Target Marketing: An Economic Approach for Integrated DSM and T&D Planning

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A remote region in northern New York has been identified for a research study which will explore the possibility of utilizing targeted DSM programs to provide short-term system reliability enhancement. Currently one transmission line serves several small municipalities in the region, and load growth projections have raised concerns over the reliability of the T&D system in the next several years.

Due to the potential high cost of transmission lines, the length of time needed to complete project planning, and environmental concerns associated with the construction, the potential for DSM to reduce load growth in the region will be investigated. The implementation of DSM, if cost-effective, may provide a short-term solution to the load problem, while allowing system planners additional time to investigate environmentally and economically sensible alternatives to the problem.

The isolated region includes municipalities served by a state owned utility company and Niagara Mohawk via a T&D system completely owned and maintained by Niagara Mohawk. During 1992, the two utilities plan to develop a DSM project which will specifically target the areas served by the single transmission line. This paper will discuss the issues involved with attempting such a project, and also offer a potential approach to the problem, which includes utilizing targeted marketing of DSM programs. The paper will further provide valuable information as to the value of DSM in spatially differentiated regions in which DSM is used to solve a unique regional problem. This paper will not address the complexities of developing a joint DSM project by two separate utilities.

Introduction

Niagara Mohawk Power Corporation, based in Syracuse, New York, has a service territory which covers approximately 24,000 miles in much of upstate, western, and eastern New York. Niagara Mohawk has made a strong commitment to provide the most cost-effective mix of resources in order to provide maximum value to its customers. With this objective in mind, Niagara Mohawk is committed to integrated resource planning which not only analyzes generation options to fulfill needs, but also recognizes that DSM can provide a viable alternative to supply options. Encouraging DSM not only helps maximize the utilization of Niagara Mohawk's resources but also is instrumental in providing customers with a total energy service package.

As with many utility companies, Niagara Mohawk's emphasis regarding DSM has been overall energy reductions. Opportunities exist, however, to incorporate DSM into the T&D system planning process. An EPRI publication on DSM and Transmission and Distribution Impacts (EPRI Final Report CU-6924, Project 2548-1, August 1990) points out that the projected capital expenditures for T&D projects in the U.S. is substantially higher than expenditures for generation projects. Therefore, in the coming years, it is in the best interest of utility companies to explore the role DSM can play in the area of transmission and distribution planning.

Background

An isolated region in the Adirondack Park in northern New York, which consists of a number of small towns and hamlets, is served by a state-owned power company and Niagara Mohawk (see Figure 1). However, the electricity is transmitted solely via Niagara Mohawk's T&D system, in which Niagara Mohawk has a wheeling arrangement with the state-owned utility. The Commission on the Adirondacks in the Twenty-First Century reports, "The Adirondack Park, the most magnificent natural resource in the eastern United States, is in danger... All state and private lands (in the park) must be administered in a manner worthy of a great park, with all public and private enterprises subject to the same review and permitting process." Needless to say, there are significant environmental hurdles to overcome when a utility is faced with constructing a new transmission line through a restricted area such as the park.

