Just How Flexible Is DSM as a Resource?

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Flexibility is touted as a powerful advantage of demand-side management (DSM) programs, when examined as a component of an electric utility's resource plan. DSM, it is argued, has an indirect benefit of being able to be turned up or throttled back as utility short-term requirements change. This flexibility gives DSM an additional value when compared to power plant construction, or long-term independent power contracts, as resource options.

But are there limits to this flexibility? Does DSM cost more if it is bought in a jagged pattern from year-to-year than if bought continuously? As what about the DSM infrastructure of service providers and product producers? Is this DSM industry as competitive in a market with dramatic swings? Does it matter how the DSM expenditure is modulated?

A collaborative study was conducted in Rhode Island on issues related to the timing of DSM purchases. As part of that study, the state public service commission and representatives of its two major utilities examined the limits of DSM flexibility, and possible methods of representing these limits in their integrated resource plans. This paper will discuss the summary findings that relate to the issue of flexibility:

1. The flexibility of DSM has a value that should be recognized in an integrated resource plan, and which can be quantified.

2. The flexibility of DSM is not absolute: modulating the DSM purchase pattern from year-to-year will increase the cost to reach a long-term DSM objective, as compared to a steady purchase pattern.

3. Varying the amount of DSM may have another penalty: the DSM infrastructure may be weakened, making it less competitive and efficient.

4. Flexibility varies depending on whether a new construction, on-replacement, or retrofit program is being examined.

Introduction

This paper develops hypotheses on important characteristics of DSM flexibility. These characteristics were studied as part of a collaborative study of DSM Timing Issues. The sponsors and participants in the study were New England Electric System, Eastern Utilities, And the Rhode Island Public Utility Commission.

The questions examined in this study, which as of this writing is nearing completion, include:

How important is resource diversity in long-term utility resource acquisition?

Is DSM uncertainty higher or lower than other resources?

Is DSM a more flexible resource than others?

This paper will focus on the issue of DSM flexibility. After a discussion of DSM in Integrated Resource Planning, the issue of flexibility will be further defined, followed by initial data regarding the costs of exercising DSM's flexibility.

DSM in the Integrated Resource Plan

To understand the context of the DSM flexibility issue, it is necessary to quickly review major issues of integrated resource planning that relate to DSM.

In the Northeast U.S., and particularly in Rhode Island, the project participants observed that Integrated Resource Planning could produce a conclusion to dramatically curtail or even stop DSM purchases, by applying conventional methods of least-cost analysis to the options available. This represented a full-swing from the earlier least-cost analyses that pointed to full-speed DSM implementation to the exclusion of most other resources.

It can be observed that least cost planning doesn't necessarily result in a mix of resources; it is most likely to justify the same resource in every resource decision. In a typical resource planning process, the most important variables are the expected future demand for electricity, and the expected future cost for competing fuels for electric generation. The "expected" values comprise the *most likely* future scenario. The last four decades favored coal generation, then oil, then nuclear, then natural gas in the resource selection process. DSM was highly favored in the planning of the late 1980's. The same forces that were signaling exhaustive DSM were now signaling a shut-down of DSM.

The participants observed that each decade had a single set of expected values that drove all decisions; a single option appeared to be the most cost-effective and therefore was selected repeatedly until the entire supply plan was met. Capacity auctions with standard rules also most often result in a standard winning technology.

With a single assumption for forecast growth and fuel costs, the playing field cannot help but be slightly tilted, and the result is a bias to a single direction. Approximately every 5 to 10 years, the tilt shifts and all the resource acquisitions move towards another alternative. At the same time, all of the resources purchased in the previous 5 to 10 years may now be viewed as inefficient or obsolete.

The only way to prevent this cycle is to put a value on resource diversity. This means that the process of resource planning puts some emphasis on buying a different resource than the last time a decision was made. At times, this will require that a utility buy, and regulators approve, a resource that *appears not to be least cost at the time the decision is made.*

It is therefore intuitive that an integrated resource planning process should have two goals, in addition to minimizing cost: diversity (i.e., don't put all of your eggs into one basket), and flexibility (i.e. plan for surprises).

It is also intuitive to identify the role of DSM within an Integrated Resource Plan:

1. There should be a continuing DSM component, and it should neither be dominant nor negligible, regardless of the current comparative financial analyses of the options.

