Energy Vol. 14, No. 10, pp. 615–628, 1989
Printed in Great Britain.

0360-5442/89 $3.00 + 0.00

COMPARATIVE ASSESSMENT OF THE DEMAND-SIDE MANAGEMENT PLANS OF FOUR NEW YORK UTILITIES

CHARLES GOLDMAN and EDWARD KAHN
Applied Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720, U.S.A.

(*Received* 7 *February* 1989)

Abstract—This study provides a comparative assessment of the initial long-term demand-side management (DSM) plans of four New York utilities. Several quantitative and qualitative indicators are developed to assess the impact of DSM programs. For example, by the year 2000, the four New York utilities project that DSM programs could produce savings representing between 15 and 60% of their projected peak-load growth for that period. However, there is no consensus among the utilities about the appropriate methods for evaluating programs or deciding on implementation. We suggest criteria against which utility DSM plans should be assessed and apply this approach to the four utilities. We also identify the most important data and analysis needs for improving future DSM plans: improved stock characterization, explicit treatment of independent power production in the resource mix, a comprehensive assessment of the achievable potential for DSM options for all end uses and sectors, research on customer response and other information relevant to DSM options (load shape impacts, incentives required to achieve certain penetration rates), and consistent avoided cost projections.

INTRODUCTION

In April 1988, New York's seven investor-owned utilities filed their first long-term demand-side management (DSM) plans as a result of a Public Service Commission (PSC) order which directed each utility to assess the potential for DSM in its service territory and identify cost-effective programs to capture that potential.[1] Prior to this decision, the utilities had spent about $60 million on demand-side activities, principally on research and development projects, as a result of a 1984 PSC decision that required the state's utilities to devote up to 0.25% of annual revenues towards investments in end-use efficiency.

The PSC's long-term goal is a planning process in which DSM competes on an equal basis with supply-side resources to meet future needs. Perspectives often differ on this question. It is common for utilities to begin their analysis by defining a load shape objective, and then shaping DSM programs to meet that goal. The Electric Power Research Institute (EPRI) has played a leading role in developing the conceptual framework for demand-side management and documenting case studies of utilities that have implemented a DSM planning process and programs.[2,3] Demand-side management options include strategic conservation, load management, customer generation, new uses of electricity, electrification, and variable levels of customer service. This approach has gained broad acceptance in the utility industry.[4] Regulators commonly approach DSM in the context of broad policy objectives that include social issues such as environmental quality and equity among interested parties. Moreover, there is often a difference in time horizon between the regulator's perspective and the utility's. The regulator's perspective, which includes this broader social agenda, is often described in the literature as least-cost utility planning.[5]

The issue of appropriate time horizon can be critical in situations where utilities have excess generating capacity during the near term. In this case, the utility's load shape objectives often focus on valley filling and load growth, and not on long-term improvements in end-use efficiency (i.e., strategic conservation). As we will see, this issue arises with several of the New York utilities. The issue of differing time horizons is also reflected in the language of economic evaluation tests that are used to measure DSM programs. Some of these tests emphasize near-term rate effects (e.g., the non-participants test); other tests attempt to capture long-term social costs. Without a common perspective on goals, the discussion of DSM programs and their economics can become a hopelessly diffuse exercise involving parties talking past each other, without much real contact and communication.

In the long run, DSM programs will only find a useful place in the utility environment if a convergence of perspectives can be achieved between the utilities and the regulators. Hirst, among others, has emphasized the importance of establishing consensus on goals and methods.[6] The example of collaborative planning between utilities and government agencies in the Pacific Northwest is an instructive model of how DSM can achieve a significant role in the planning and resource acquisition process that is satisfactory to all parties.[7] However, the particular circumstances which led to the convergence of perspectives in that case are not general. We find that the environment in New York does not support consensus at this time. Nonetheless, the dialogue among utilities, regulators, and other interested parties initiated by the filing and review of these initial DSM plans provided an opportunity for the articulation of differences and creates the pre-conditions for their possible resolution.

In this study, we review the current state of this dialogue in New York and assess the extent to which perspectives differ among the utilities and between their goals and those articulated by the PSC. The DSM plans of four utilities are analyzed: Consolidated Edison (Con Ed), Rochester Gas & Electric (RG&E), New York State Electric and Gas (NYSEG), and Niagara Mohawk Power Co. (NMPC).† The study begins with a summary of the current load/resource balance of the NY utilities in order to provide a context for the comparative assessment. Next, we examine the DSM plans of the individual utilities in some detail: the technical and market potential for conservation, cost-effective programs in each sector, impact on future load growth, and efficiency options that are not included in the plans. We then develop overall criteria to use in assessing DSM plans, and discuss the strengths and limitations of the plans of the New York utilities in that context. Finally, some suggestions are offered for improving future DSM plans.

CURRENT SITUATION OF NY UTILITIES

New York's seven major investor-owned utilities, along with the New York Power Authority, are members of the New York Power Pool (NYPP). Member utilities engage in coordinated planning as part of the Pool. Current reserve margins for the Pool are significantly higher than the required reserve margin target (32 vs 22%, respectively). Most of the state's utilities have excess generating capacity, with the notable exception of Long Island Lighting Co. (Table 1).

