Impact of DSM on U.S. Electrical Usage, 1990-2000: An Update

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This paper contains estimates of the likely impact of utility-sponsored DSM programs on U.S. electric usage in the 1990-2000 timeframe. It suggests that DSM programs will reduce annual energy consumption by 4.3% and summer peak demand by 8.3% in the year 2000. At the margin, DSM will offset 22% of the growth in annual energy consumption and 36% of the growth in summer peak demand. These estimates are conditional on the continuation of the current structure of the utility industry and the continual aggressive pursuit of DSM key utilities.

These DSM impact estimates are considerably higher than projections developed only three years ago, which estimated a 3% reduction in annual energy and a 6.7% reduction in summer peak demand. They reflect increased utility DSM activity, brought on by rising regulatory incentives for engaging in DSM programs, and improved program designs that have resulted in greater program participation rates.

Estimates are presented by end use and program type for the United States as a whole. Overall, 80% of the annual energy impacts are concentrated in 8 of 38 end uses. The commercial sector accounts for almost half of the DSM impacts.

These estimates are derived by reviewing about 70 utility resource plans. This review helped to identify typical program concepts, and representative impacts per customer and number of participating customers for each of these program concepts. These estimates were combined with a forecast of customer usage in the absence of utility DSM programs developed with EPRI's system of end-use forecasting models to yield DSM impacts by program type.

Introduction

Surveys conducted by the Electric Power Research Institute (EPRI), document that utility-sponsored demand-side management (DSM) programs have involved more than 18.6 million residential customers, 730,000 commercial customers, and 144,578 industrial customers.[1] In 1990, utilities are estimated to have spent $1.5 billion on these programs, according to a survey conducted by the U.S. Energy Information Administration (EIA).

This paper presents results of a 1993 study that updates estimates of the likely impact of these programs on customer electricity demand in 1990 and 2000.2 These estimates are developed through a series of assumptions about:

- Market size
- DSM program applicability
- Customer participation
- Energy or demand reductions per customer, device, or square foot (called "unit DSM impacts")

These assumptions reflect estimates provided by utilities through a review of DSM and IRP documents, supplemented with a reading of the trade and technical literature. This study is a update to a similar study published in 1990 which estimated DSM impacts over the same period. [3] EPRI commissioned the 1993 study to reflect the major changes that have taken place in the DSM criteria of the past several years. Recent trends toward competition and industry restructuring have not been factored into this paper.

DSM impacts aggregated over all customer sectors are projected to grow from 22,690 GWh in 1990 to

140,680GWh in 2000, achieving an annual growth rate (AGR) of 20%. Peak summer demand impacts are projected to increase from 18,540 MW in 1990 to 51,590 MW in 2000, achieving an AGR of 11%. Peak winter demand impacts will rise from 16,530 MW in 1990 to 41,240 MW in 2000, achieving an AGR of 10%.

Over the 1990 to 2000 period, DSM is projected to reduce the AGR of the baseline forecast of annual energy consumption from 1.8% to 1.4%. The baseline forecast is a forecast of customer usage in the absence of any DSM program activity. It incorporates efficiency improvements due to market forces, such as changing energy prices and technological innovations, and due to government standards. Table 1 compares DSM impacts with the baseline forecast.

Trends in the baseline forecast, DSM impacts, and the forecast net of DSM are displayed in Figure 1.

Approach

The numbers shown in Table 1 and Figure 1 are based on a review of four major sources:

- Baseline forecast
- Utility Integrated Resource Planning (IRP) documents
- DSM program experience
- U.S. Energy Information Administration (EIA)

To develop the baseline forecast of end-use electricity consumption and peak summer and winter demand for the residential, commercial, and industrial sectors, we used information from EPRI's end-use forecasting models, REEPS, COMMEND, and INFORM. The baseline forecast reflects national macroeconomic conditions; market trends in buildings, processes, and equipment; and government standards. This forecast was calibrated to 1990 energy consumption data published by the U.S. Energy Information Administration. Forecast data for peak demand were calibrated to recent forecasts by the National Electric Reliability Council (NERC).