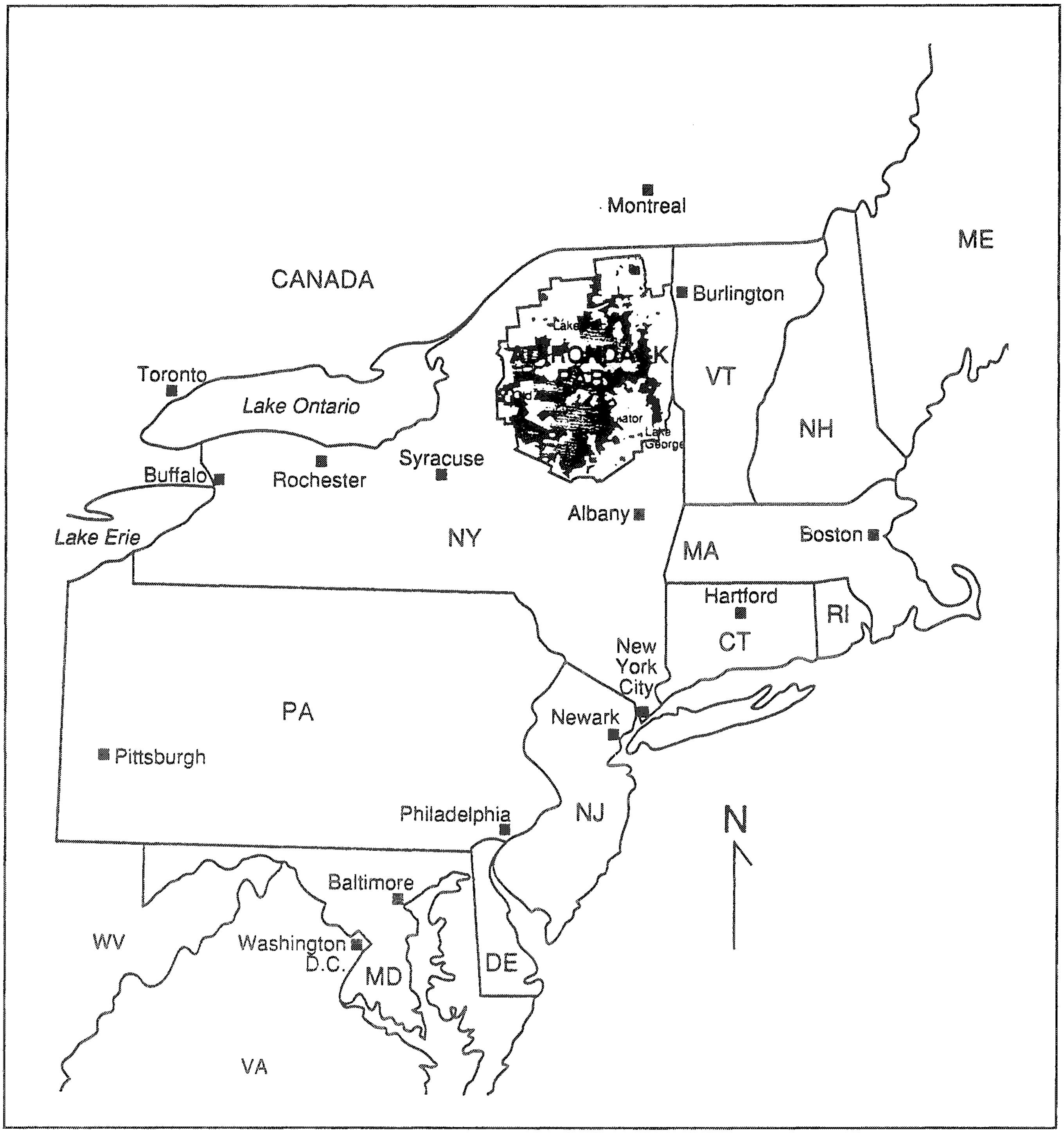

Figure 1. The Adirondack Park in the Northeastern U.S.

Access to electricity is limited in this isolated region due to its northern location and the fact that it is a mountainous and forested region with protected wildlife, and there are only a handful of small towns in the region. This region is served by a single circuit 115 kV radial transmission line. As previously stated, several municipal power companies, as well as Niagara Mohawk customers, are served by this one, long line.

The municipal power companies in this region account for 70% of the electric consumption, and rely on the purchase of low cost hydro and nuclear power from the state owned power company. Niagara Mohawk's customers account for approximately 30% of the load. According to current projections the municipal loads are growing twice as fast as Niagara Mohawk's (this is directly related to the differential in electric service rates, in which the municipal rates are approximately 30% of the Niagara Mohawk rates). If load projections hold true, the single 115 kV line capacity will be exceeded in the 1998-1999 time frame (see Figure 2).

In addition to the capacity issue, residents in the region perceive a reliability problem with Niagara Mohawk's transmission line. Although the region has a similar outage history as other areas in the Adirondacks, this perceived reliability problem has negatively affected relations between the state's municipal customers and Niagara Mohawk. (Niagara Mohawk, 1989). Reliability (i.e., thermal capability) concerns due to load growth are real however, and this issue is currently being addressed from a T&D planning standpoint. Utilizing DSM could further help to solve reliability concerns associated with load growth by slowing down or eliminating the growth in peak demand.

Alternative Options

During the last five years many different options have been considered as solutions to both the capacity problem and the perceived reliability problem. Most of the options considered were either to upgrade and enhance the current system, or to build a second line into the area.

