Demand Response Grows More Resourceful

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ABSTRACT

Demand response resources refer to distributed energy assets that can be managed to reduce loads of end-use customers during critical or expensive periods of time on the electric power grid. Two types of demand response programs are popular. Load response programs contract and pay for participants to curtail all or parts of their load for periods of two to four hours, typically for a limited number of days, such as 15. Price response programs offer innovative rates, such as real-time pricing and critical peak pricing, that allow customers to save money by optimizing energy use, and thereby make more efficient use of electric system resources.

Demand response programs are growing among distribution electric utilities and the regional power grid operators. Three of the largest grid operators are showing great success with demand response. They are the PJM, the New York Independent System Operator, and the Independent System Operator of New England. For 2004, they enrolled 7,190 megawatts (MWs) of resources, an increase of 72 percent from 2003. Further increases may be expected as ancillary services, such as spinning reserve and replacement reserves, are supplied by some demand response resources, which can react quicker than traditional central station power plants.

INTRODUCTION

After several years of struggle, demand response resources are establishing themselves more firmly as market participants in meeting energy and capacity needs on the electric power grid. Furthermore,

demand response resources appear poised to grow in size and application.

Demand response resources refer to distributed energy assets that can be managed to reduce loads of end-use customers during critical or expensive periods of time on the electric power grid. Examples of demand response resources in commercial buildings include temporarily reducing lighting, changing temperature settings on air conditioning systems, and shutting down some equipment, such as certain elevators and down escalators. Industrial facilities practice demand response by interrupting production processes, postponing batch process operations, and pre-cooling refrigerated materials before allowing the systems to coast through the curtailment or a high-cost period. Standby emergency generators are also a great demand response resource. In residential applications, demand response programs cycle central air conditioners and curtail electric hot water heaters.

There are two broad types of demand response programs: load response and price response.[1] In load response programs, participants are asked to curtail or interrupt loads for periods of two to four hours, typically. The customer usually is contracted for a maximum number of events during a year, such as 12 or 15. Most programs pay an incentive based on the amount of load reduced. In certain program designs, customers may elect not to participate for some of the events.

The second category of demand response program is called price response. In price response programs, participants shift energy use to obtain better rates, reduce costs or earn a credit on their energy bills. Examples include: time-of-use rates, with published daytime and nighttime tariffs; real-time pricing with rates that vary hour to hour throughout the year or season; and critical peak pricing with rates that are imposed for a certain number of hours when utility and grid conditions warrant.

The load response programs are often called reliability or emergency demand response programs. This is because the load response programs are called upon when the power grid is facing reliability challenges, such as failure of central station power plant or insufficient capacity to move power into a neighborhood or area with high load requirements as might occur on a hot summer afternoon in the middle of the week.

The price response programs are often called economy programs.

Rather than being tied to electric system operating conditions, economy programs are structured to allow customers to react to power costs on the grid and minimize energy bills for their facilities by reducing usage or shifting consumption to lower-cost periods.

This article summarizes the demand response programs encouraged by the three most active independent system operators of the electric power grid: PJM, New York, and New England. There are other power grid operators, including the California Independent System Operator (CAISO), the Midwest Independent System Operator (MISO), and the Electric Reliability Council of Texas (ERCOT). While these other operators are not operating demand response programs yet, many of the utilities in those reliability regions are offering programs.

For 2004, the three most active operators enrolled 7,190 megawatts (MWs) of resources. This is an increase of 72 percent from 4,180 MW in 2003. One way to think about the 7,190 MW of demand response resources is that it is equivalent to 14 power plants of 500 MW. Thus one of the key drivers of demand response is to take advantage of existing customer resources and avoid the need for new power plants.

PJM

The Pennsylvania New Jersey and Maryland (PJM) power grid system is the oldest and largest operator of demand response programs. PJM covers the states implied by its name and extends into all or parts of other Great Lakes and Mid-Atlantic states.[2]

By December 2004, PJM had enrolled 5,259 MW for demand response in its three main programs. This is an increase of 145 percent over the 2,145 MW in 2003. The demand response resources amount to about 5 percent of the 110,700 MW of peak demand on the system.