To determine trends in the utility industry's DSM activities, we drew upon more than 70 recently filed IRP documents. We collected information on trends in DSM program design and projected DSM impacts. To further determine the composition of typical utility DSM programs-and to make assumptions about program and end-use applicability, penetration rates, and unit DSM impacts—we relied on the industry's collective DSM program experience, as reported at national DSM conferences and as published in the trade and technical press. This experience reflects utility activities from all parts of the United States over the past ten years.

Finally, we used information in a 1991 U.S. EIA survey (Form 861, Schedule V) to cross-check our estimates of DSM impacts.[4]

DSM Impacts by End-Use Market

An important finding of this study is that a very large share of DSM's energy impacts are attributable to only 8 of 38 end-use markets, as shown in Table 2. In terms of the baseline forecast, these eight markets account for nearly 60% of the total energy consumption of 3.3 million GWh projected for the year 2000. In terms of DSM impacts, however, these markets comprise nearly 80% of the energy impacts, over 60% of the peak summer demand impacts, and nearly 50% of the peak winter demand impacts. Programs directed at these end uses—such as commercial lighting, industrial motors, and commercial cooling—are typically cost-effective for a broad range of geographic and demographic segments, and are included in most utilities' DSM portfolios.

DSM Impacts by Customer Class

DSM programs directed at the commercial sector account for the largest share of total DSM impacts. In the year 2000, commercial DSM programs account for almost half of the total energy savings (49%), with the industrial sector accounting for another 26% and the residential

Table 1. Comparison of DSM Impacts With the Baseline Forecast

	DSM Impacts as a Percentage of Baseline Forecast, 2000	Percent of New Load Growth Offset by DSM, 1990-2000	Reduction in Annual Growth Rate of Baseline Forecast, 1990-2000
Annual energy consumption	4.3%	22%	0.4% per year
Summer peak demand	8.3%	36%	0.5% per year
Winter peak demand	7.2%	22%	0.4% per year