Currently, there are plans to provide voltage support and subtransmission reinforcement to the T&D system in the region which will potentially solve some of the reliability issues associated with the load growth in the region. The need for a second power source, though, some time in the future may be inevitable.

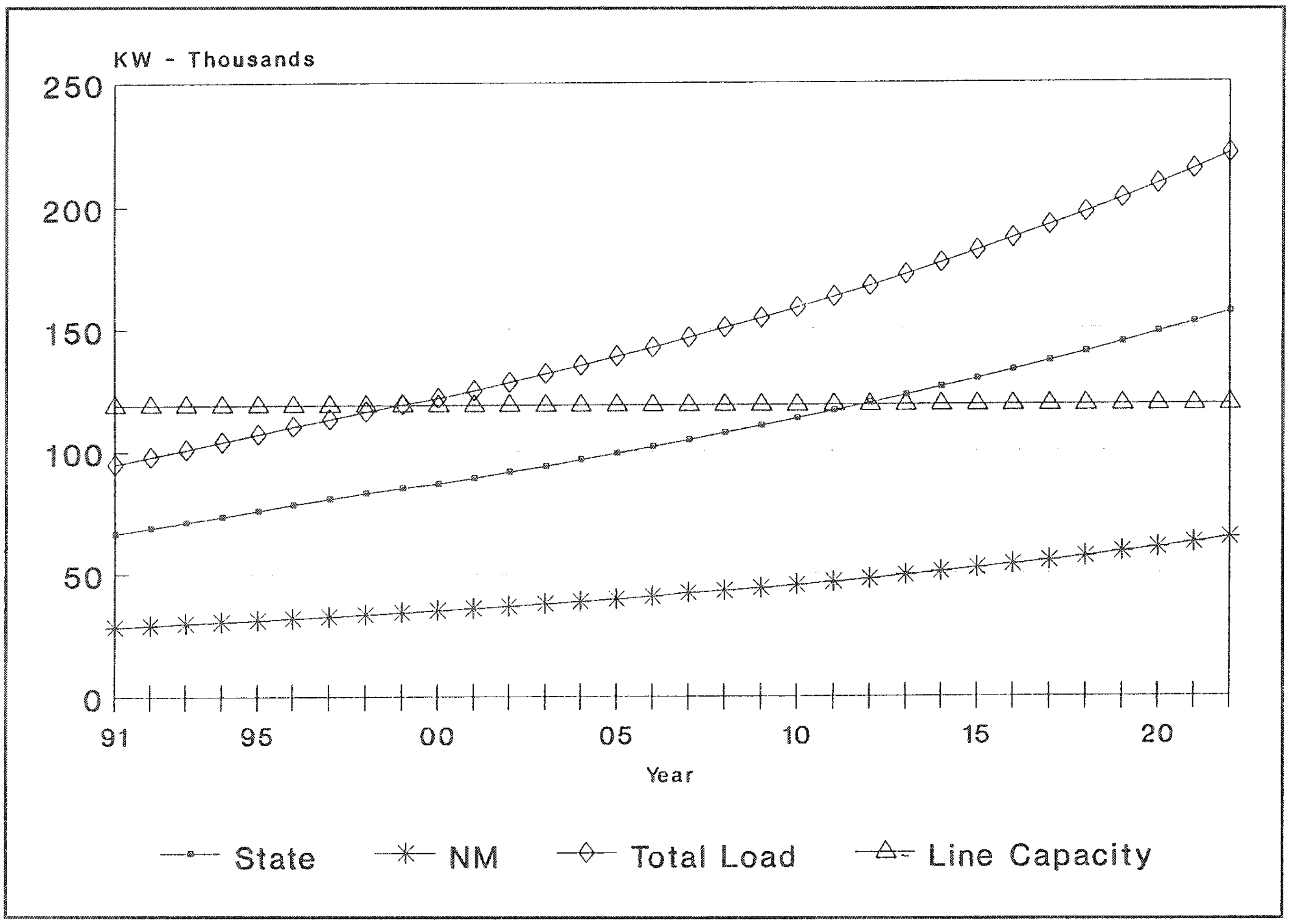

Figure 2. Projected Winter Peak Loads

In order for a second source to become a reality, regulatory approval would be required (and most probably very difficult to get). As part of the approval process, proof that a new line is needed would have to be established along with other alternatives in order to avoid penalties. In 1990 the District of Columbia Public Service Commission penalized a utility company which failed to integrate DSM planning with its supply and transmission planning (Electric World, October 1990).