The Pool's summer peak load is projected to increase at an annual rate of 1.2% during the forecast period (1988–2004). Forecasts of peak load growth range from 0.9%/yr for NMPC to 2.3%/yr for NYSEG. Among the four utilities. Con Ed and RG&E are summer peaking, while NYSEG and NMPC experience peak loads during the winter. Con Ed's summer peak loads are dominated by electricity use in commercial buildings, which accounts for about 70% of the total system peak. In contrast, residential buildings are the largest contributor to RG&E and NYSEG's peak loads (40%), while the industrial sector contributes about 25% of the total system peak. Average electricity rates (in 1986) were between 6 and 7 cents/kWh for the three upstate utilities, while average rates for Con Ed's customers were significantly higher (about 12.5 cents/kWh).

COMPARATIVE ASSESSMENT OF UTILITY DSM PLANS

The Public Service Commission (PSC) provided the utilities with substantial latitude in developing initial DSM plans. As a result, the information and data provided by the utilities

† We did not review the DSM plans of two smaller investor-owned utilities, Central Hudson Gas and Electric and Orange and Rockland Utilities, as well as the Long Island Lighting Co., which is in a unique position because it needs capacity immediately.

Table 1. Current situation of the New York utilities.

System Characteristics	Utility				NY Power Pool
	Con Ed	RG&E	NYSEG	NMPC	
1988 Reserve Margin (%)	34%	40%	20%	37%	32%
Peak Load Growth (%/year) (1987-2000 Projected)	1.0%	1.5%	2.3%	0.9%	1.2%
Peak Season[†]	S	S	W	W	S
Estimated Class Peak or Sales (%)[‡]					
- Residential	30%	40%	41%		
- Commercial/Govt	70%	33%	34%		
- Industrial	-	27%	25%		
1986 Avg. Electricity Rates (¢/kWh)[§]	12.5	7.2	7.1	6.1	
- Residential	14.9	8.8	9.5	7.6	
- Commercial	12.1	15.3	8.5	7.4	
- Industrial	11.9	-	6.5	4.2	

Sources: DSM Plans of individual utilities; New York Power Pool, "Electric Power Outlook:1988-2004," (April 1988). [†] S = Summer; W = Winter [‡] Summer peak for Con Ed and RG&E; sales for NYSEG; Con Ed's industrial customers are grouped with the commercial class, although contribution to peak demand is quite small. [§] Energy Information Administration, "Financial Statistics of Selected Electric Utilities 1986," DOE/EIA-0437(86), Table 41, (February 1988).

varied significantly in terms of format, quality (e.g., reliance on empirical data vs estimates), and level of detail, which complicates efforts to evaluate and compare the plans.

Quantification of DSM technical potential

The identification of large-scale demand-side resources is strongly influenced by the range of DSM options considered as well as the approach taken to the initial screening process. Of the four utilities, Con Ed's plan provided the most comprehensive assessment of the technical potential for DSM. Con Ed developed a large menu of DSM options for the residential and commercial sectors, including operating strategies and rate design (about 75 measures). Con Ed estimated that these DSM options had the technical potential for reducing its summer peak in the year 2000 by about 2800 MW. Con Ed defined technical potential for DSM as the maximum attainable savings without considering cost-effectiveness or ability to physically install the measure; the market potential for DSM will be significantly lower.

NMPC argued that it was not worthwhile to devote substantial resources to quantifying the technical potential for demand-side options and thus restricted its effort to a qualitative assessment of various end uses (e.g., residential space and water heating, refrigerators, and commercial lighting). NMPC stated that there were significant aggregation problems in estimating total potential based on individual options (e.g., double-counting of savings) and that there were conceptual problems in defining the potential for certain types of measures (e.g., load-shifting options that could ultimately create a new peak in formerly off-peak hours).

RG&E and NYSEG did not attempt to quantify the technical potential for DSM. Instead, each utility evaluated the market potential for a relatively limited range of DSM options (about eight programs). Many promising options were deferred for future analysis, and neither utility attempted to identify the full technical potential of DSM programs.

Options for the industrial sector were not examined in detail by any of the utilities, although NMPC's plan recognized the potential opportunities in this sector. The industrial sector probably poses the most difficult challenge for estimating the technical and market potential of DSM because of the heterogeneous nature of the sector, the diversity of firms within the same industry, as well as difficulties in forecasting energy savings from technical improvements in process-related loads. Thus, given the gaps in coverage of certain sectors, the initial plans of the utilities should not be viewed as comprehensive assessments of the DSM potential.

Impact of proposed DSM programs

Table 2 presents several indicators that show the impact of DSM programs proposed by the four utilities: the cumulative reduction in peak load (MW) by the year 2000, savings from DSM programs as a fraction of projected peak load growth and as a fraction of total peak load (in the year 2000 without DSM). The initial DSM plans of all four utilities are modest in terms of the contribution of DSM options to reducing total system peak load (3–8%). Moreover, the various indicators are calculated based on the optimistic assumption that *all* proposed programs will be implemented. These values are lower than the market potential for DSM identified in other recent studies. For example, the Michigan Electricity Options Study (MEOS) concluded that aggressive implementation of conservation and load management options could reduce summer peak loads by 1500 and 650 MW respectively, over the next 15–20 yr, which would reduce total system peak load by about 9–11% (depending on assumptions regarding load growth). The estimates in the MEOS study were based on 36 DSM measures; these measures covered end uses representing 70% of residential and only 30% of commercial sector electricity use.[8] Similarly, the Northwest Power Planning Council concluded that conservation resources could reduce Bonneville Power Administration's overall demand for electricity by 14% over the next 20 yr and could meet virtually all of the needed system-load growth for the next 10 yr, except in the high-load growth scenario (Ref. 7).