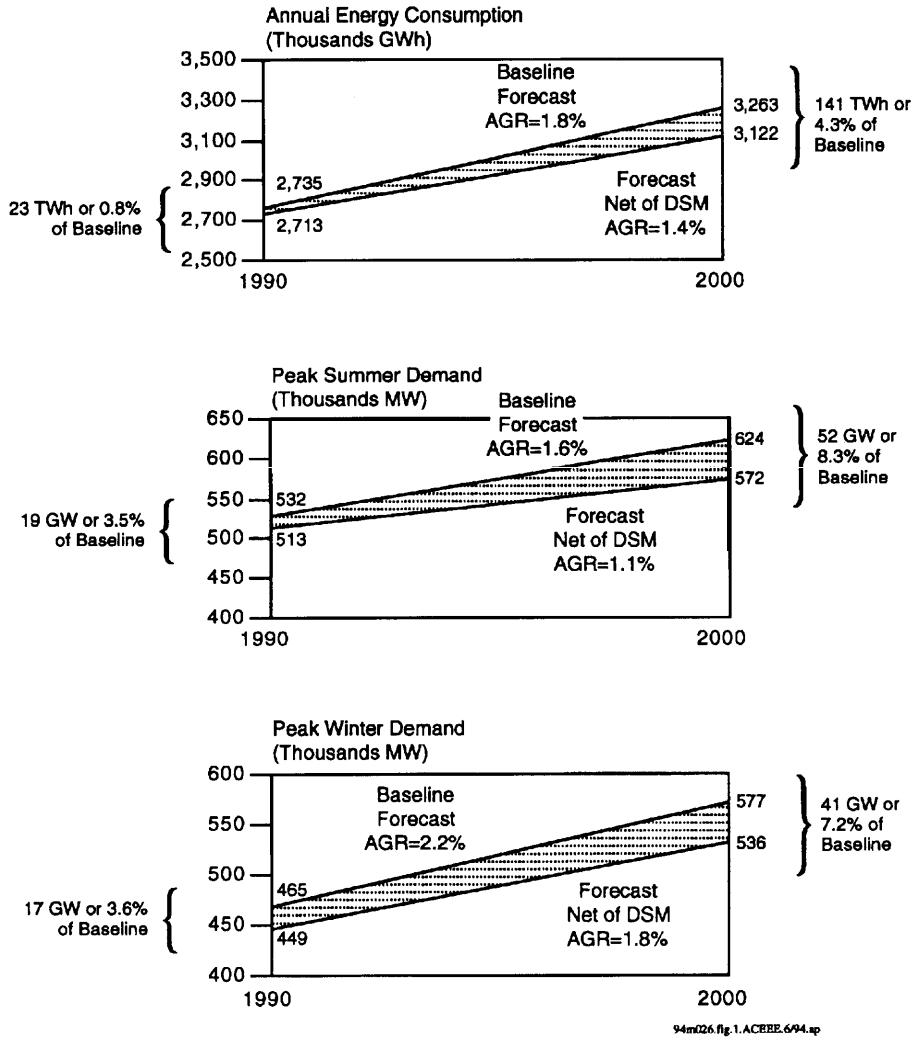


Figure 1. Estimated DSM Impacts

sector for the remaining 25%. Additional details on impacts by sector are presented in Table 3. A closer look at the key results by sector follows.

Residential Impacts

Figure 2 shows that the most common residential DSM programs in the 1990s relate to new construction, audit/weatherization, and high-efficiency equipment. These programs focus on end uses that account for the largest share of household loads—heating, cooling, water heating, and lighting. Program designs vary from utility to utility, reflecting regional diversity in both incentives offered and household uses and load shapes, as well as utility-specific diversity in DSM objectives. The three most common programs are projected to account for 83% of energy savings in the year 2000. Similarly, four end uses—space heating, cooling, water heating, and lighting—are projected to account for over 90% of residential energy savings estimates.

Commercial Impacts

Figure 3 shows that the most common commercial DSM programs are prescriptive and customized incentives, which target replacement and retrofit construction. These programs encourage commercial customers to buy and install energy-efficient equipment. DSM programs affect end uses that account for the largest share of baseline commercial building loads—indoor lighting, HVAC, and refrigeration. Program design variations among utilities reflect regional diversity in the measures offered (particularly under prescriptive rebate programs), building types and end-use markets, and load shapes. The two most

Table 2. DSM Impacts for the Eight Largest End-Use Markets, Year 2000

Sector and End-Use Market	Annual Energy GWh	%	Cumulative %	Peak Summer Demand MW	%	Cumulative %	Peak Winter Demand MW	%	Cumulative %
Commercial lighting	33,370	24%	24%	7,340	14%	14%	5,010	12%	12%
Industrial motors	22,870	16%	40%	2,070	4%	18%	1,830	4%	16%
Commercial cooling	16,380	12%	52%	9,830	19%	37%	80	0%	16%
Residential space heating	10,520	7%	59%	0	0%	37%	8,460	21%	37%
Residential water heating	9,240	7%	66%	3,020	6%	43%	5,980	15%	52%
Residential cooling	6,360	5%	71%	9,600	19%	62%	0	0%	52%
Residential lighting	6,920	5%	76%	530	1%	63%	1,220	3%	55%
Commercial refrigeration	6,610	4%	80%	1,020	2%	65%	780	2%	57%
All others	28,420	20%	100%	18,200	35%	100%	17,890	43%	100%
Total	140,680	100%		51,590	100%		41,240	100%	

Table 3. DSM Impacts by Sector

Annual Energy Impacts

Sector	1990 GWh	1990 % of Total	1990 % of Base[(a)]	2000 GWh	2000 % of Total	2000 % of Base[(a)]
Residential	7,060	31%	0.88%	35,110	25%	3.3%
Commercial	10,960	48%	1.3%	69,040	49%	6.8%
Industrial	4,680	21%	0.5%	36,530	26%	3.1%
Total	22,690	100%	0.85	140,680	100%	4.3%