It has been proven by other utility companies that DSM can be a viable option in at least deferring the need for T&D capacity if not eliminating the need. Companies including Bonneville Power Administration, Central Maine Power, and Pacific Gas and Electric Company have all begun to develop integrated DSM and T&D strategies (EPRI End Use News, Winter 1990-1991).

In this particular case, load growth projections indicate that eliminating the need for a second source through DSM is unlikely. Deferring the need date, however, may be a very beneficial option, both from an economics standpoint. In addition, planners will gain time to investigate and hopefully integrate new and emerging technological options (e.g. fuel cells located in the area, improved photovoltaic options, emerging DSM technologies, etc.).

Benefits of Integrated DSM and T&D Planning

Although a short term solution, the use of DSM to defer construction of a new T&D system has many positive attributes. EPRI has reported that "if DSM is carefully aimed at transmission and distribution areas where a utility would otherwise need to expand its T&D facilities because of local load growth, it can defer or reduce construction needs and deliver large savings" (Electrical World, March 1991). A recent EPRI study conducted at Gulf Power showed that DSM could produce significant savings and benefits (EPRI Report - DSM: Transmission and Distribution Impacts Volume 1, August 1990).

Integrating DSM and T&D planning can produce benefits which are apparent to both the customer and to a utility company's bottom line. DSM may:

1. improve reliability to the regional electric system by lowering the loads
2. offer environmental benefits which include lower levels of power plant emissions and potentially less land and water use,
3. defer significant capital expenditures on transmission facilities as well as power plant additions,
4. offer real public relations enhancements by offering customers an alternative solution to their problem which has the added benefit of lowering their electric bills, and
5. provide economic benefits in terms of net resource savings associated with the production and delivery of electricity, and reduction of line losses.

Improved Reliability

In addition to the voltage support, use of DSM to cut peak loads could provide substantial benefits to the capability of the T&D system. The region is winter-peaking, and demand-side options such as thermal storage, water heating timers, and other load shifting options, could be used to reduce peak loads. Energy efficiency programs including weatherization, lighting, heating, motors, and water heating may also be employed. It is possible that given the current system, voltage levels, especially at peak times, are vulnerable to falling below prescribed normal operating voltage limits. This has been of such great concern that a step-switched shunt capacitor bank will be installed to help alleviate the problem (Henry, March 1992). Effective use of load shifting and economic conservation DSM options is being viewed as an additional measure for furthering system reliability.

Applying an integrated T&D and DSM approach to the reliability problem may not only solve the problem, but will also enhance the system to the point that consumer attitudes concerning reliability may be drastically improved.

Environmental Benefits

Currently, New York State recognizes the environmental benefit of curtailing electrical usage, and the state has mandated that the dollar value of environmental benefits be included when considering the cost-effectiveness of any resource, supply or demand. The value of the environmental externality, currently set at 1.57 cents per kWh, is based on the benefit to society of reducing emissions of nitrogen oxide, carbon dioxide, sulfur dioxide, and other particulate matter, as well as reducing the water and land use impacts associated with generating electricity (see New York State PSC Case 88-E-242). Demand-side options which encourage conservation would provide these benefits to both Niagara Mohawk's customers as well as the rest of the state.

Beyond the benefit of reducing emissions, the construction of a transmission line in the Adirondack region poses many other environmental problems not associated with the generation of electricity. The Adirondack region of New York is known for its mountains, streams and lakes, large forests, and plenty of wildlife. One of the main reasons reliability is such an issue in this area is due to the fact the T&D lines must run through these environmentally sensitive areas, and the state has made a commitment to preserving the environment. Often, during rough storms, falling trees are responsible for cutting power to the region. Residents of the area perceive this as a utility reliability problem, when in fact, it is a problem created because Niagara Mohawk and the state have taken an initiative to preserve the environment through minimal disruption of the land and timber.

Constructing another line into the region would not completely solve the reliability problem in circumstances such as the one just stated. Further, T&D construction would require more trees to be cut and more land to be used for right-of-ways and substations. The use of DSM to defer construction can aid greatly in "buying time" for system planners to explore other alternatives for supplying power to the region.