The quantitative indicators are most meaningfully interpreted in the context of an assessment of the utility's commitment to implement large-scale DSM programs. The PSC directive to develop DSM plans is only a first step toward comprehensive integrated resource planning. There is clearly lacking the shared and uniform perspective on this process that Hirst, for example, has identified as a key element in its success.[9] The contrasting attitudes of the utilities can best be seen by a measure of their interest in realizing DSM options over the next decade. The indicator "utility commitment" is qualitative and admittedly somewhat subjective. However, at the present time, we believe that it is the key factor. We have defined it as the utility's stated willingness or actual commitment of dollars to implement new full-scale DSM programs in the near-term. Using this standard, only Con Ed and NYSEG actually propose to implement new full-scale DSM programs. RG&E and NMPC's willingness to commit to major expenditures is contingent on satisfactory resolution of the lost revenues problem. DSM programs, particularly those that promote higher end-use efficiency, can cause revenue shortfalls or lost revenues because utility rates are calculated on the basis of a specific demand forecast and, in some cases, on both sunk and planned supply investments to meet that demand. In cases where the utility has excess capacity and slow or stagnant load growth, DSM programs that reduce sales (and revenues) adversely impact the utility's ability to recover sunk investments, without either raising average rates or reducing shareholder earnings.

Table 2. Potential impact of utility DSM programs.

Utility	(1) 1987 Peak Load (MW)		(2) Projected Load Growth to 2000 without DSM		(3) DSM Impact Indicators: Peak Load Reduction due to DSM (MW)		(4) % of Peak Load Growth†	(5) % of Peak Load‡	Utility Commitment§
	S	W	S	W	S	W			
Con Ed	**7964**	5655	**1216**	680	**742**	---	61%	8.1%	A
RG&E	**1205**	1105	**255**	325	**0-115**	0-85	0-45%	0-7.8%	P
NYSEG	2055	**2530**	667	**802**	62	**130**	16%	3.9%	A
NMPC	5565	**6124**	359	**752**	0-99	**0-198**	0-26%	0-2.9%	P

Sources: DSM Plans of individual utilities; New York Power Pool, "Electric Power Outlook: 1988-2004" (April 1988). † Col.(4) = Col.(3)/Col.(2); calculated based on system peak of each utility (in bold). ‡ Col.(5) = Col.(3)/Col.(1)+(2); calculated based on system peak of each utility (in bold). § P = planned; A = action on some programs. • Con Ed and RG&E are summer peaking; NYSEG and NMPC are winter peaking.

Of the four utilities, Con Ed's DSM programs are probably the most ambitious. Con Ed projects that its proposed DSM programs could reduce summer peak loads by 742 MW in the year 2000, which represents about 60% of its projected load growth. Con Ed proposes full-scale implementation of five programs in the near-term and intends to expand seven pilot programs to full-scale if ongoing pilot projects prove them to be viable. However, some of the programs may not prove to be cost-effective from the utility's perspective or the technologies are not completely developed. For example, direct control of room air conditioners and swimming pool motors programs, representing about 140 MW, are just in the development stage, because the load management hardware has not been successfully tested.[10]

NYSEG proposes to implement several DSM programs, principally load-shifting measures (e.g., residential thermal storage and demand-controlled water heating), which are expected to reduce its winter peak by 130 MW in the year 2000.[11] The company's commitment to these programs appears strong and is in line with corporate objectives to improve system load factor. Most of the benefits from NYSEG's DSM programs occur relatively far in the future (e.g., peak load reduction of 130 MW by 2000; 220 MW by the year 2006) and also result in only a minimal reduction in electric sales (e.g., 34 GWh saved compared to total sales of 18,688 GWh in the year 2000).

Rochester Gas & Electric (RG&E) and Niagara Mohawk Power Co. (NMPC) identify significant DSM opportunities, although both utilities are very concerned about the impacts of lost sales associated with conservation programs. RG&E projects that three large-scale DSM programs could reduce its summer peak by 115 MW in the year 2000, about 45% of projected peak load growth. However, RG&E claims that DSM program uncertainties are much too high to justify major investments at this time.[12] The DSM programs proposed by Niagara Mohawk Power Co. (NMPC) represent about 26% of the utility's projected peak load growth. NMPC will initiate the DSM programs "provided that procedures for recovering lost revenue can be developed that are mutually acceptable to NMPC and the Commission".[13] Because the two utilities have attached major contingencies to full-scale implementation of DSM programs, peak load reductions are shown as ranges in Table 2.

Where are the large-scale demand-side resources?

Table 3 presents the cumulative peak load savings by the year 2000 for DSM programs/measures identified by each utility as potentially cost-effective. DSM measures targeted to commercial buildings account for about 75% of Con Ed's total peak-load reduction, which includes gas/steam A/C options. RG&E expects that DSM options for commercial and residential buildings will produce comparable reductions in peak loads, while NYSEG's and NMPC's programs focus primarily on reducing peak demand in the residential sector. Of the four utilities, only NMPC proposes a DSM program targeted at industrial customers, an energy management information service.