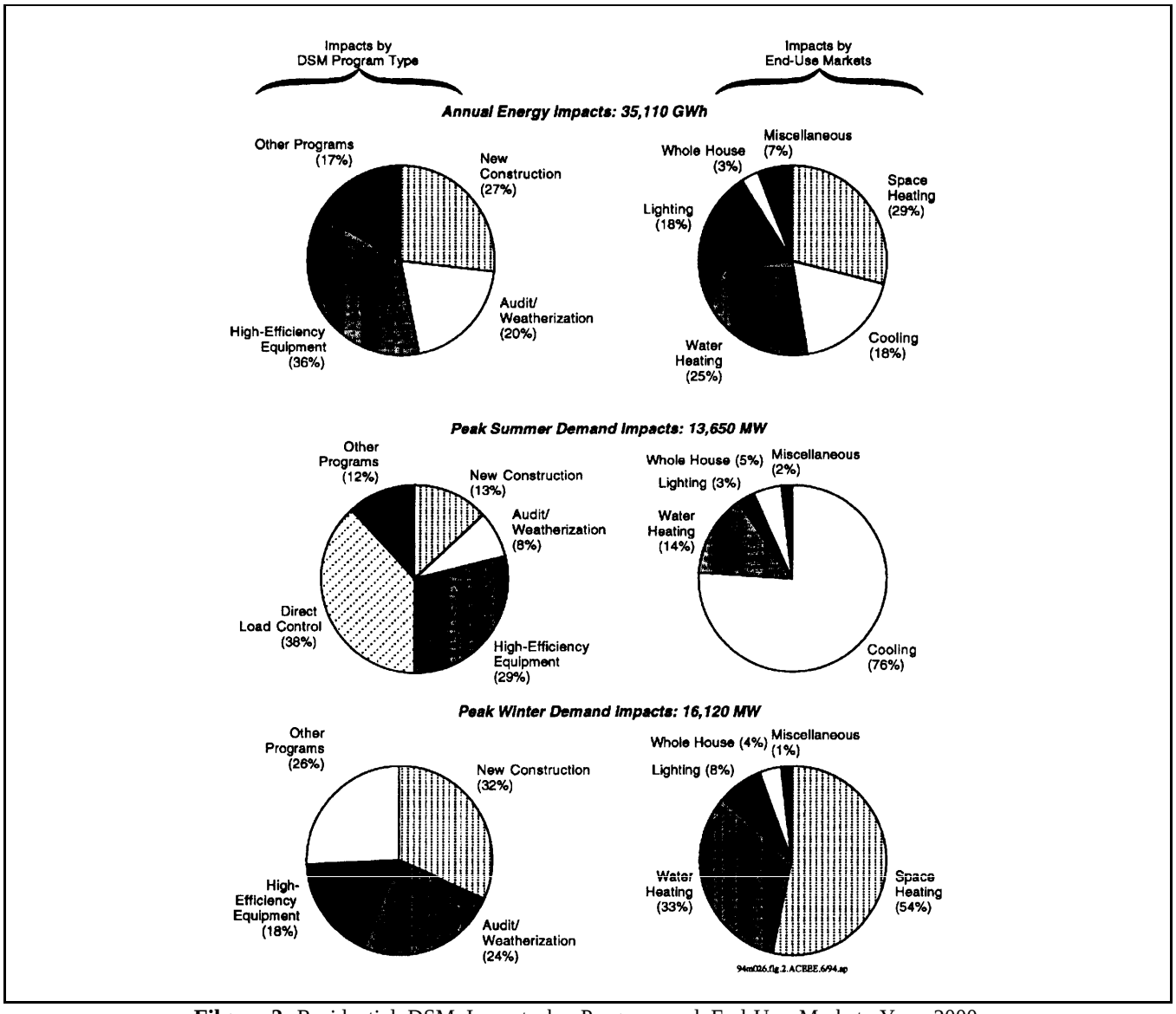
Peak Summer Demand Impacts

Sector	1990 MW	1990 % of Total	1990 % of Base[(a)]	2000 MW	2000 % of Total	2000 % of Base[(a)]
Residential	4,760	26%	2.6%	13,650	26%	6.8%
Commercial	3,870	21%	1.9%	21,360	41%	8.8%
Industrial	9,910	53%	6.7%	16,580	32%	9.7%
Total	18,540	100%	3.5%	51,590	100%	8.3%

Peak Winter Demand Impacts

Sector	1990 MW	1990 % of Total	1990 % of Base[(a)]	2000 MW	2000 % of Total	2000 % of Base[(a)]
Residential	5,550	34%	2.6%	16,120	39%	6.1%
Commercial	2,080	13%	1.8%	10,240	25%	6.9%
Industrial	8,910	53%	6.5%	14,880	36%	9.0%
Total	16,530	100%	3.6%	41,240	100%	7.2%

(a) Percentage of baseline forecast



Filgure 2. Residential DSM Impacts by Program and End-Use Market, Year 2000

common programs are projected to account for more than 70% of the energy savings in the year 2000. Similarly, two end uses—indoor lighting and space cooling—are projected to account for two-thirds of the energy savings.

