

DEMAND RESPONSE PERFORMANCE

An Analysis of Demand Resource Participation



Issue Brief

John Ellis

Graduate Student Analyst, Institute for Building Efficiency

DATA PROVIDES NEW PERFORMANCE RESULTS ON ENERGY CURTAILMENT

Demand response is helping to resolve a number of challenges facing today's electricity grid, among them reducing energy demand at peak times, balancing energy generation from intermittent renewable energy sources, and relieving transmission congestion. In addition, electricity markets increasingly look to demand response to manage emergency or scheduled downtime from power plants, and as a mechanism to lower overall grid management costs and mitigate high wholesale electricity prices.

Rising demand on utility grids is a costly problem. Until relatively recent years, utilities relied largely on peaking power plants to manage spikes in energy consumption, or would build new plants if overall electricity demand was rising. But building new fossil fuel power plants is expensive, requires extensive planning and permitting, and has negative health and environmental impacts. Renewable energy production is rising, but is often intermittent in nature, so requires a more nimble grid. Demand response helps with both issues. Instead of adding generation capacity, utilities pay customers to use less energy at peak or when renewable energy production is down. By acting as "virtual power plants," demand response participants help stabilize the grid. Demand can be reduced through measures such as turning off air conditioning, pumps, lights and other equipment where doing so will not interrupt business or cause people great discomfort.

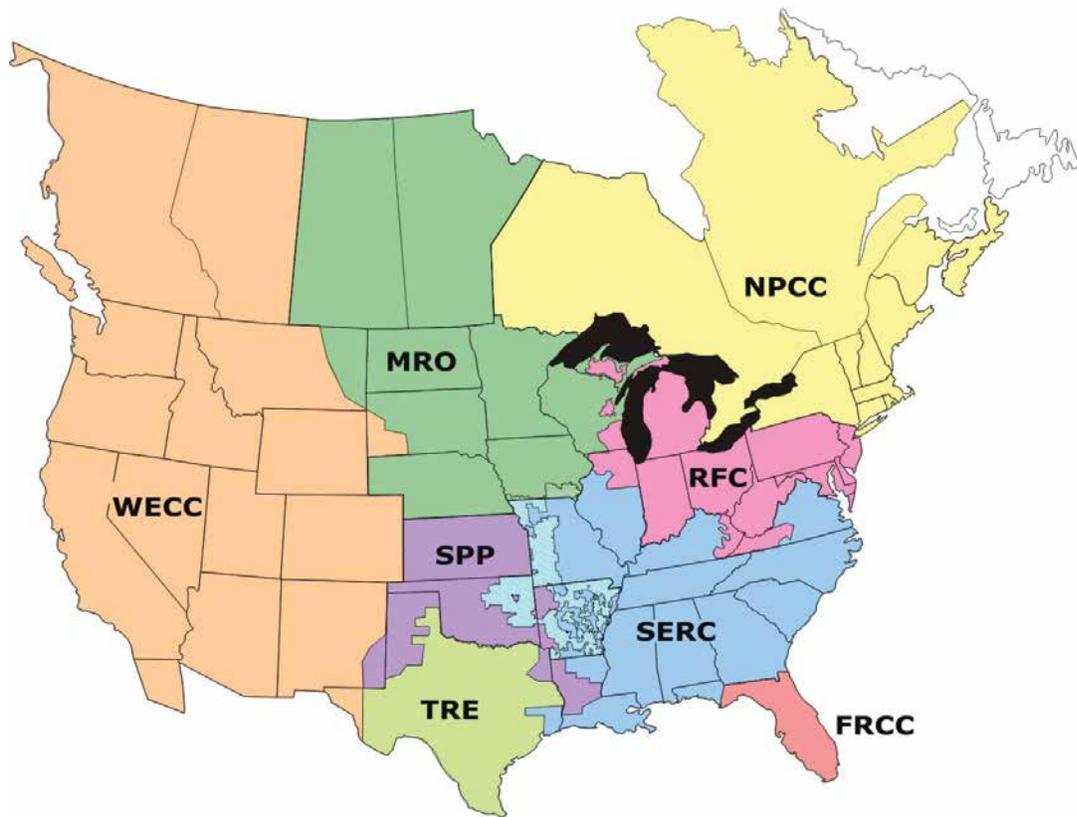
A crucial aspect of demand response programs is how well electricity users respond to utilities' or system operators' calls to curtail demand: a low response rate essentially negates the impact of such programs.

