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Environmental Benefits of Demand Response

By reducing electric demand during peak hours, demand response (DR) can provide multiple environmental benefits while making regional electric grids more reliable. Demand response can save energy, reduce the need for fossil fuel power plants, and help integrate renewable energy onto the electric grid by providing increased stability and management.

Energy Efficiency

Demand response programs increase overall system efficiency by shifting electricity consumption away from peak load times to more desirable periods when demand has settled. In addition to shifting demand, DR reduces overall energy consumption and has historically been included in utility conservation plans.

While the peak reduction impacts of demand response are well-known, the overall energy conservation impacts are less understood. At issue is the magnitude of the *snapback effect*, or the increase in energy use experienced after a DR event. For example, if a utility reduces output from residential air conditioners during a hot summer day, the A/C units may in theory need to work harder afterwards to return their homes back to the original temperature.

A recent study done for the state of Minnesota explored the energy savings impacts of demand response. It found that even after incorporating the snapback effect, residential demand response technologies still generate overall energy savings after an event (see table below). The degree of savings varies by technology. For example, the study found that cycling electric heaters generates a net savings of 3.11 kilowatt-hours (kWh) per household for each DR event, while cycling air-conditioners produces a net savings of 0.71 kWh per household.

The study also showed even greater energy savings from commercial and industrial demand response programs.

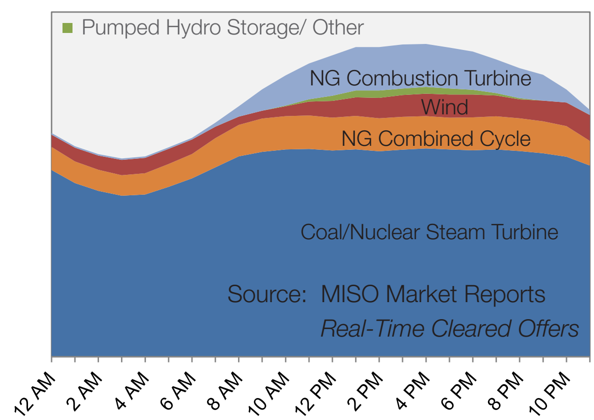
Program Type	**Net savings** per home, per event
Air Conditioner Cycling	0.71 kWh
Electric Heat Cycling	3.11 kWh
Domestic Hot Water Curtailment (summer)	0.4 kWh

Sources:
1. Minnesota Department of Commerce and Michaels Energy, *Demand Response and Snapback Impact Study*. August 2013
2. Star Tribune, *Schafer: Promise of power storage still lacks payoff*. February 15, 2014.
3. California Public Utilities Commission, *Decision Authorizing Long-Term Procurement for Local Capacity Requirements Due to Permanent Retirement of the San Onofre Nuclear Generation Stations*. February 11, 2014

Reduced Reliance on Fossil Fuel Power Plants

Power plants that run during peak hours tend to be inefficient and higher-emitting. For example, during the summer the carbon intensity of electricity in California can be up to 33% higher during peak times compared to off-peak times.[2] Offsetting these peaking plants with demand response can significantly reduce environmentally-harmful emissions. In the Midwest, natural gas combustion turbines are often used for peak electricity. While this type of electric generation from natural gas is significantly less carbon intensive than baseload coal plants, it is actually more carbon intensive than baseload combined cycle natural gas plants.

Example MISO Summer Day Generation by Source



When considering new investments in electricity resources, demand response should be looked at on equal footing with electric generation as an option for meeting demand. For example, regulators and utilities conducted an analysis after the shutdown of a large nuclear power plant in southern California, and recommended that over a third of the replacement resources should be met with *preferred resources*, including demand response, energy storage, renewable energy and energy efficiency.[3] This reduced the need for new conventional generation. Given declining technology costs, these resources make economic sense in many situations. Many states in the Midwest have well-established integrated resource planning, which are well equipped to give similarly fair consideration to demand response and other technologies as alternatives to conventional generation.