The Commission on the Adirondacks in the Twenty-First Century recommends "a program to bury utility lines, or to relocate them out of sight should start now, with the cost to be borne by all state taxpayers." Obviously, this Commission has attached a very high environmental cost to transmission lines. DSM may be able to support this recommendation by possibly postponing the construction of a new line.

Dollar Value of Deferring Construction Costs

The approximate cost of building a line into the region would be in the range of $500,000 to $800,000 per mile. The most viable alternative would require 24-25 miles of line to be constructed. Niagara Mohawk engineers estimate that this could cost in excess of 16 million dollars (1991 Dollars). This alternative assumes that the line is built overhead. Should it be determined that for environmental reasons the line will need to be built underground, the cost of the line would rise substantially.

Deferring construction will not only give planners time to explore other options, it would also provide anywhere from 1.8 to 7.2 million dollars in net-present value savings depending on the length of time that construction is deferred. Table 1 illustrates how these savings are calculated. Internal estimates have shown that constructing a new transmission line would cost approximately 16.4 million dollars (1991 dollars). For the purposes of this analysis it was assumed that construction would have to begin immediately in order to be in place by the need date, and the construction costs would be constant throughout the period of construction. Given these assumptions, net-present value costs can be calculated given a two, four, six, eight or ten year delay as the table shows. The savings therefore can be calculated by subtracting the delayed net-present value construction costs minus the original net-present value construction costs (Example: a six year delay would result in 4.8 million dollars in savings: 16.4 - 11.6 = 4.8).

Along with the avoided costs and environmental savings associated with DSM, the value of deferring construction presents another benefit that enhances the value of DSM.

Public Relations Aspects

From a public relations aspect, a DSM program sponsored by Niagara Mohawk in the region could be a great way to build public confidence that Niagara Mohawk is concerned with both T&D reliability and environmental issues. In Niagara Mohawk's own service territory over the last three years, consumer attitude towards the company has been enhanced greatly since consumer-oriented conservation programs were initiated throughout the service territory.

Overall Economic Benefits Associated with a DSM Approach

Many of the benefits discussed above are directly quantifiable. In order to illustrate and quantify these benefits, analysis was completed assuming a four year construction deferral was desired. Utilizing DSManager, a demand-side screening computer model, a DSM approach was designed with the software to simulate a program which would generate enough peak kw savings to defer construction of a new transmission line by four years. (The DSM program model assumed that measures would be installed over a four year period with approximately 12,000 MWH savings per year over a ten year life). Table 2 summarizes the results of this analysis by showing what the winter peak loads are projected to be with and without a DSM program.

As shown, approximately a 12 MW peak reduction is needed to defer the need date of a new construction line for four years. DSManager also calculated the potential production and capacity savings (based on Niagara Mohawk's avoided costs), and environmental benefits (based on 1.57 cents/kwh) due to reduced emissions.

Table 1. Savings from Delay of Construction of T&D Line

Year	Original Construction Plans	Savings: 2 Year Delay $1,787,882	4 Year Delay $3,381,103	6 Year Delay $4,800,858	8 Year Delay $6,066,033	10 Year Delay $7,193,459
1991	$16,421,016	$14,633,135	$13,039,913	$11,620,158	$10,354,983	$9,227,557
1992	$3,451,082					
1993	$3,451,082					
1994	$3,451,082	$3,768,668				
1995	$3,451,082	$3,768,668				
1996	$3,451,082	$3,768,668	$4,115,479			
1997	$3,451,082	$3,768,668	$4,115,479			
1998	$3,451,082	$3,768,668	$4,115,479	$4,494,206		
1999		$3,768,668	$4,115,479	$4,494,206		
2000		$3,768,668	$4,115,479	$4,494,206	$4,907,786	
2001			$4,115,479	$4,494,206	$4,907,786	
2002			$4,115,479	$4,494,206	$4,907,786	$5,359,425
2003				$4,494,206	$4,907,786	$5,359,425
2004				$4,494,206	$4,907,786	$5,359,425
2005					$4,907,786	$5,359,425
2006					$4,907,786	$5,359,425
2007						$5,359,425
2008						$5,359,425
2009						
2010						

Table 3 shows a summary of the total net-present value of the readily quantifiable benefits, including the savings that would be realized from deferring the construction.

The results of this analysis indicate that in order to achieve cost-effective DSM program to defer construction four years, a program would need to be designed such that the costs of delivering the program do not exceed the $2000/kw benefit to be realized from the deferral (from a total resource cost perspective).