The largest program is the price response or economic program. Registered load is 2,113 MW in 2004, or about three times the level in 2003. The price responsive program offers participants two choices to participate. One choice is the day-ahead program where participants may receive payment based on the locational marginal prices for the next day. The second choice is for a real-time option and receive payments based on reductions for locational marginal prices during that day.

The PJM emergency load response program includes 1,783 MW of capacity. This is also a dramatic increase over the 659 MW enrolled in 2003. The participants are called upon in the event of an emergency and have the option to curtail load or not. No emergency events were called in 2004.

PJM price response participants took advantage of the program for a total of 4,123 hours in the first half of 2004. Most chose the real-time price option accounting for 94 percent of the megawatthour (MWh) reductions. In terms of payments, about one-third of the real-time reductions earned over $75/MWh.

In addition to the PJM programs for demand response, other demand response programs are active among its members. About 1,800 MW are enrolled in programs operated by the load serving entities (LSEs), also know as local distribution companies (LDCs). These supplementary programs are called active load management (ALM). This active load management programs represent an increase of 50 percent from the 1,200 enrolled in 2003. About 450 MW of the ALM resources also participate in the PJM programs.

Hence the net load available for demand response is 5,259 MW as noted initially. A total of 6,344 sites participate in the PJM price and load response programs.

In addition to these resources, time-of-use rate programs and other price response program exist among PJM members. This adds approximately 3,000 MW of load engaged in demand response programs.

NYISO

The New York Independent System Operator (NYISO) offers both price response and load response programs. Load response programs enrolled 1,562 MW.[3]

The number of load response resources numbered 2,059 participants as of the end of August 2004 in the annual report of the NYISO to the Federal Energy Regulatory Commission. The participating loads declined 8 percent to 1,562 MW in 2004 from 1,694 MW in 2003. The load response resources are equivalent to 5 percent of the all-time system peak of 31,000 MW in August 2001.

There are two principal load response programs for the NYISO.

The largest is a load response reliability program called the installed capacity-special case resource program or ICAP-SCR. The program allows customers to bid in load reductions as part of six-month or monthly auctions by the NYISO. Resources must curtail load when notified, which is at least two hours prior to the event and often with advance notice of 24 hours. Distributed energy resources such as standby generators can participate.

The ICAP program sold 981 MW of load from 933 participants in 2004. A bid ceiling of $500/MWH was in place. Nearly all the capacity was bid close to the strike price of $500/MWH. However, the program was not activated in 2004.

The second load response program also supports system reliability and is called the emergency demand response program or EDRP. Participating resources are paid at least $500/MWH and more if the locational marginal price is higher. Participants must enroll, but suffer no penalties if they are called upon to curtail and do not.

Enrolled loads in EDRP accumulated 581 MW from 1,126 participants. No payments were made in 2004 since no emergency events were called.

The price or economic program is called the day-ahead demand response program or DADRP. Retail customers may bid their curtailable loads into the spot market for energy supply resources. The bid must be made a day ahead of when the resource may be called. The minimum bid is $50/MWH.

The number of customers enrolled declined to 17 in 2004, down 32 percent from 25 in 2003. The enrollment of 377 MW was a 20 percent decline from 2003. Price response resources should not be added to load response resources, since price response resources may also participate in load response programs for the NYISO.

Bids were accepted for 1,275 hours for the year ending August 31, 2004. Fewer bids were accepted as compared to 2003 due to lower price volatility on the spot markets. Nevertheless, an average hourly load reduction of 2.7 MW was achieved for the 15 percent of the hours in the year when accepted. Most of the reductions were accepted in winter and summer months and between the hours of 9 a.m. and 10 p.m.

From the NYISO perspective, the programs are worth continuing, even though little activity took place in 2004. To encourage greater participation in the day ahead price response program, plans are

being made to allow standing bids rather than requiring daily bids. However, the minimum bid price was raised to $75/MWH, effective November 2004. By raising the minimum bid price, the NYISO believes it will reduce "free rider" behaviors, where reductions may have been paid for loads that would have been reduced by the customer anyway.