Industrial Impacts

Figure 4 shows projected year 2000 impacts of industrial DSM programs offering prescriptive rebates, customized incentives, and innovative rates. Prescriptive rebate and customized incentive programs focus on end uses accounting for the largest electricity use in the industrial sector, including motors, lighting, electrolytic, and process heat. Innovative rate programs emphasize managing whole-plant industrial electric loads through curtailable or interruptible rates, time-of-use rates, and real-time pricing. Industrial programs tend to be broadly targeted compared with residential or commercial programs, reflecting the diversity of industrial market segments, processes, and equipment. Motors are projected to account for 63% of the energy impacts, followed by innovative rates, which are projected to account for 24% of energy impacts in the year 2000.

Changes in DSM Forecasts

Reflecting the dynamic nature of the DSM industry, forecasts of future DSM impacts have continued to change. Table 4 shows a comparison of 1993 forecasts that are discussed in this paper with 1990 forecasts contained in an EPRI report (EPRI CU-6953). As the table indicates, both energy and peak demand impacts for the year 2000 have risen in 1993. The mix across sectors has also changed in 1993, with the commercial sector

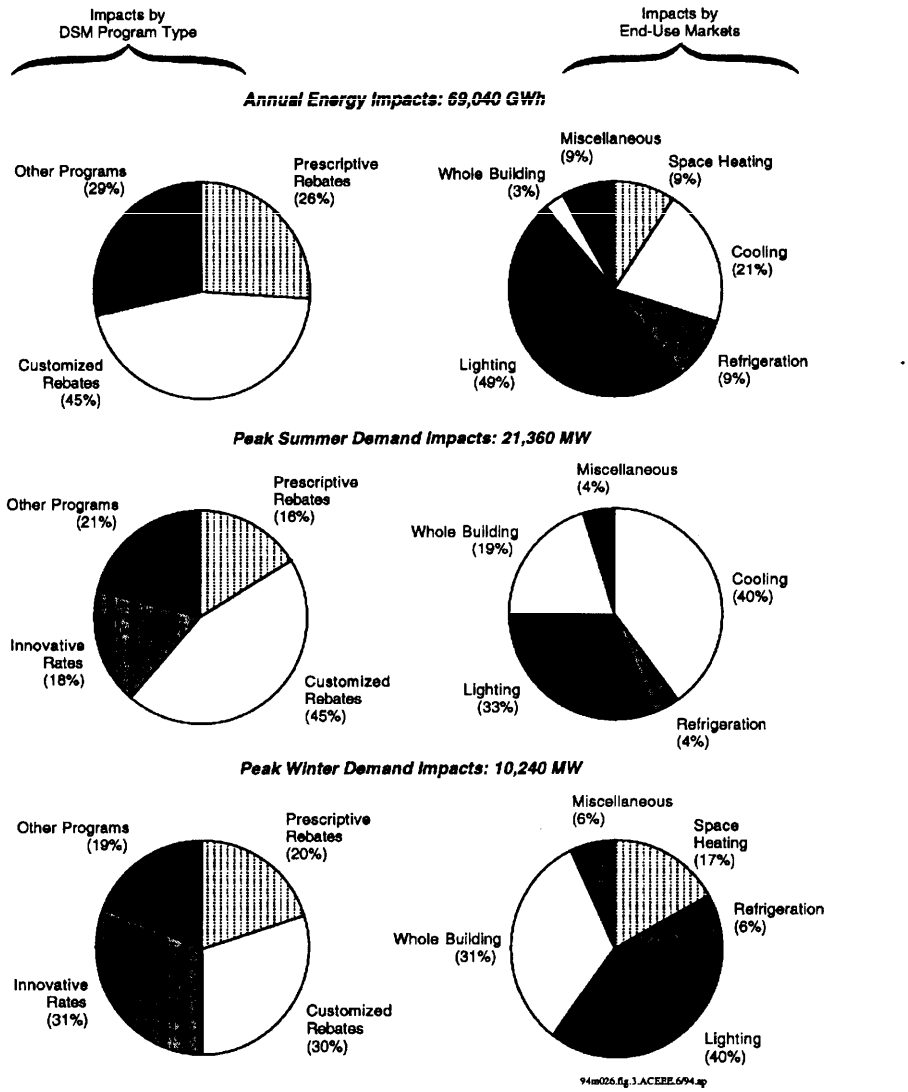


Figure 5. Commercial DSM impacts by Program and End-Use Market, Year 2000

the year 2000 have risen in 1993. The mix across sectors has also changed in 1993, with the commercial sector moving from third to first place, and the industrial sector moving from first to third place. This change in project impacts reflects:

- The increased emphasis on energy-efficiency programs made possible by the provision of financial incentives to utilities for investing in energy-efficiency programs;
- The effects of electrification and self-generation, which are not included in the 1993 estimates as DSM impacts. Such effects are now accounted for in the baseline forecast and include factors such as natural market forces, productivity enhancements, and utility economic development programs;
- Commercial-sector technology impacts and market penetration rates, particularly in lighting, have been revised upward to account for increased commercial DSM activities nationwide; and
- Industrial-sector technology impacts attributable to motor drives have been revised downward to reflect pending national standards pertaining to applications of energy-efficient motors.

Due to scope limitations, no sensitivities were performed for the 1993 study. However, DSM specific sensitivities pertaining to these estimates were performed and are reported in a recently published paper. [5]