Commercial sector lighting. Three of the four utilities identify commercial lighting as an end-use for which there are cost-effective DSM options. For example, Con Ed proposes three commercial lighting programs (incandescent to fluorescents, relamping of fluorescents, and high-efficiency ballasts) which have installed costs that range between $400 and 900/kW. By the year 2000, Con Ed estimates that its programs can reduce peak loads by 168 MW, about 40% of the technical potential, which it estimates at about 400 MW. High-efficiency ballasts have the largest market potential (90 MW). Based on pilot studies, Con Ed also attempts to account for the effect of free riders, which reduces the market potential by about 13%. NMPC found that the penetration of efficient lighting technologies was quite low in most commercial building types (<10%) with the exception of hospitals. Thus, NMPC estimated that fluorescent relamping and conversion of incandescents to fluorescents had the technical potential to reduce peak loads by about 107 MW, although it did not propose these programs in its DSM plan.† These studies suggest that the technical potential for reducing lighting electricity use is quite large; the challenge is to fully exploit the identified potential. Thus, differences in program

† NMPC is currently conducting a large pilot study in its service territory on commercial sector lighting programs and may propose a DSM program in this area, depending on the results of this study.

Table 3. Demand-side programs proposed by New York utilities.

Sector	DSM Strategy	Cumulative Peak Savings by year 2000 (in MW) Con Ed	RG&E	NYSEG	NMPC
Commercial					
Lighting Replacement	C	168	52	25	
Efficient Motors	C	5			
Thermal Cool Storage	LS	41			
Energy Management Systems	C	9			
Efficient Air Conditioning Replacement	PC	81			10
Curtailable Electric Service	FLS	80			
Residential					
Replace existing room air conditioning	C	41	49		
Water heaters	C		4		14†
High efficiency refrigerators	C			5	
Room air conditioning - direct control	PC	119			
Pool Motors - direct control	PC	21			
Water Heating - direct control	LS			49	42
Thermal storage - new	LS/VF			25	82‡
- existing	LS/VF			26	
Time of Use Rates	LS				50
Industrial					
Energy Management information					NA§
Other (gas/steam A/C)		177			
Total Peak Load Reduction (MW)		742	115	130	198

C = Conservation; LS = Load-shifting; PC = Peak-clipping; FLS = Flexible load shape; VF = Valley filling; † Low-cost water heating measures program will reduce peak load by 42 MW by mid-1990s. ‡ NMPC estimate for residential thermal energy storage includes existing and new homes. § NA = not available at this time.

design (rebate levels, delivery mechanism, marketing strategies) and key input assumptions (problem of free riders) need to be examined in more detail.

Commercial sector: other end uses. Con Ed identifies several other DSM options that are applicable to commercial buildings (e.g., motors, thermal cool storage, efficient air conditioning replacement, curtailable electric service), while NMPC proposes a program to promote the installation of energy-efficient HVAC equipment in new commercial construction. These other DSM options could also represent significant cost-effective opportunities for the other three utilities, although their relative impact in terms of reducing system peak loads is smaller because the commercial sector accounts for a smaller share of total system peak (e.g., 70% for Con Ed vs 25–35% for NYSEG and RG&E).

Utilities in other regions have implemented some of these DSM options in full-scale programs. For example, Texas Utilities and Southern California Edison estimate that they have each shifted about 30 MW of peak load because of cool storage installations in commercial buildings.[14] Additional commercial sector DSM options should be examined by the three upstate utilities in future plans.

Residential sector. In the residential sector, the summer peaking utilities (Con Ed and RG&E) found that upgrading replacement room air conditioners along with several peak clipping measures (e.g., direct control of room air conditioners and pool motors) were cost-effective DSM options. Utilities with winter peaks (NYSEG and NMPC) favored load-shifting and valley-filling DSM options (e.g., direct control of water heating and residential thermal storage). In addition, several utilities proposed conservation programs for water heating, either installation of low-cost measures (NMPC) or replacement of existing water heaters with high efficiency units (RG&E).

Results from other studies suggest that residential DSM conservation options can be particularly attractive to customers. For example, in the MEOS study, residential lighting programs accounted for 33% of the electricity savings, and were particularly effective in reducing winter peak loads.[15] These type of programs should be explored by New York's

Table 4. High-efficiency refrigerator programs: key assumptions.

Program Features	Con Ed	RG&E	NYSEG	NMPC
Program Design	New/Repl.	All Existing	New/Repl.	New/Repl.
Target Market (homes)	NA	170,000	600,000	NA
Penetration Level (%)	NA	50%	41%	NA
Penetration Rate (%/yr)	NA	100%/yr in 1 yr.	3.5%/yr over 12 yrs	NA
Cost ($/unit)				
- Administrative	NA	15	20†	NA
- Field labor	NC	10	NC	NC
- Incentive/Rebate	NA	900	62	29
Total Cost ($/unit)	NA	925	82	NA
Electricity Savings (kWh/unit-yr)	NA	NA	180	104

Sources: DSM Plans of individual utilities. Con Ed, p. 94-95; RG&E, p. 42; NYSEG, p. V-A-11,23,24; NMPC, p. 6-5,7. † Based on administrative and promotional costs of $240,000 and $150,000/year, respectively, which was divided by average number of rebates for refrigerators over study period. NA = information not provided in DSM plan. NC = not considered.

winter-peaking utilities, NYSEG and NMPC. In their plans, residential conservation options either were not thought to match the load shape objectives of the utilities and therefore were eliminated or were not cost-effective from the utility's perspective. Thus, conservation options are a relatively small component of the DSM programs proposed by the utilities.

In looking at residential DSM options, it is also important to account for the impact of the National Appliance Energy Conservation Act (NAECA) of 1987, which mandates minimum levels of energy efficiency for selected new residential appliances (refrigerators, freezers, central and room air conditioners, heat pump, electric and gas water heaters, and gas furnaces). For example, a recent study by Geller concluded that utility-funded rebates may still be a cost-effective strategy for several products, including highly-efficient air conditioners and heat pumps; appliances in which there are significant efficiency differences between the top-rated models and the initial standards (i.e., about 30–50%).[16] Program design of future utility appliance rebate programs may focus more on accelerating the turnover of inefficient existing stock, rather than stimulating purchase of high-efficiency new equipment.