To better understand and track changes in the use of demand response as a resource, the North American Electric Reliability Corporation (NERC) created the Demand Response Availability Data System (DADS).¹ This program collects information about the use of demand response programs throughout NERC regions to stabilize the grid or reduce high wholesale energy prices.

From the summer of 2011 through the summer of 2012, NERC collected information for the first time on demand response events dispatched by the grid operator, and the resulting reduction of load or provision of ancillary services. This database represents the first mandatory reporting of comprehensive demand response program information, and it supplies data to help determine demand response performance across the NERC regions (Figure 1).

¹ Demand Response Availability Data System, <http://www.nerc.com/pa/RAPA/dads/Documents/DADS.xlsx>

Figure 1. NERC Reliability Regions



Useful Terms:

- Grid operators **dispatch** demand response through pre-existing contracts with industrial facilities, buildings or residences.
- **Realization rates** measure overall performance and are defined as the level of demand reduction achieved when the grid operator asks for decreased electricity consumption.
- **Ancillary** services are rapid adjustments to maintain proper grid frequency at times of supply/demand imbalance. Such services can include extra power generation from plants not running at capacity, quick startup of an ancillary power plant or rapidly deployed demand response.

The analysis that follows describes how well demand response resources and ancillary services responded to demand response needs regionally. It also illustrates several trends and explores how they may affect reliable operation of the electrical grid.

DEMAND RESPONSE RESOURCES ARE RESPONDING TO EVENTS

Demand Response is being dispatched year-round: best response occurs in summer periods

The NERC data shows that demand resources were highly responsive to demand response events in the summers of 2011 and 2012. Table 1 shows the average dispatched demand response and the mean realized electrical load reduction, both in megawatts. The reduction rate is the mean realized demand reduction divided by the mean dispatched demand response.

Table 1. NERC-Wide Demand Response Event Reduction Rate

	Summer 2011	Winter 2011	Summer 2012
Mean Dispatched (MW)	23,667	22,090	38,621
Mean Realized Demand Reduction (MW)	19,976	8,256	27,931
Total Number Demand Response Events	604	234	575
Reduction Rate (%) (mean demand reduction divided by mean dispatched demand response)	84%	37%	72%

Demand response in 2011 was consistently called throughout the year to respond to grid needs. However, high levels of participation and performance in demand reduction appear to be seasonal. The 2011 data shows minimal seasonal difference between the dispatched level of demand response during the summer of 2011 compared to the winter of 2011. During the winter of 2011, 22,090 MW was dispatched for reduction – 93 percent of the total 2011 summer dispatch of 23,667 MW.

However, the actual reduction rate by consumers in the winter of 2011 (8,256 MW) was less than half what was realized during the summer of 2011 (19,976 MW). One possible reason for this seasonality is the design of the demand response program structure. Many dispatched demand response programs have seasonal contracts that often are only active during the summer (April to September), when the majority of the demand reduction needs occur. The seasonal design of demand response programs may affect the ability of grid operators or utilities to secure the demand resources needed to support reliability on a year-round basis. This may be particularly true of emergency demand response programs, a service typically used to reduce summer peak electrical loads and available to all customer groups.

The summer of 2012 saw a 163 percent growth in dispatched demand response from 2011 summer levels. The realized demand reduction was largely maintained, as the demand reduced grew from 19,976 MW to 27,931 MW. Nearly three-quarters of the 38,621 MW of demand response sought by grid operators in the summer of 2012 was delivered into the market.

ANCILLARY SERVICES ARE BEING PROCURED AND DEPLOYED REGIONALLY

Reserve ancillary services data collected by DADS provides an interesting look into the regional use of demand response resources. Spinning reserves are demand resources that are able to respond quickly to a dispatch, either to generate power or curtail demand. A spinning reserve is expected to respond nearly instantaneously to a control signal from the grid operator. The time between a spinning reserve dispatch

and when that resource reaches maximum effectiveness is usually less than 10 minutes. A non-spinning reserve performs a similar function but is available either to generate power or curtail demand within 10 to 30 minutes, depending on region – it may not have the capability to respond immediately. Table 2 shows spinning and non-spinning reserve resources by region and the realization rate of those resources.