2. DSM can be modulated to respond to surprises, due to its small unit size and short lead time.

The key question then becomes: How much can DSM be modulated without consequences?

DSM **Flexibility Issues and Research Approach**

Four issues with DSM flexibility were examined:

Does the flexibility of DSM have a value that can be recognized in an integrated resource plan, and which can be quantified?

The project examined ways to put a value on the risk reduction that results from having flexible options. Among the methods examined were:

1. Limit the acceptable resource plans to those that are reasonably successful when examined under varying scenarios of load growth and fuel price. Both utilities subjected their resource plans to this type of scrutiny. By eliminating plans that had major downside consequences in any scenario, the tendency was to select options that possessed DSM for its flexibility.

2. Put a value on risk reduction. A hypothetical analysis was performed using Monte-Carlo simulations to quantify the likelihood of various future electric prices when choosing an inflexible set of resource options, as compared with a flexible set. The result was to demonstrate that a quantifiable benefit could be computed by adding flexibility to the resource plan. (Hildebrandt, 1994).

Does it affect the cost to reach a long-term DSM objective to modulate the DSM purchase pattern from year-to-year, as compared to a steady purchase pattern?

The project examined the cost of DSM resource acquisition under scenarios of steady purchase, and under a jagged purchase pattern. The result was to demonstrate that modulated DSM purchasing increased the total cost of DSM, by itself, in a manner that was quantifiable. This is described below.

Does the cost of modulating DSM vary among program types?

Three major classifications of DSM programs were examined: programs that encourage efficiency in new construction, programs that encourage selection of high efficiency equipment when equipment is being replaced at the conclusion of its normal life cycle, and programs that encourage early retrofit of equipment with high efficiency alternatives. By modeling the program attributes, it could be calculated that modulating programs for new construction had the highest cost, while varying replacement programs were less costly, and retrofit programs were least costly. This is also shown below.

Does the modulation of DSM weaken the infrastructure of DSM, making it less competitive and efficient, and increasing the cost of DSM?

It was hypothesized that, if DSM is viewed as a permanent resource, long term product and software development is more credible to capital markets. The stability will also result in more qualified personnel, since college training and career choices to focus in this area would be more popular. The result would be more resources, higher quality and efficiency of products and services, and lower costs through competition and innovation.

An examination of the DSM industry and parallel industries was conducted to see if the impact on market efficiency could be quantified.

The DSM Flexibility Benefit

Using DSM to respond to load growth is an important hypothesis in integrated resource planning. It is argued that DSM incentive programs can be designed and implemented often with lead times of 6 months or less. Supply options have lead times of 2 to 8 years, by comparison. This benefit of DSM enhances its value, as it can be increased rapidly in response to load growth that is above the base case of expectations.

It is similarly hypothesized that DSM can be slowed or stopped rapidly in response to decreasing loads, or diminishing load growth. The ability to slow or stop the investment in many DSM programs, such as incentive programs, is also unique to the demand options. Supply options, once purchased or built, are typically capitalized over the life of the facility resulting in substantial expenditure even if the facility's power is not needed.

The value of DSM's ability to be modulated is referred to as its flexibility benefit. Several efforts have been made to quantify this benefit. The quantifications hinge on the probabilities that future load growth will not follow an anticipated pattern, but rather be unexpectedly high, unexpectedly low, or cyclically high or low.

Load forecast history shows that surprise is likely. In the Northeast, long-term forecasts were much too high in the 1970's, resulting in substantial plant overbuilding. Forecasts were then too low in the 1980's, resulting in relatively severe power shortages in the late 1980's. Forecasts in the late 1980's were then too high, resulting in aggressive IPP and power supply contracts, aggressive DSM, and some new utility construction. During the recessionary period from 1991 to 1993, forecasts again revised downward.

It is in this environment that the principle of DSM flexibility is now being scrutinized. For the first time in the Northeast U. S., fully developed DSM programs are being reduced or stopped. DSM budgets for 1994 are at or below 1993 levels. It now becomes relevant to determine how, and if, to cut back some DSM programs.