Target Marketing of DSM

Niagara Mohawk has been implementing DSM programs for approximately 3 years (and performing DSM research for over 7 years), and these programs have been quite successful. The design of these programs, however, are such that they try to reach a broad range of customers and they promote a broad range of measures. Most of the programs to date have been driven by monetary incentives that partially cover the incremental cost of installing high efficiency measures. The design and delivery mechanisms built into our programs are such that rebate levels are designed to be as cost-effective as possible, while ensuring that maximum participation is garnered.

In isolated regions such as the one at hand, however, another approach to delivering DSM programs is needed. Consumer participation in Niagara Mohawk's mass rebate programs has been limited in towns served by Niagara Mohawk in the Adirondack region. This suggests that a more targeted approach may need to be taken in isolated regions.

A DSM program which provides free, direct installation of a variety of measures may be the most cost-effective way of reaching and gaining participation in a utility-sponsored conservation program. Direct installation of measures could provide the best way of making sure equipment is installed correctly, and further would be a major selling point of the program to gain participation. This program would have to be intensely promoted on a regional level in order to gain awareness of the population.

Table 2. Load Projections With and Without DSM

Winter Of	Load Projection W/O DSM (kW)	DSM Load Reduction (kW)	Load Projection With DSM (kW)
1991-92	94,850	0	94,850
1992-93	97,748	3,017	94,731
1993-94	100,819	6,035	94,784
1994-95	103,861	9,052	94,809
1995-96	107,049	12,069	94,980
1996-97	110,195	12,069	98,126
1997-98	113,250	12,069	101,181
1998-99	116,292	12,069	104,223
1999-00	119,291	12,069	107,222
2000-01	121,780	12,069	109,711
2001-02	125,002	12,069	112,933
2002-03	128,321	9,052	119,269
2003-04	131,740	6,035	125,705
2004-05	135,261	3,017	132,244
2005-06	138,888	0	138,888
2006-07	142,626	0	142,626
2007-08	146,476	0	146,476
2008-09	150,445	0	150,445
2009-10	154,535	0	154,535
2010-11	158,751	0	158,751
2011-12	163,097	0	163,097
2012-13	167,578	0	167,578

Table 3. Total Benefits

	Millions $
Production and Capacity	$15.5
Savings	$3.3
Transmission Deferral NPV	
Benefits	$4.9
Environmental Benefits	
(Emissions Only)	$23.7
Total Benefits	
Maximum Load Reduction	12.1 MW
Dollar/kW Benefit	1,959 $/kW

Other Benefits Not Quantified:
- Line Loss Reductions
- Other Environmental Benefits
- Consumer Satisfaction
- Outage Cost Savings

One approach to delivering such a program would be to employ energy service companies in the region to promote free, direct installation programs. In order to estimate the cost of this approach, the results from Niagara Mohawk's all source bidding program were utilized. (During 1990, Niagara Mohawk implemented a bidding program to procure both demand-side and supply-side resources. A total of 29 demand-side bids were submitted, and were not in any way associated with this project.). Many of the demand-side bids that were received were direct installation programs and involved multiple measures. For the purposes of this analysis, the results of the bidding procurement are used here as a proxy for estimating the costs of running a targeted DSM program. Table 4 illustrates the net-present value cost of these projects as well as the total NPV cost per kw.

As shown, the bids range in value from $953/kw to $6921/kw, with the majority in the $1000-$2500/kw range.

Table 4. Typical Program Costs from Niagara Mohawk's All Source Bidding Program

Bid #	Cost NPV ($)	Peak kW Reduction	NPV Cost ($ Per kW)
1	13,642	4,023	3,391
2	7,329	7,690	953
3	11,624	4,360	2,666
4	13,308	8,000	1,664
5	13,831	6,267	2,207
6	39,765	10,792	3,685
7	12,141	5,980	2,030
8	17,572	10,000	1,757
9	2,680	1,050	2,552
10	6,986	5,000	1,397
11	3,662	1,970	1,859
12	3,662	1,970	1,859
13	11,679	5,000	2,336
14	9,503	7,920	1,200
15	10,261	7,920	1,296
16	10,261	7,920	1,296
17	15,098	8,026	1,881
18	23,262	8,026	2,898
19	16,652	8,026	2,075
20	1,075	400	2,688
21	10,064	5,810	1,732
22	8,797	1,271	6,921
23	8,237	5,134	1,604
24	2,593	2,035	1,274
25	1,452	1,108	1,310
26	535	349	1,533
27	1,813	495	3,663
28	623	187	3,332
29	4,513	1,343	3,360

Note: Bid identification #'s shown above do not correspond to actual Niagara Mohawk internal bid identification #'s.