High-efficiency refrigerator programs. All four utilities considered various types of refrigerator rebate programs. Only NYSEG actually proposed a rebate program, while the other three utilities concluded that it was not cost-effective. The differences among the utilities appear to be primarily related to differing views on program design and costs, although there are significant gaps in data reporting which make it difficult to draw definitive conclusions (Table 4). For example, RG&E's program would stimulate customers to replace existing refrigerators before the end of their useful lifetime and includes very high penetration rates. The other three utilities designed their programs toward influencing the decisions of those customers purchasing new refrigerators or replacing existing refrigerators and used much lower penetration rates over a longer time period than RG&E (although overall saturation levels are comparable). RG&E's proposed rebate levels of $900 are more than an order of magnitude greater than those proposed by NYSEG and NMPC and are out of line with the estimates of other studies.†[17] At such levels, the programs cannot be cost-effective.

DSM options for new construction: capturing lost opportunity resources. The utilities should emphasize DSM programs that attempt to improve the efficiency of new construction, given their current situation (i.e., excess generating capacity). The timing of these type of programs

† Eto et al examined market discount rates for refrigerators by looking at historic appliance purchase decisions in conjunction with historic energy prices and found that market discount rates are high (80–100%). They concluded that rebates must essentially offset the entire increase in *first* cost of each successive level of efficiency; not the entire cost of the appliance.

coincides well with utility revenue and capacity needs: minimal lost sales in the near-term combined with development of a long-term DSM resource that can be acquired more cost-effectively by promoting energy-efficient new construction compared to the future costs of retrofitting. Facing a similar near-term resource glut, the Northwest Power Planning Council (NPPC) and Bonneville Power Administration (BPA) have established several innovative programs, including building performance standards for new residential and commercial construction and design assistance programs for builders, to ensure energy-efficient construction of the new stock. Developing a comprehensive approach will require cooperation from the appropriate institutions within the State that have jurisdiction over building performance standards.

Strengths and limitations of utility DSM plans

Regulators that are evaluating utility DSM plans probably will find it useful to establish broad guidelines that can serve as an independent yardstick against which individual plans can be assessed. We developed such criteria and used them to evaluate the strengths and limitations of the DSM plans of the four utilities. The following areas were considered: (i) How comprehensive was the assessment of potential DSM options (e.g., extent to which the plan considered all end uses, sectors, and options that included different load shape objectives)? (ii) DSM technical and market potential—how well did the utility assess the technical and market potential of DSM options (e.g., scope, approach to screening DSM options and estimating energy and demand impacts)? (iii) DSM program costs—are DSM program costs reasonable and well-documented (e.g., are incentive levels for programs based on pilot studies or estimated, relation between participation rates and program costs, utility administrative costs)? (iv) Program design and implementation—are the programs logical given the utility's assessment of the DSM potential and the costs and benefits of the program? To what extent has the utility paid attention to how individual DSM options (end-use technologies) are combined into programs (the utility's delivery system)? Did the utility evaluate alternative program designs and strategies? (v) Economic assessment of DSM—what economic tests were used by each utility to evaluate costs and benefits of DSM programs? Were they appropriate? Did the utility consider other factors in screening and selecting DSM programs (e.g., customer service, ability to avoid lost opportunities, equity issues—availability to low-income customers)? (vi) To what extent did the utility's economic analysis incorporate transactions with the Power Pool (e.g., were avoided costs estimated from the perspective of the utility as an island)? (vii) Commitment of utility resources to assure development of DSM resources—how much effort is the utility devoting to DSM data collection/analysis, research and development, and pilot programs? Is the utility's program evaluation effort adequate?

Not surprisingly, the initial DSM plans of the utilities tend to be uneven. Several utilities were particularly strong in some areas, but could benefit from additional efforts in other areas (see Table 5). For example, Con Ed's DSM plan provided a fairly comprehensive assessment of the technical and market potential of a wide-range of DSM options, including an estimate of "free rider" effects for each program. However, its documentation of program costs was quite sketchy. Con Ed did not explicitly include the utility's administrative and incentive costs in its economic analysis. Initially, these cost elements were arbitrarily set at zero in the non-participant test; the amount by which the option passed the test established a cost guideline for utility expenditures. While this may be a useful analysis technique, it tends to lower confidence in the projected savings for various DSM programs. Achievement of the market potential of a utility DSM program is closely linked to the program's design and required incentive levels; Con Ed's approach masks this key feature.

Conversely, NYSEG's DSM plan considered a rather limited number of DSM programs/measures. However, programs that were evaluated by the utility had a detailed assessment of energy and peak demand impacts, the target market for each program, and components of program costs. Assumptions were clearly stated and typically based on experience in pilot programs, which tends to increase confidence in the reliability of the savings and cost estimates. In addition, NYSEG's DSM plan had a particularly strong link between the utility's Action Plan (e.g., strategic marketing action plan endorsed by top management) and its longer-term DSM objectives. NYSEG's challenge is to broaden its menu of DSM options to include additional strategic conservation programs. This issue is related to the relatively short time horizon that the company uses to define its current load shape objectives (e.g., load-shifting and valley-filling). In the longer run, strategic conservation may play a much larger role.