The Costs of DSM Curtailment

Costs of DSM curtailment studied in this project can be categorized as follows:

1. Inefficiencies of cyclical purchase patterns.

2. Marketplace confusion.

3. DSM infrastructure deterioration.

Inefficiencies of Cyclical Purchase Patterns.

Over a 20 year forecast horizon, the cost of an equivalent aggregate amount of DSM was examined under two extreme DSM purchase plans. One purchasing scenario presumed that DSM purchases ceased during low load growth periods, and were accelerated during higher growth periods. Another scenario presumed that DSM purchases were constant throughout the forecast period.

These scenarios are illustrated on Figure 1.

Using a model of DSM cost and market penetration, many variants were examined. Among these were more cyclical and less cyclical load patterns, and adjusting different types of DSM programs by differing amounts. Initial findings are contained in this paper. Important robust conclusions include the following, as illustrated on Figure 2.

It can be concluded that flexible DSM purchases, in all cases, increase the average cost of DSM. This occurs because of a demonstrated diseconomy of scale in DSM.

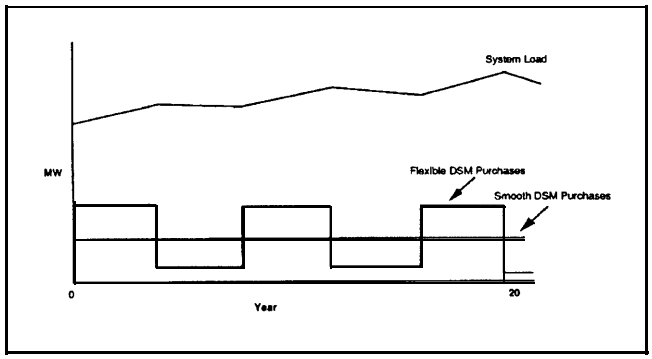

Figure 1. DSM Purchase Patterns

The least expensive options are purchased first, and as a utility looks for greater quantities of DSM, the cost per unit of additional DSM saved kW or kWh increases. This characteristic results in the typical DSM supply curve that shows steadily increasing DSM costs per unit as DSM acquisition goes up.

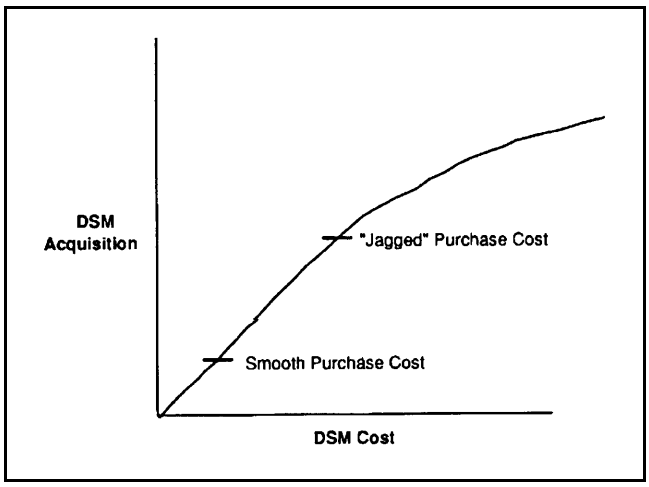

Figure 2. DSM Supply Curve

The irregular purchase pattern results, in all cases, in greater amounts of DSM being purchased in the periods when load growth is high. This higher acquisition rate requires higher incentives, and investment in measures and programs with weaker benefit-cost ratios, as compared with what would be required with the smooth acquisition rate. This results in higher DSM costs during DSM "boom" years.

These higher costs are not balanced out by lower costs in the valleys, or "bust" years. This occurs primarily because little DSM is purchased in these years with the flexible purchase pattern. As a result, the average cost of DSM under the flexible pattern is weighted towards the cost in the boom years, when most of the DSM is purchased. In many scenarios, the DSM cost per unit was more than twice as high when flexibly purchased.

There are important differences by DSM program type. Broad types being analyzed include:

- New construction programs: these subsidize the use of high efficiency equipment and construction methods in homes and facilities when built.

- New equipment programs: these subsidize the selection of high efficiency models for appliances and energy consuming systems, when use to replace existing equipment at the normal end of its operating life. High efficiency motor programs, refrigerators, and air conditioners are often in this category.

