents) and (2) the resulting electric rate of 5.27 cents per kilowatt-hour, also under the supply option. (This amount can be thought of as the difference between the marginal and average cost of providing electricity under the supply option.)

Table I.2: Effects of Limiting DSM Payment on Electric Rates

Scenario	Kilowatt-hours demanded and supplied	Effects on Electrico: Supply cost	DSM price	Revenue required	Average cost	Economy's resource cost
Existing situation	1,000	5,000¢	[a]	5,000¢	5.00¢	5,000¢
Supply option	1,100	5,800	[a]	5,800	5.27	5,800
Utility-financed DSM program						
Price is 6¢ per kilowatt-hour avoided	1,000	5,000	600¢	5,600	5.60	5,600
Price is 8¢ per kilowatt-hour avoided	1,000	5,000	800	5,800	5.80	5,600
Price is 2.73¢ per kilowatt-hour avoided	1,000	5,000	273	5,273	5.27	5,600

[a]Not applicable.

One potential problem with this approach is that the DSM provider will have to charge program participants to fully cover the actual cost of conservation. If the participants are convinced of the potential benefits, the DSM provider may be able to charge them up to 5.27 cents per kilowatt-hour saved. However, if participants are not willing to pay at least 3.27 cents per kilowatt-hour saved, then there will be less investment in conservation than is economically efficient.

Some economists favor a different approach based on "decoupling" utilities' financial incentives from the sale of electric power, per se, and linking incentives instead to the quantity of "energy services" that the power provides. Under "decoupling," the success of DSM is not contingent upon the willingness of a utility's customers to pay for conservation investments. The utility itself pays for DSM investments, but it is given a financial interest in the most efficient use of the electric power that it produces.

The following example illustrates one variant of the decoupling approach:[9]

- Electrico decides to pursue a DSM program that will allow the same energy services to be produced by 1,000 kilowatt-hours instead of 1,100, in effect saving 100 kilowatt-hours. Electrico will bill customers for 1,100 kilowatt-hours although it will actually produce (and the customers will actually consume) only 1,000 kilowatt-hours.
- Electrico offers to pay DSM providers a price for each kilowatt-hour saved that does not exceed Electrico's full avoided cost (8 cents per kilowatt-hour). The actual cost of the conservation is 6 cents per kilowatt-hour.
- Through negotiations, a DSM provider contracts to provide the conservation and sell the saved electricity to Electrico for prices ranging from 6 cents to 8 cents per kilowatt-hour.

Table I.3 shows the electric rates and societal resource costs resulting from the decoupling approach. These can be compared with the pricing options in tables I.1 and I.2. "Low" and "high" refer to the lower and upper end of the range for Electrico's payment (per kilowatt-hour) to the DSM provider.

Table I.3: Impact of Decoupling Revenues and Kilowatt-Hours

	Killowatt-hours		Effects on Electrico's:				
	Supplied	Billed	Supply cost	DSM price	Revenue requirement	Average cost	Economy's resource cost
Low	1,000	1,100	5,000¢	600¢	5,600¢	5.09¢	5,600¢
High	1,000	1,100	5,000	800	5,800	5.27	5,600

From the perspective of the economy in general, the decoupling approach is desirable, because it ensures that the efficient level of conservation will be chosen. From the perspective of consumers, this

[9]This example is based on the work of C.J. Cicchetti and W. Hogan, "Including Unbundled Demand-side Options in Electric Utility Bidding Programs," Public Utilities Fortnightly, June 8, 1989, pages 8-20.

approach is at least as desirable as the supply option and as a DSM program in which Electrico pays 2.73 cents for each avoided kilowatt-hour. In the "high" case, the electric rate is 5.27 cents per kilowatt-hour, while in the "low" case it is only 5.09, lower than under the supply option and the DSM programs at any of the prices shown in table I.1. Moreover, this approach gives utilities an incentive to pursue DSM programs because it is not incompatible with growth in sales revenues.

The Potential for DSM Failures

DSM programs may be less than fully successful in delivering the proposed level of conservation gains. This potential failure complicates the economic feasibility of DSM programs. Consider the example in which the utility offers 273 cents per kilowatt hour avoided for conserving 100 kilowatt hours. As a practical matter, Electrico may be unable to find enough DSM providers and/or willing customers—at 273 cents or at some other price—to achieve savings of 100 kilowatt-hours. If, after expending 273 cents, only 50 kilowatt-hours were saved, Electrico's total costs would increase. Electrico would have to supply an additional 50 kilowatt-hours, probably at the full marginal cost of 8 cents, or a total of 400 cents. Rates might have to be adjusted upwards again to the extent that overall costs increased.

The actual results of DSM programs may differ from the results forecasted, either because participation is not as expected or because participation does not lead to the demand reductions expected. Such differences may ultimately affect whether DSM programs meet tests of equity and economic efficiency.

Efficient Electricity Use and International Economic Competitiveness

Because the United States is energy-intensive compared with its primary foreign competitors, improvements in energy efficiency could improve the international economic position of the nation vis-a-vis its competitors. Benefits might include reducing petroleum imports and increasing opportunities to export energy-efficient goods and technologies. Because electricity is a major energy source, in 1989 accounting for 35 percent of the nation's energy consumption, improvements in electricity efficiency have the potential to significantly improve the nation's overall energy efficiency. Furthermore, reducing investment in capital-intensive electric power plants and power transmission systems could free up funds for investment elsewhere in the economy.

However, the extent of such benefits depends on a number of factors, such as the relative intensity of electricity use among various industries or economic sectors and how each is affected by attempts to bring about efficiency improvements. Also, efficiency gains are not free. If the cost of adopting new, efficient technologies exceeds the value of the energy savings, then economic costs will rise, not fall. Even utility DSM programs that successfully reduce overall economic costs may cause non-participating industrial consumers' costs to rise. Because the relationship between electricity use and U.S. international economic competitiveness has not been extensively studied, the extent to which increased electricity efficiency alone would engender competitive benefits is unclear.