RG&E's DSM plan was a useful exercise for the utility because it highlighted the commitment of utility resources that are required in order to develop full-scale DSM programs. However, the plan is primarily illustrative and focuses on the development of a planning methodology that can be used to evaluate DSM options and identify key uncertainties. The initial plan does not provide a basis to guide implementation of large-scale DSM programs. RG&E needs to address a broader range of DSM options and assess alternative implementation strategies and program designs based on pilot studies or the experience of other utilities. RG&E's program design focused too much on "blitz" programs that required very high incentive levels to induce high participation rates. RG&E's economic analysis of the costs and benefits of DSM was relatively sophisticated; their analysis included the impact of DSM options on the sale or purchase of economy energy from the Power Pool.

NMPC's economic analysis also attempted to account for interactions with the Power Pool. In addition, NMPC's Plan reflects its strong commitment to demand-side R&D activities—the Company's market research and stock characterization are quite developed, and its pilot programs include strong monitoring and evaluation components. In terms of limitations, NMPC's analysis bundles several programs by load shape, which makes it impossible to

Table 5. Strengths and limitations of utility efforts.

Program Features	Con Ed	RG&E
DSM Options		
- Comprehensiveness	Excellent (75 measures)	Limited (7 programs)
- Assess Tech. Potential	Thorough	No
- Market Potential	Well-developed (quantified free-rider effects)	Exogenous penetration rates; not based on pilot studies
- Program Cost Data	Poor documentation	Incentive levels are excessive
- Program Design & Implementation	Transition to full-scale programs linked to pilot program results & cost-effectiveness	Blitz programs primarily; no timing strategy; penetration levels and time allowed to achieve them are unrealistic
Economic Tests/Analysis		
Screening	Total resource cost; participant	
Selection	Non-participant†	Rev. Requirements
Program Start Date	Non-participant†	
- Interaction with Power Pool	No	Yes
Commitment of Utility Resources to Development of DSM Options	Strong pilot programs, particularly commercial sector	Accelerating R&D and pilot program efforts; program evaluation needs additional emphasis

† DSM program costs, both administrative & incentives, are set equal to zero.

continued overleaf

Table 5—*continued*

Program Features	NYSEG	NMPC
DSM Options		
- Comprehensiveness	Limited (6 programs; building standards)	Good (~50 options initially; 20 measures for further screening)
- Assess Tech. Potential	No	Illustrative; Qualitative only
- Market Potential	Driven by load shape objective; good data on energy demand impacts by measure.	Bundle measures by load shape impact; aggregate impact tested only
- Program Cost Data	Well-documented; reasonable & well-adjusted incentive levels	Well-documented; based on pilot program results
- Program Design & Implementation	Penetration level bounded by system peak impacts; pilot study on alt. program design	Long range timing drives implementation level
Economic Tests/Analysis		
Screening		Participants test
Selection	Rev. requirements	Non-participant
Program Start Date		
- Interaction with Power Pool	No	Yes
Commitment of Utility Resources to Development of DSM Options	Strong link between action plan and long-term DSM plan; good R&D program on load-shifting measures and DSM information exchange (NORDAX)	Very strong R&D program; good experimental design on pilot programs, particularly real-time pricing

evaluate the merits of individual programs. For example, NMPC's combined conservation program is an aggregation of several individual programs, including residential low-cost water heating measures, residential refrigerator rebate program, commercial sector efficient exit lighting, and commercial sector efficient motors. In addition, NMPC's approach to implementing DSM programs is so cautious, that, in some cases, the utility appears to miss some obvious opportunities, which could be identified based on the experience of other utilities. For example, NMPC identifies commercial lighting efficiency options as having significant technical and market potential for DSM, yet it was the only utility that did not propose a DSM program in this area (although the company is currently conducting a pilot study).

Finally, we note that all four NY utilities have a reasonably strong commitment to developing the infrastructure to conduct, monitor, and evaluate demand-side programs. In particular, R&D and pilot program efforts are accelerating; the challenge is to make an effective transition to full-scale implementation of DSM programs.

DISCUSSION

Table 6 summarizes our assessment of the data and analysis needs for improving future DSM plans. Items that in our opinion are highest priority are indicated by a dagger. These include: improved stock characterization, explicit treatment of qualifying facilities (QFs) in the resource mix, a comprehensive assessment of the market potential for DSM options for all end uses and sectors, research on customer response and other information relevant to DSM options (e.g., load shape impacts, incentives required to achieve certain penetration rates), and avoided cost projections. In general, more reliable data are available on DSM options for the residential

Table 6. Data/analysis needs for improving DSM plans.

Area	Current Situation	Priorities for Future
Electricity Demand Forecast		
Sales Forecasts by Sector	Type of Model	
- Residential	Appliance End Use	Best characterized
- Commercial	Econometric	Incorporate engr. end use approach
- Industrial	Econometric or typical customers	Needs improvement; address heterogeneity, market conditions, cogeneration and bypass
Peak Load Models	HELM	Focus on commercial & industrial load shapes
† Peak Impacts by End Use	Incomplete	Key area; needs improvement (esp. comm./ind.)
Appliance Saturation	2 of 4 utilities report	Comm'l office equipment (computer loads, internal heat gains)
† Stock Characterization (EUIs)		Focus on commercial sector
Thermal Integrity	Not included	Impt. for assessing weatherization pgms.
Generating Resources		
Resource Mix		Include in future plan for reference
Reserve Margin		Include in future plan for reference
† Treatment of QFs	Inconsistent among util.	Include in load/resource balance