Because spinning and non-spinning reserves have limited advance notice times and shortened “ramping” periods (the time to reach maximum effectiveness), those resources are often dispatched automatically. They are procured through energy markets for a pre-specified number of hours. The realization rate of these resources is shown by region in Table 2. *(Only regions supplying information to the DADS database are listed.)*

Table 2. NERC Ancillary Services Utilization Rate

		April 2011	May 2011	June 2011	July 2011	August 2011	September 2011
(Non-Spinning)	North American Electric Reliability Corporation (NERC)-All Regions	66%	60%	53%	53%	55%	62%
	Texas Reliability Entity (TRE)	25%	25%	25%	25%	25%	25%
	Western Electricity Coordinating Council (WECC)	33%	34%	33%	33%	33%	33%
Spinning	Reliability First Corporation (RFC)	92%	88%	87%	84%	85%	89%
	Texas Reliability Entity (TRE)	–	25%	25%	25%	25%	25%

RFC had the highest realization rate, maintaining an overall 87 percent utilization of procured spinning reserves through the summer of 2011. TRE had a much lower rate, maintaining 25 percent utilization of procured spinning and non-spinning reserves through that summer. Across all NERC regions, the average utilization of spinning reserves was 58 percent.

The realization measures of how well the grid operator is deploying ancillary services that have been procured through the energy marketplace. RFC, a reliability region containing the PJM energy market, executes the use of ancillary services well, adjusting the procured demand resources from month to month in response to both reliability and market forces. In the RFC region, the PJM market operates many demand response programs. These include a program that creates an active marketplace: a bidding program that allows utilities, aggregators and other participants to buy and sell curtailment services ahead of demand events. TRE, a reliability region that contains portions of the ERCOT energy market, has a lower realization rate for procured ancillary services. In ERCOT, over-purchasing of reserve resources becomes increasingly important as an “insurance policy,” but those resources may not be prepared to respond to any given event. A possible explanation for the difference between the regions is how performance is measured and whether the measurement methods are appropriate for demand resources.

INCREASED NUMBERS OF DEMAND RESPONSE EVENTS SUPPORT IMPROVED DEMAND REALIZATION

When the realization rate performance is analyzed by region, an interesting correlation exists between the number of demand response events and the realization rate achieved: As events increased, so did the realization rate. This trend covered the three-season collection period across all NERC regions and moderately and positively correlates ($R=0.47$) to the realized reduction rate across most NERC regions (Table 3 and Figure 2).

Table 3. Correlation of the Number of Events to the Reduction Rate

	FRCC	MRO	NPCC	RFC	SERC	SPP	TRE	WECC	NERC
Number of Events (#) (Summer 2011–Summer 2012)	45	26	102	341	336	83	168	316	1417
Realized Reduction/Dispatched MW Summer (2011–Summer 2012)	70.4%	89.6%	83.5%	63.4%	81.7%	103%	104%	22.9%	66.6%
Correlation	-0.23	-0.39	0.48	0.50	-0.04	0.69	0.34	0.35	0.47