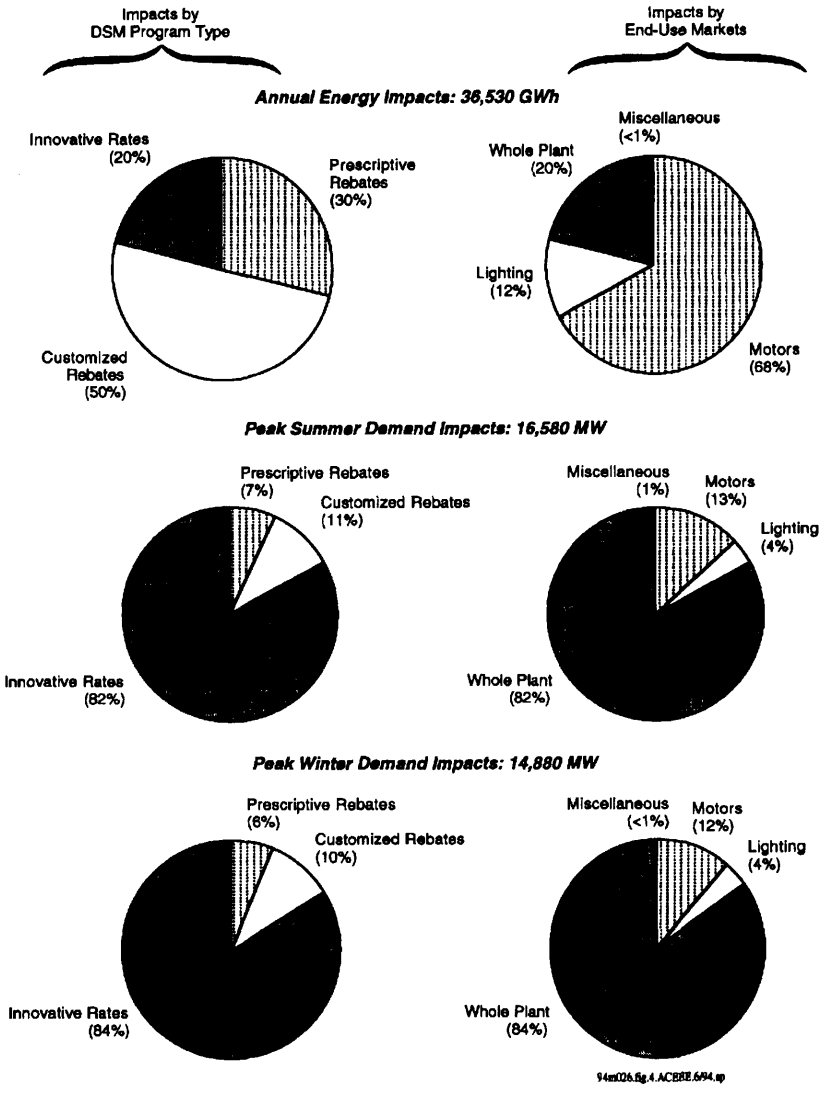


Figure 4. Industrial DSM Impacts by Prograrn and End-Use Market, Year 2000

Conclusion

DSM programs in the United States could have a significant impact on the projected customer demand for electricity. On average, in the year 2000, they could offset 4.3% of annual energy consumption, 8.3% of summer peak demand, and 7.2% of winter peak demand. At the margin, between 1990 and 2000, they could offset 22% of the new growth in annual energy consumption, 36% of the new growth in summer peak demand, and 22% of the new growth in winter peak demand.

These estimates were based on the best available information about the trends in the underlying drivers, such as the baseline forecast, percent unit DSM impacts, and customer participation rates.

Endnotes

1. EPRI report entitled 1992 *Survey of Utility Demand-Side Management Programs,* EPRI TR-102193, 1993.

2. Additional details are contained in an EPRI report, *Drivers of Electricity Growth and the Role of Utility Demand-Site Management,* TR-102639, 1993.

3. EPRI report entitled "Impact of DSM on Future Customer Electricity Demand: An Update," EPRI CU-6953, 1990.

4. Data from the U, S. EIA survey were derived from a report by Eric Hirst, *Electric-Utility DSM Programs: 1990 Data and Forecasts to 2000,* June 1992.

Table 4. Comparison of Year 2000 DSM Impacts Estimated in This With Those in 1990 EPRI Report

Annual Energy Impacts, Year 2000

Sector	1990 Estimates GWh	1990 Estimates % of Total	1990 Estimates % of Base[(a)]	1993 Estimates GWh	1993 Estimates % of Total	1993 Estimates % of Base[(a)]