- Retrofit programs: these subsidize the removal and disposal of operating inefficient equipment and the reinstallation of higher efficiency equipment. Lighting programs often fall in the category.

The characteristics of these program types that affect the conclusions are:

The new construction programs and new equipment programs are less expensive than the retrofit programs. This results because only the incremental cost of high efficiency vs. standard efficiency needs to be subsidized, while in the retrofit programs, the full cost of the equipment needs to be subsidized.

New construction and new equipment programs have a lost opportunity if canceled for a period of time, since only the buildings currently being built or equipment currently being replaced can be addressed by these programs. Buildings built or equipment replaced during years when the program is not operating have no opportunity to be readdressed at a later date with these programs.

Retrofit program opportunity "stores up" to a greater extent during inactive DSM years. To make up for the lost opportunity in new construction and new equipment, the retrofit programs need to carry a greater share of the total DSM requirement using a flexible DSM purchase scenario. Since these programs are substantially more expensive, the effect is to drive the overall penalty for DSM flexibility quite high.

An intermediate "mini-flex" scenario was therefore also modeled, that maintained new construction and new equipment programs in full operation, and only modulated retrofit programs in response to system load. This scenario has important advantages. Much of the flexibility is retained, since active DSM programs in the Northeast have about 50% of their expenditure in retrofit. However, some of the penalty is reduced, since the more cost effective new construction and new equipment components have a dramatically increased fraction of the total DSM acquisition.

Figure 3 shows the rate impact of the three scenarios, as modeled for Rhode Island, assuming a moderate cycling to the load growth pattern. The data shows that the stable purchase scenario costs substantially less than the other two scenarios. The mini-flex scenario saves about 20% as compared with a full start-stop to the programs.

The variation in rate impacts for the stable DSM scenario results from greater construction, and therefore greater DSM expense, during rapid load growth years.

Marketplace Confusion

When programs start and then stop, and then modify and restart, a marketplace dynamic is created that confuses customer and business decisionmaking. Information was obtained from companies affected by the shutdown and subsequent restart of a New England Electric commercial rebate program.

During periods that the program is open, there was a rush of applications based on the concern that the program would again close. The rush strained the program systems at the utility, made quality control difficult, caused delays, and created customer relations problems.

During periods when the program was closed, commercial DSM activity came to a complete halt. This was the result of the customer expectation that in the future incentives would again be available.

Other examples were found of customers delaying during open periods because they thought incentives might go up. Customer representatives complained of promoting DSM with a customer, and then to be rebuked by the customer when the incentive went up at a later date.

Most problematic were the cases where the customer expended substantial effort and costs to design a DSM retrofit for his facility, and then found the program canceled before the incentive was committed to. In the case of the New England Electric restart in 1992, the rush of applications meant that many applications received before notice of program shutdown could not be funded. In this case, NEES negotiated partial incentives.

While anecdotal, it seems clear that program uncertainty add to the customer's discount rate. It makes the outcome of an effort to pursue a program uncertain, and leave open the possibility of lost opportunity from acting too soon. Since a higher customer discount rate leads inevitably to higher DSM costs, this factor needs to be quantified better to understand the costs of DSM flexibility.

DSM Infrastructure Deterioration

Also impacted by flexible DSM purchasing are the companies and professionals involved in DSM. Information was gathered from manufacturers of efficient equipment, and from local distributors and installers.

Manufacturers of high efficiency lamps and ballasts tended to conservatively add capacity for their products, since much of the short-term demand was produced by utility incentives. When these programs were cut back, it was feared that demand would drop, and therefore it was prudent to minimize investment in plant and equipment beyond that which could be carried in the absence of utility incentives.