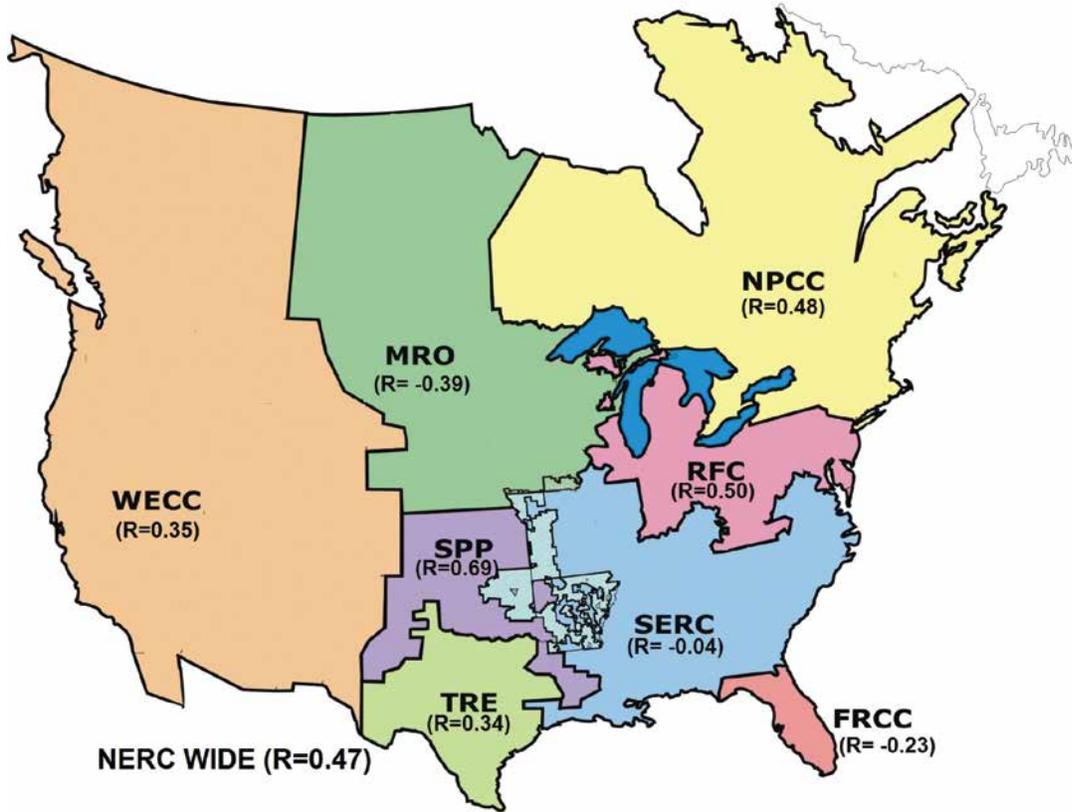
KEY:

FRCC Florida Reliability Coordinating Council
 MRO Midwest reliability Organization
 NPCC Northeast Power Coordinating Council
 RFC Reliability First Corporation
 SERC Southeast Reliability Corporation

SPP Southwest Power Pool
 TRE Texas Reliability Entity
 WECC Western Electricity Coordinating Council
 NERC North American Electric Reliability Corporation

This correlation suggests that as the number of demand response events increases, so does the realization rate of demand response resources. This runs contrary to an industry assumption that an increased number of demand events may cause end-user fatigue. Instead, increased numbers of demand response events may train end-users to better respond when curtailment is needed.