Residential	15,568	14.7%	1.3%	35,110	25%	3.3%
Commercial	33,310	31.4%	3.1%	69,040	49%	6.8%
Industrial	57,256	53.9%	4.6%	36,530	26%	3.1%
Total	106,134	100.0%	3.0%	140,680	100%	4.3%

Peak Summer Demand Impacts, Year 2000

Sector	1990 Estimates MW	1990 Estimates % of Total	1990 Estimates % of Base[(a)]	1993 Estimates MW	1993 Estimates % of Total	1993 Estimates % of Base[(a)]
Residential	10,984	24.6%	5.4%	13,650	25%	6.8%
Commercial	12,637	28.3%	4.8%	21,360	41%	8.8%
Industrial	20,966	47.0%	10.8%	16,580	32%	9.3%
Total	44,587	100.0%	6.7%	51,590	100%	8.3%

Peak Winter Demand Impacts, Year 2000

Sector	1990 Estimates MW	1990 Estimates % of Total	1990 Estimates % of Base[(a)]	1993 Estimates MW	1993 Estimates % of Total	1993 Estimates % of Base[(a)]
Residential	7,613	23.6%	2.7%	16,120	39%	6.1%
Commercial	5,794	18.0%	3.8%	10,240	25%	6.9%
Industrial	18,809	58.4%	10.7%	14,880	36%	9.0%
Total	32,216	100.0%	5.3%	41,240	100%	7.2%

(a) Percentage of baseline forecast

Note: 1990 estimates are from an Electric Power Research Institute report entitled *Impact of Demand-Side Management in Future Customer Electricity Demand* (CU-6953). These estimates include the impact of electrification and self-generation programs, whereas this paper includes these effects in the baseline forecast.

5. For a further discussion about the uncertainty behind the impact projections reported in this paper, see Faruqui, Wikler and Chamberlain, "Clouds in the Future of DSM," *The Electricity Journal,* July/August 1994.

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