† Indicates high priority needs

Area	Current Situation	Priorities for Future
DSM Options		
Assess Tech. Potential	1 of 4 utilities	Useful for targeting DSM opportunities
† Achievable Potential	Few end uses, mostly resid.	High priority; focus on comm. & ind. sector
Elect. Savings	Engr. estimates	Measured data needed to confirm engineering estimates
Load Shape Impacts	Engr. estimates	High priority although metered data is expensive
DSM Costs		
- Installed Cost	Pilot pgms; other utilities	
† - Incentive/Rebate	Pilot programs	Experience from full-scale implementation
- Administration	Pilot programs	
Penetration Level	Estimates	Establish targets for full-scale pgms
† Penetration Rates	Pilot pgms.	High priority; based on experience with full-scale pgms.
Cost/Benefit Analysis		
† Avoided Costs	Key for assessing DSM benefits	Use long-run avoided costs
- Energy	Information available but not always included in Plan	Include fuel price sensitivity analysis
- Generation	Used combustion turbine or combined cycle proxy	Agree on allocation of capital-related costs and reliability discounting factor
- Trans.& Dist. (T&D)		Quantify DSM impacts on T&D costs; area needs additional work
- Add'l Time differentiation		Standardize and define costing periods

† Indicates high priority needs

sector. The commercial and industrial sectors are less well characterized, particularly in terms of peak impacts by end use and achievable DSM potential.

The avoided supply costs are one critical element in the evaluation of the benefits of DSM options. The utilities' projections of avoided costs should be based on their long-term resource outlook and include sensitivity analyses of varying fuel prices and levels of independent power production. Additional work is also needed on quantifying the impact of various DSM options on avoided transmission and distribution losses and costs.

Our analysis also suggests that the PSC and utilities must resolve several thorny analytical and methodological problems. We briefly discuss several of these issues: (1) economic tests for DSM measures, (2) timing of DSM programs, (3) DSM uncertainties vs supply-side uncertainties, (4) key factors to assess in sensitivity analysis, and (5) evaluating DSM options: individual utility vs power pool.

Economic tests for DSM measures

The four utilities used varying economic tests for initial screening and final selection of DSM options. There is a large literature on the appropriate economic tests to use in selecting DSM options.[18–20] For example, Con Ed and Niagara Mohawk argued strongly that the non-participants (or "no-losers") test should be used in selecting DSM options and in determining appropriate start dates. The non-participants test considers the impact of DSM programs on average rates; benefits are defined as avoided generation, T&D capital costs, and avoided fuel costs which are subtracted from DSM program costs and lost revenues. RG&E and NYSEG point out that all DSM options failed this test. Both RG&E and NYSEG selected DSM options based on the utility revenue requirements test. The utility revenue requirements test represents total discounted benefits and costs for the entire study period. Benefits include transactions, capacity and production cost benefits. Costs include costs of the program to the utility but exclude revenue impacts. It is clear that reliance upon the non-participants test will severely limit the amount of resources available from DSM options. From our perspective, the PSC needs to develop a more explicit treatment of the various economic tests and their role in program evaluation. For example, the total resource cost test has a plausible claim to priority among the several tests because it addresses the resource allocation issue directly from a broad social perspective. This test includes both utility and consumer costs balanced against avoided cost benefits. Institutional constraints dictate the use of other tests as well.

Timing of DSM programs

The utilities were particularly concerned that DSM programs would lead to substantial near-term revenue losses. In the long-run, the avoidable costs associated with new supply-side resources should offset future revenue losses of many DSM options. It may be advisable to start implementation of DSM programs now at a modest scale to realize the long-term benefits of such resources. Such efforts could be expanded as the resource balance becomes tighter. Thus, the timing of DSM programs is a particularly critical issue: programs and incentives should be selected that meet the twin goals of minimizing short-run negative rate impacts while preparing for long-run expansion of DSM programs. It would also be useful to integrate this planning with the identification of long-run avoided costs.

DSM uncertainties vs supply-side uncertainties

The utilities expressed significant concerns about key aspects of DSM programs (e.g., customer response, marketing and administrative costs, and load shape impacts). One utility claims that the uncertainties are so great that it is not feasible to implement large-scale DSM programs. We make two observations: (1) several utilities failed to adequately distinguish between sources of uncertainty, and (2) the utility's analysis seemed to implicitly downplay the uncertainties associated with supply-side resources. With respect to the first point, one or two of the utilities lumped exogenous factors (e.g., regulatory treatment, load growth, independent power production, and relative gas and electric prices) with uncertainties that are specific to DSM programs (e.g., program costs and load shape impacts). The exogenous factors listed are obviously not unique to demand-side options and would affect the costs and benefits of supply-side resources as well.[21]

Key factors to assess in sensitivity analysis

Most of the utilities incorporated sensitivity analysis in their DSM plans in order to evaluate the cost-effectiveness of DSM options under different scenarios. This approach is now standard practice in utility resource planning. The key factors that should be included in a sensitivity analysis in future DSM plans are: differing assumptions about load growth, fuel prices and avoided costs, the level of independent power production, and varying assumptions in the estimates of the costs, savings, and customer response to DSM programs. The range in uncertainties associated with implementing DSM programs can be reduced as utilities gain experience with conducting pilot programs or incorporate lessons learned from utilities in other regions.