U.S. Economy Is Relatively Energy-Intensive

Compared with its European and Japanese competitors, the United States is relatively energy-intensive. According to the International Energy Agency, the United States uses 1.6 times more energy to produce one dollar of gross national product (GNP) than Japan.[1] Moreover, the United States uses from 20 to 33 percent more energy per dollar of GNP than six leading industrial European nations, while U.S. industries use from 10 to 25 percent more energy per dollar of value added to manufactured goods.

However, while the United States is relatively energy-intensive compared with its chief competitors, it is not clear that the nation's international competitive position would benefit significantly from improved energy efficiency. First, because domestic energy prices are lower in the

[1] A nation's gross national product is the value of all goods and services produced during a specified time period, usually 1 year.

United States than in such competitor nations as Japan, there is an economic incentive for U.S. businesses to invest in more energy-intensive industries such as aluminum and petrochemicals. The opposite is true in countries with higher energy prices. At the same time, countries with higher energy prices have a greater incentive than the United States to invest in, produce, and export energy-saving technologies.

Moreover, because almost 90 percent of the United States' overall energy needs are met from domestic sources, the intensity of energy use may not diminish U.S. international competitiveness or U.S. national security to the same extent that such use would affect other large industrial nations that rely more on imported sources.[2] Some 94 percent of U.S. electricity is generated using domestic energy sources other than oil.

Effects on U.S. Production Costs and Exports

If electricity efficiency improvements reduce a company's or industry's production costs, particularly in export-oriented industries that are also electricity-intensive, the nation's exports may increase. However, as shown in appendix I, the effects of utility DSM programs on electricity costs can vary widely. Such programs may result in higher electricity rates, possibly increasing—rather than decreasing—production costs for electricity customers who do not participate in the DSM programs.

To appreciate these different effects, it is necessary to differentiate between social costs, market costs, and costs incurred by DSM program participants and nonparticipants. The following hypothetical examples illustrate how DSM programs can affect these cost categories.

Example 1

An electric utility company operates in an area that suffers from serious air pollution problems. This company faces a growth in demand, which may be met by building a new power plant or by curtailing demand through a DSM program aimed at residential consumers. This example includes an industrial firm that is both electricity-intensive and export-oriented, and is an important local customer served by the utility.

Although the dollar cost of the new plant is somewhat lower than the cost of the DSM option, the new power plant would result in increased air

[2]The United States typically produces three times as much energy as do the other large industrial nations combined. For purposes of this report, the large industrial nations are the so-called "Group of Seven" or "G-7" nations—Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

pollution emissions. Under a wider definition of costs that includes the social cost of pollution, the DSM option may be more economic than building a new, polluting power plant.

Under these circumstances, rather than approving construction and operation of a new power plant, state regulators decide that the utility should implement a DSM program. However, the DSM program causes electric rates to increase more than they would if the power plant had been built.[3] The DSM option increases the industrial firm's manufacturing costs, thereby potentially hurting its exports.

Example 2

The scenario is exactly the same as in the first example, except that the utility's proposed DSM program is aimed at industrial consumers, and the industrial firm in our example decides to participate in the program.

Although electric rates in the DSM case are higher than they would be if a power plant were built, the industrial firm saves enough electricity to decrease its total costs per unit of production. In this case, DSM-induced efficiency improvements are likely to help exports.

Effects on Imports and Energy Security

Unlike efficiency improvements in the transportation sector, improvements in electricity efficiency would not be likely to have a significant effect on petroleum imports or U.S. energy security. In 1989 the value of the nation's net energy imports (primarily oil) reached $33 billion, accounting for over 25 percent of the U.S. trade deficit.

Generally, oil imports tend to decrease as the economy becomes more energy-efficient, thus improving the nation's balance of payments. However, in the United States, only about 5 percent of electric power is generated using petroleum products. About 94 percent of U.S. electricity is generated using domestic resources other than oil—primarily coal, natural gas, renewables (mostly hydroelectric dams), and uranium (nuclear power). Therefore, improvements in electricity efficiency would have to be quite dramatic to have any appreciable influence on the volume of petroleum imports.

[3] As shown in app. I, even if a DSM option costs less than the new plant option, electric rates may be higher if the DSM case is implemented. This is because with a DSM program, fewer kilowatt-hours are sold, so the average cost per unit may be higher.

Other Effects

Besides the potential for lowering production costs, more efficient use of electricity could enhance U.S. economic competitiveness in other ways:

- Achieving greater electricity efficiency could entail U.S. development of more efficient technologies, possibly increasing exports of efficient goods and technologies. However, because electricity is cheaper here, U.S. industry has less incentive than do overseas competitors to develop efficient goods.
- Increasing electricity efficiency contributes to the nation's overall energy efficiency because electricity accounts for 35 percent of U.S. energy consumption. Increased energy efficiency reduces the nation's overall expenditures on energy. In 1988 the nation's energy bill was over $414 billion. According to the Alliance to Save Energy and the Congressional Research Service, realizing technically feasible decreases in the nation's energy use could result in a $100-billion net annual savings in the national energy bill.
- Reducing investments in the energy sector may free up capital for other investments such as plant modernizations and new products. The energy industries are very capital- intensive, consuming about 11 percent ($46 billion) of all investment capital in the United States in 1987 and as much as 25 percent in other years. Because greater energy efficiency could constrain growth in energy demand, it could reduce the amount of investment capital needed by energy-producing and -distributing industries, including the electric utility industry. Thus, the pool of investment capital available for other productive uses would be expanded.

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