Figure 2. Correlation of Number of Events to Realized Demand Reduction Rate



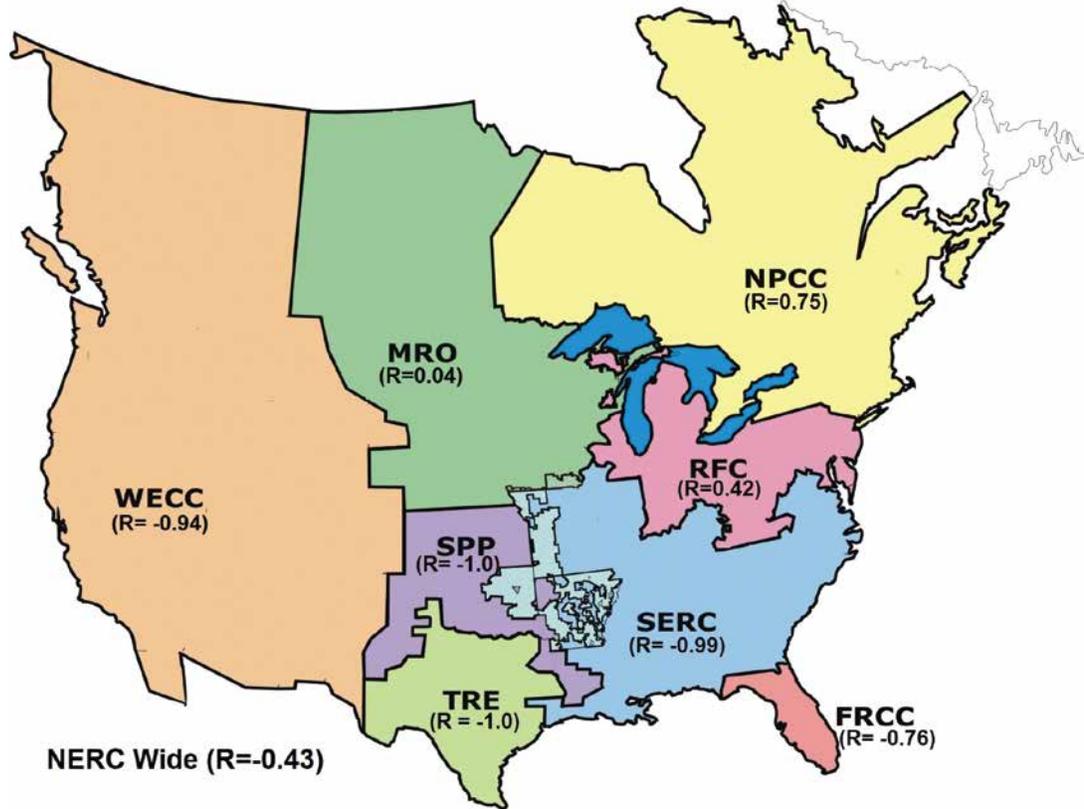
SUSTAINED DEMAND RESPONSE EVENTS MAY RESULT IN DECREASED DEMAND REALIZATION

In the dataset, it appears that some markets may have experienced declines in realization rates as the duration of demand response events became longer. Table 4 and Figure 3 show regional data and the calculated correlation of demand response event.

Table 4. NERC Demand Response Event Duration and Reduction Rate

	FRCC	MRO	NPCC	RFC	SERC	SPP	TRE	WECC	NERC
Ave. Event Length (Min)	29.79	83.33	268.33	131.47	139.67	156.33	88.33	154.29	148.00
Ave. Reduction Rate (%)	76%	93%	85%	66%	83%	107%	104%	30%	65%
Correlation	-0.76	0.04	0.75	0.42	-0.99	-1.00	-1.00	-0.94	-0.43

Figure 3. Correlation of Duration of Events to Realized Demand Reduction Rate



In NERC regions FRCC, SERC, SPP, TRE, and WECC, the reduction rate decreased as the length of the demand response event lengthened. NPCC and RFC, on the other hand performed better as the length of calls extended. NERC-wide, the average demand response event lasted 93 minutes during the summer of 2011 and increased by 1 hour and 33 minutes to 3 hours and 12 minutes during the summer of 2012. The realization rate dropped 12 percent from 2011 to 2012.

These correlations may point to sensitivity in the FRCC, SERC, SPP, TRE, and WECC regions to the length of demand response events. Presumably, as the event extends, the demand resources may become less available. This trend appears most prevalent in the most southern regions. Conversely, in NPCC and RFC regions, the realized reduction improved when the demand event was extended. This information may change or become more reliable as more data is collected, when program design is taken into account, and the effects of weather patterns are removed.

It is possible that with more data and analysis fatigue point – a time duration at which energy users are less willing to curtail – may be discovered and help inform demand response program design.

CONCLUSION

Demand response is being used to respond to a number of challenges to the grid. NERC's DADS project is providing the first comprehensive details of how well these resources are responding.

From the preliminary data from the 2011–2012 DADS database, a few important themes emerge:

- Demand response is working. The realization rate of demand response in the two summers analyzed is particularly impressive, with an average 78 percent demand reduction. The three-season average demand reduction was 64 percent. Lower performance was seen in the single winter analyzed from this dataset.
- Ancillary services NERC-wide had comparable realization rates to that of demand response realization rates. Some regions, such as PJM, were procuring and deploying ancillary services with high demand reduction realization rates, while other regions may have been under-utilizing market-procured ancillary services.
- Increased numbers of demand response events did not necessarily correlate with decreased reduction realization rates. Across all NERC regions except FRCC and MRO, there was a moderate-to-strong positive correlation between more demand response events and improved demand reduction realization rates.
- It will be important to track if increased duration of demand response events leads to decreased realization rates. In five of the eight major NERC regions, increased average event duration showed a strong-to-moderate inverse correlation to demand reduction realization rates.

The initial findings from the DADS database reveal interesting trends in demand response. In the next phases, DADS will deliver information on two additional demand response programs: economic DR (demand bidding) and time-sensitive DR (critical peak pricing). As this information becomes available, the market will have a more complete picture of the variety of benefits the grid is achieving through demand response.

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If you are interested in contacting the authors, or engaging with the Institute for Building Efficiency, please email us at: InstituteforBE@jci.com.

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