The result of this capital behavior was a slow ramp up of production to meet demand, less efficient production, shortages, and higher prices. Manufacturers claimed that

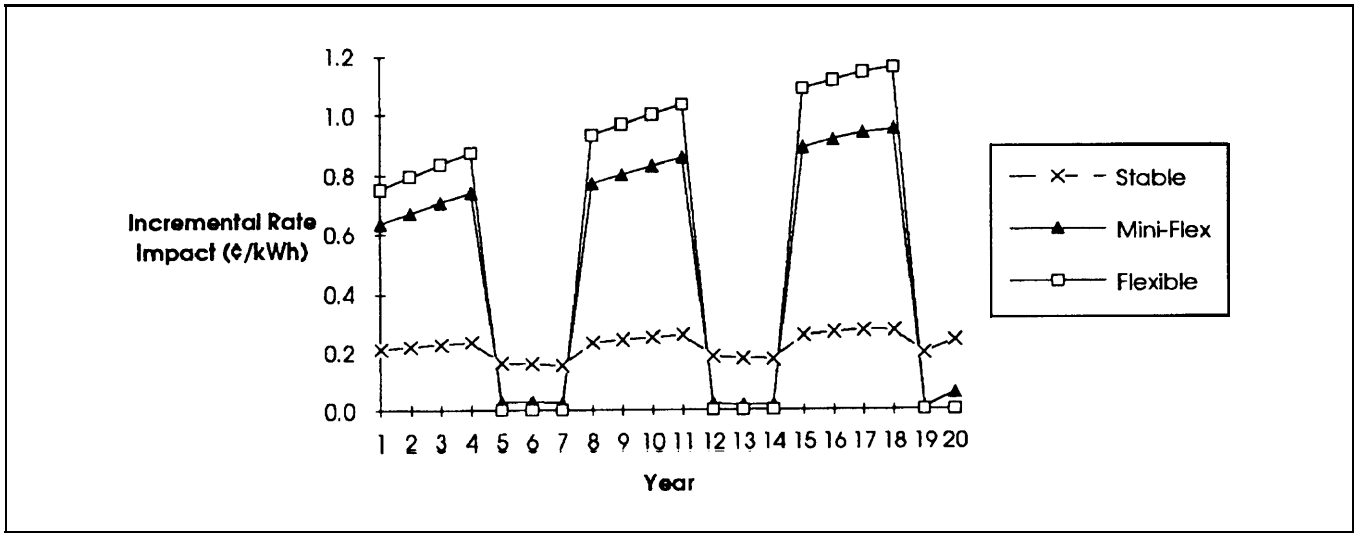

Figure 3. DSM Cost Impact - Low Cycle Load Growth

product planning for a stable market would have resulted in more long-term capita, increasing production and improving production efficiency.

Local distributors and installers were less able to handle swings in demand. During the program stops, distributors and installers noticed that sales were below levels they would expect, had no DSM program ever been offered. This created inventory losses, layoffs, and in some cases, shutdowns. Some suppliers joined the lobbyists in favor of permanent abandonments of DSM, so that a more predictable demand pattern would persist for which their operations could be prepared with proper inventories and staffing.

On the other hand, a number of highly entrepreneurial firms developed within the energy services industry, that were able to manage the uncertainty of markets, diversify geographically, and benefit from the specialization that the DSM-influenced efficiency market demanded.

Finally, the uncertainty of the DSM program continuation affects professional training and career selection. College and trade programs focusing on engineering and economic skills related to DSM have become less popular, and some professionals within utilities and DSM firms have chosen to diversify their careers. As a result, the number of professionals, and the quality of training, is diminished by flexible DSM purchasing (Lula, 1994).

Conclusions

Flexibility in DSM purchasing has substantial cost. At a minimum, reducing DSM expenditure may need to be made up with more expensive DSM purchasing at a later date.

Most clearly, the utility needs to create an environment for its customers, as well as the DSM industry, that mitigates risk by promoting stability. Utilities can improve the perception of the industry to its customers by showing a long-term commitment to at least some level of DSM, and reasonable stability to programs and incentives offered. This nurturing will result in long-term investment and long-term training and career development, which should result in the most cost-effective DSM.

Within this constraint, however, there is substantial opportunity to modulate DSM, and to a much greater extent than other resources. Most modifiable is the marketing: with a given incentive level, substantial change can be fostered to the rate of adoption by choosing aggressive or modest program promotion.

Within the incentive programs, modulation should be focused on retrofit programs. New construction and new equipment programs are usually highly cost-effective, and lost opportunities cannot be as inexpensively recovered.

While the Rhode Island project will create some quantification of flexibility costs, further work is needed to fully represent these costs in integrated resource planning at electric utilities. It is clear that a full accounting will reduce the modulation of DSM as compared with the Northeast experiences of the last several years.

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