Evaluating DSM options: individual utility vs Power Pool

Two utilities (NYSEG and Con Ed) evaluated the costs and benefits of DSM options from their individual perspective only and did not consider interactions with the Power Pool. This approach is clearly a simplified representation of the actual operating environment of the utilities. The key question for regulators is what bias does this approach introduce in terms of evaluating the cost-effectiveness of DSM programs. For example, does a utility with a winter peak understate the benefits of DSM measures that can reduce summer peak load (which is the peak period for the Pool) if it evaluates those options solely from its own avoided costs of supply? DSM options that are economic from the perspective of the Power Pool (i.e., reduce summer peak) may not be economic from the perspective of a winter-peaking utility. The PSC will likely have to address both modeling and policy issues related to the Power Pool in order to give individual utilities proper signals and adequate incentives with regard to assessing the costs and benefits of DSM options.

CONCLUSIONS

The initial DSM plans of the four utilities provide a useful foundation upon which future efforts can build. The plans highlight the principal near-term load shape objectives of the utilities (e.g., peak-clipping and valley filling) and their concern about the rate impacts of lost sales associated with conservation programs. In many cases, conservation options either were not thought to match the load shape objectives of the utilities and therefore were eliminated or were not cost-effective from the utility's perspective (particularly in the residential sector). Thus, conservation options are a relatively small component of the DSM programs proposed by the utilities. However, given that the plans involve limited reductions in electricity sales, it is likely that the PSC will be frustrated by the utilities' reluctance to identify and implement customer conservation programs. DSM planning in the long-run requires a convergence of perspectives. At the present time, there are still substantial differences among the utilities and between utilities and regulators. The PSC may well have to develop mechanisms that alter current ratemaking practices which act as disincentives for conservation investments or devise additional incentives for the utilities to encourage them to implement conservation programs more aggressively.

Acknowledgements—While the opinions, recommendations, and errors in this report are those of the authors, we wish to acknowledge helpful comments from T. Flaim, K. Fuller, J. Gallagher, J. Harris, E. Hirst, F. Krause, M. Levine, L. Saalman, P. Schulhof, S. Swanson, and E. Vine. The work described in this study was funded by the Assistant Secretary for Conservation and Renewable Energy, Office of Building and Community Systems, Buildings Systems Division of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

REFERENCES

1. New York Public Service Commission, "Order Directing the Submittal of Annual Demand-Side Management Plans," Case 28223, Albany NY (22 September 1987).
2. Electric, Power Research Institute and Edison Electric Institute, "Demand-Side Management, Vol. 1: Overview of Key Issues," EPRI EA/EM-3597, Palo Alto, CA (August 1984).
3. Electric Power Research Institute, "Demand-Side Planning: Sierra Pacific Power Case Study," EPRI EA-4314, Palo Alto, CA (November 1985).
4. Electric Power Research Institute, "DSM Regulatory Impacts," EPRI/EM-5631, Palo Alto, CA (March 1988).
5. National Association of Regulatory Utility Commissioners (NARUC), "Least-Cost Utility Planning Handbook for Public Utility Commissioners," Washington, DC (July 1988).

6. E. Hirst, *Publ. Utilities Fortnightly* **122,** 6 (15 September 1988).
7. Northwest Power Planning Council, "Northwest Conservation and Electric Power Plan," Portland, OR (1986).
8. Michigan Electricity Options Study, "Integrated Analysis: Issues, Assumptions, and Methodologies" Work Group No. Report, Lansing MI (October 1987).
9. E. Hirst, *Energy* **13,** 33 (1988).
10. Consolidated Edison, "1988 Demand-Side Management Plan," New York, NY (April 1988).
11. New York State Electric and Gas Corp., "Long-range Demand Side Management Strategy" Binghamton, NY (April 1988).
12. Rochester Gas & Electric, "1988 Demand-Side Management Plan," Rochester, NY (13 April 1988).
13. Niagara Mohawk Power Corp., "Amendment to the 1988 Long-range Demand Side Management Plan," Syracuse, NY (August 1988).
14. M. A. Piette, "Technology Assessment: Thermal Cool Storage in Commercial Buildings," Lawrence Berkeley Laboratory Report LBL-25521, Berkeley, CA (January 1988).
15. F. Krause, J. Brown, D. Connell, P. DuPont, K. Greely, M. Meal, A. Meier, E. Mills, and B. Nordman, "Analysis of Michigan's Demand-Side Electricity Resources in the Residential Sector" Lawrence Berkeley Laboratory Report LBL-23025, Berkeley, CA (April 1988).
16. H. Geller, "Prospects for Residential Incentive Programs in light of the National Appliance Efficiency Standards," *Proc. Symp. on Demand-Side Management,* Albany, NY (May 1988).
17. J. Eto, J. McMahon, J. Koomey, P. Chan, and M. Levine, "The Regional Energy and Economic Impacts of The National Appliance Energy Conservation Act of 1987," Lawrence Berkeley Laboratory Report LBL-25471, Berkeley, CA (June 1988).
18. California Public Utilities Commission and California Energy Commission, "Standard Practice Manual: Economic Analysis of Demand-Side Management Programs," San Francisco, CA (December 1987).
19. Electric Power Research Institute, "TAG Technical Assessment Guide, Vol. 4, Fundamentals and Methods, End Use," EPRI P-4463-SR, Palo Alto, CA (August 1987).
20. F. Krause and J. Eto, "Least-Cost Utility Handbook for Public Utility Commissioners; Vol. 2, The Demand-Side: Conceptual and Methodological Issues," NARUC, Washington, DC (December 1988).
21. E. Hirst and M. Schweitzer, "Uncertainty in Long-Term Resource Planning for Electric Utilities," ORNL/CON-272, Oak Ridge, TN (December 1988).