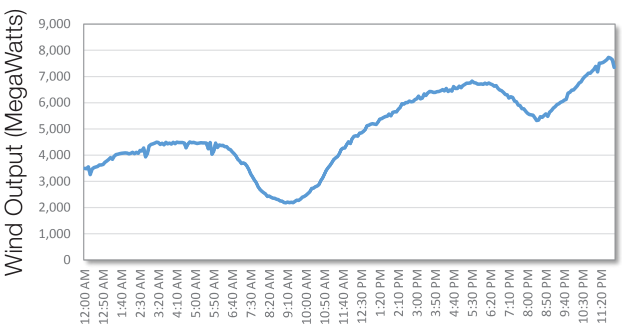
Renewable Energy Integration

Renewable energy like wind and solar are variable by nature—the sun does not always shine nor does the wind always blow. Demand response can help manage this variability and will become increasingly valuable as renewables continue to come online. Many power plants cannot vary their output quickly in response to changes in renewable generation, but demand response can be deployed quickly to respond to variation and help integrate wind and solar.

Managing an electricity system with higher levels of wind and solar requires more system flexibility to manage swings in supply. For example, wind output in the Midwest can vary significantly throughout the course of a day (see figure below).

MISO Wind Power Availability

From July 18, 2013, MISO's summer peak.



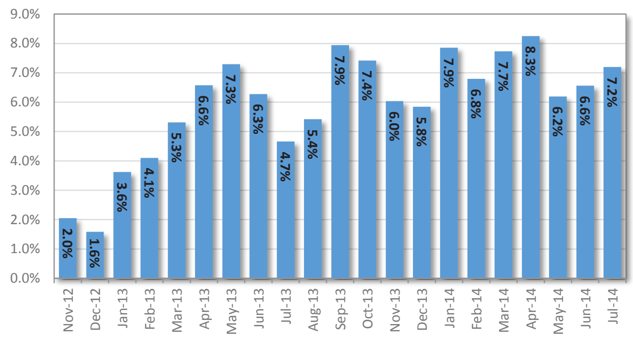
Source: MISO Market Reports, "Real-Time Cleared Offers"

If the supply of energy surpasses demand, then system operators may need to curtail renewable energy generation, effectively wasting the opportunity to generate clean energy. Wind curtailments in the MISO region have been increasing over the past couple years (see next figure) in conjuction with growing wind generation in the Midwest. Demand response is one tool to deal with this issue. Managing demand to match more closely with renewable generation will help reduce curtailments and ensure that wind energy can meet its full potential. This could involve shifting some energy usage to night, when wind production is typically higher and demand low.

Sources:
3. Rocky Mountain Institute, *Reinventing Fire*. October, 2011.
& National Renewable Energy Laboratory, *Renewable Electricity Futures Study; Volume 3, End-use Electricity Demand*. 2012.

MISO Wind Curtailments

From November 2012 to July 2014



Source: MISO Monthly Market Assessment Reports

California is facing increasing penetrations of solar, which impacts the system differently than wind. A challenge arises when electricity demand increases as people get home from work at the same time as solar generation diminishes with the setting sun. High demand combined with the drop-off in solar produces a steep ramp-up in the evening that must be met by other resources. Deploying demand response to manage energy usage during this period would help mitigate system challenges brought about by solar generation.

Recent studies exploring high penetrations of renewable energy point towards the important role of demand response in facilitating the implementation of high renewables. Research exploring 80% renewable electricity penetrations conducted by the National Renewable Energy Laboratory and the Rocky Mountain Institute assumed aggressive expansions of demand response as a tool to reliably operate the system.[3] They determined demand response could reduce peak electricity demand by 20% or more, which can be used to mitigate reliability issues and shift electricity usage to hours when renewable supply exceeds demand.

Demand response offers a variety of environmental benefits, such as reducing energy usage, offsetting the need for fossil-fueled power plants, and helping to manage system challenges from increased wind and solar energy. Thus, demand response has an important role to play in helping us meet clean energy and climate goals throughout the US.

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