Taking the benefits from Table 3 and comparing them to the estimated cost of running a targeted, direct installation program shown in Table 4, it is very possible to design a program which should be cost-effective from a total-resource cost test perspective. Table 5 compares the costs of not doing DSM by beginning to build a new line (Option 1) to the costs of utilizing DSM to defer line construction (Option 2).

As shown in the table, if a DSM program which costs $1500 per kW of reduction is implemented over a four year period, the DSM option would yield a 3.7 million dollar net benefit.

This approach may provide the quickest and most effective way to conserve energy and cut peak loads. The small towns could immediately realize the results of such a program, and the utility companies could begin to put resources toward solutions to the longer term problems. Pacific Gas and Electric has implemented this target marketing approach in their Delta District and has proven to be great success in the eyes of both the company and its customers (Heffner, December 1991).

Table 5. Cash Flow Analysis: Construct Now Versus Deferred Construction

	OPTION 1	OPTION 2				
	Construction Costs (Not Deferred)	Construction Costs (Deferred)	Production and Capacity Savings	Environmental Benefits	DSM Program Costs (Assumed 1500$/kW Cost	OPTION 1 - OPTION 2
1992	$3,451,082	$0	($514,360)	($21,532)	$4,525,500	($538,526)
1993	$3,451,082	$0	($1,067,940)	($43,064)	$4,527,000	$35,086
1994	$3,451,082	$0	($1,675,790)	($64,596)	$4,525,500	$665,968
1995	$3,451,082	$0	($2,295,440)	($86,128)	$4,525,500	$1,307,150
1996	$3,451,082	$4,115,479	($2,329,490)	($86,128)	$0	$1,751,220
1997	$3,451,082	$4,115,479	($2,502,620)	($86,128)	$0	$1,924,350
1998	$3,451,082	$4,115,479	($2,744,050)	($86,128)	$0	$2,165,780
1999	$0	$4,115,479	($2,976,500)	($86,128)	$0	($1,052,852)
2000	$0	$4,115,479	($3,240,390)	($86,128)	$0	($788,962)
2001	$0	$4,115,479	($3,582,310)	($86,128)	$0	($447,042)
2002	$0	$4,115,479	($2,894,850)	($64,596)	$0	($1,156,034)
2003	$0	$0	($2,122,280)	($43,064)	$0	$2,165,344
2004	$0	$0	($1,184,330)	($21,532)	$0	$1,205,862
2005	$0	$0	$0	$0	$0	$0
2006	$0	$0	$0	$0	$0	$0
2007	$0	$0	$0	$0	$0	$0
2008	$0	$0	$0	$0	$0	$0
2009	$0	$0	$0	$0	$0	$0
NPV	$16,421,016	$13,039,913	($14,010,993)	($443,879)	$14,131,748	$3,704,226
Total Net-Present Value Benefit of Deferring Construction Using DSM -						$3,704,226

Recommendations/Conclusions

The benefits of utilizing DSM in conjunction with T&D planning are too substantial to be ignored. The makeup of the region and the potential savings from deferring construction make the DSM alternative the most attractive option at this time. Target marketing of DSM would provide the savings in an efficient manner and would be an effective way of delivering a DSM program to an area that is not accustomed to this new way of thinking. It would also provide an alternative to the current traditional methods of delivering DSM programs that many utility companies are currently undertaking. These traditional methods may not be adequate for all DSM program designs.

From a more global perspective, the success of this program would be a benchmark for other isolated regions in Niagara Mohawk's service territory as well as other utilities. A company that endorses the use of integrated planning should look at the benefits of being totally integrated, not just by looking at supply elimination, but also by considering T&D systems in the DSM planning process. This total integration will not only maximize a utility company's resources, but also enhance the reliability of the system as a whole. Furthermore it will provide all customers with the best possible service, and the opportunity to enjoy additional benefits.

Acknowledgments

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