ISO-NE

The Independent System Operator of New England (ISO-NE) reports there were 468 assets or participants enrolling 369 MW of available load reduction in both price and load response programs. As of November 1, 2004, the number of assets increased from 2003 to 2004 by 34, or about 8 percent. The enrolled load also increased by about 8 percent or 28 MW. The 369 enrolled MWs represent about 1.5 percent of the all-time system peak of 25,358 MW in 2002.[4]

The load response or reliability programs are the largest component, totaling 264 MW. Three load response programs were in place. The largest load response program requires resources to respond within 30 minutes of notification by the ISO-NE. Enrollments totaled 169 MW. Participants qualify for $500/MWh.

A second load response program gives customers two hours notice. Only 12 MWs registered for an incentive of $350/MWh.

The third load profile program also has a two-hour response time, but the customers are not required to have interval meters as are required in the other programs. Called the real-time profiled response program, it serves smaller direct load control applications for residential air conditioners, water heaters, pool pumps and distributed generation. The aggregator must have an approved monitoring plan to verify load reductions. Enrollments total 83 MW and earn a minimum of $100/MWh.

Compliance is mandatory for all load response programs. However, failure to respond is dealt with by reducing a monthly capacity payment associated with membership. No events were scheduled for the load response programs in 2004.

The price response program was exercised in 2004 with enrollments reaching 105 MW. Program participants agree to reduce load voluntarily when the locational marginal price exceeds $100/MWH

and the ISO has requested it, usually a day ahead or earlier in the morning of the subject day.

Price response events were declared on ten days for a total of 104 hours. The hours called were only about a third of the hours called in 2003 due to mild weather in 2004.

About 835 MWH were saved with nearly half in Connecticut, where transmission constraints are greater. The average payment was $100.29 per MWH.

Ancillary Services Markets Are Next

Currently, demand response resources are restricted to certain times and applications. Demand response resources are prevented by most electric industry reliability rules and regulations from participating in ancillary services markets. However, the rules are changing.

Ancillary services include such functions as providing spinning reserves in the event of power availability failures and electric system regulation on the power grid in the event of power quality fluctuations.[5] Traditionally, ancillary services have been provided by central station generation plants. Plants are kept in spinning reserve, but not under load, in the event of a system failure on the grid and additional load is needed suddenly. They must be able to supply capacity and regulate power within minutes. Another type of ancillary service is called the supplemental reserve, which is like the spinning reserve, but with a longer response time, such as 15 to 30 minutes.

Many demand response resources perform within the short time deadlines needed to supply ancillary services. Some resources can respond within seconds to provide spinning reserves. For example, standby generators can respond within 10 to 15 seconds.

As another example, air conditioner cycling programs for residential and small commercial buildings can be signaled within a minute. Cycling programs interrupt the operation of the equipment for short periods of time, such as 15 minutes out of each half hour over a two to four hour event. If called upon for spinning reserves, cycling programs are even more advantageous, since they can easily operate for the minimum of 30 minutes required of ancillary services.

The 30-minute time period allows central station generation resources to come on line and make up for the capacity lost in spinning reserves. Then the cycling schedule can be discontinued and the resources once again are available on standby to provide spinning re-

serves. Multiple parties are satisfied since power plants can operate for hours to meet system needs, while if cycling programs operate for too many hours, the customers may start to experience more discomfort and inconvenience that they are not likely to notice in a thirty minute event.

Another benefit is that the aggregation of many demand response resources, while small individually, makes it highly probable that the assigned ancillary services will be achieved in total. This means that demand response resources are more reliable, when compared to a central generation resource, where a failure of one turbine could cause large losses of spinning reserves.

Independent system operators are pursuing options to allow demand response resources to participate in ancillary services markets. This would help level the playing field by allowing demand response resources to perform as an equivalent and competitive asset to central station power plants.

ABOUT THE AUTHOR

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Footnotes

1. "Demand Response: Principles for Regulatory Guidance," Peak Load Management Alliance, February 2002, p. 3. www.peaklma.com.
2. PJM Load Response Programs, www.pjm.com.
3. "NYISO 2004 Demand Response Programs," www.nyiso.com.
4. "Semi-Annual Status Report on Load Response Programs of ISO New England, Inc., FERC Docket No. ER03-345-004, www.iso-ne.com
5. B.J. Kirby, "Spinning Reserve From Responsive Loads," Oak Ridge National Laboratory, March 2003.