# Innovative Technologies in Demand Response:

## Delivering Increased Value for Utilities, Grid Operators and Consumers on Electricity

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ABSTRACT

Demand response is the reduction of consumption on an electric grid in response to peak demand, high prices, or other system contingencies. Over the past several years, technology advancements have enhanced the capabilities of demand response and have increased the value of the resource for all stakeholders—utilities, grid operators, and consumers of electricity. In this article, we present a framework for understanding the benefits that demand response technology can provide.

## INTRODUCTION

Demand response is the reduction of consumption on an electric grid in response to peak demand, high prices, or other system contingencies. A successful demand response (DR) program must balance the needs of all stakeholders (utilities, grid operators, and the capabilities of participating consumers of electricity). On the one hand, utilities and grid operators want a reliable and transparent resource. In many cases, new resources must also be environmentally sound, or clean, to receive necessary regulatory approvals. Utilities and grid operators need to be able to dispatch their resources quickly, sometimes in as little as ten minutes, and to be available across large windows of availability, sometimes at night and on weekends. Portfolio performance must be measured and verified accurately and quickly for resource planning and

financial reasons. On the other hand, for DR to be successful, electricity consumers want program participation to be straightforward. They need a hassle-free protocol for reducing consumption during DR events in order to maximize program revenues. The most successful DR programs for commercial and industrial consumers are enabled by a full suite of innovative technologies. Automated demand response can meet all of these criteria, whereas resources like wind and solar, while clean, are not quick-starting and dispatchable; natural gas, which is reliable and quick starting, is carbon-emitting and costly.

DR technology is complex. A strong DR aggregator will continually innovate and enhance the capabilities of DR by developing new technology features. If developed effectively, the software and hardware systems of a consumer will enhance operational processes surrounding a DR event, making the resource more reliable and enabling more electricity consumers to participate. Innovative technologies have accelerated the growth of the load response industry and will continue to be the distinguishing feature, enabling the next phase of development of this important resource.

## BENEFITS OF TECHNOLOGY

While the benefits that technology-enabled DR delivers to utilities/grid operators and end-use consumers are different, these benefits can be considered through a common framework: *reliability, simplicity,* and *transparency*. This framework is outlined in Figure 1.

### Reliability

First and foremost, to provide value, DR must be reliable. The resource must "show up" when dispatched by utilities and grid operators; electricity consumers must have confidence that they will be paid consistently for good performance during a DR event.

In DR programs, consumers benefit from participation if they are able to optimize their event performance and receive fair compensation. Accurate measurement and verification systems, real-time performance coaching, and rigorous enablement testing are all intended to ensure maximized load curtailment that meets end-user and grid operator expectations. End-users want to be reliable. DR programs provide financial incentives for them to deliver reliable load reductions, and innovative

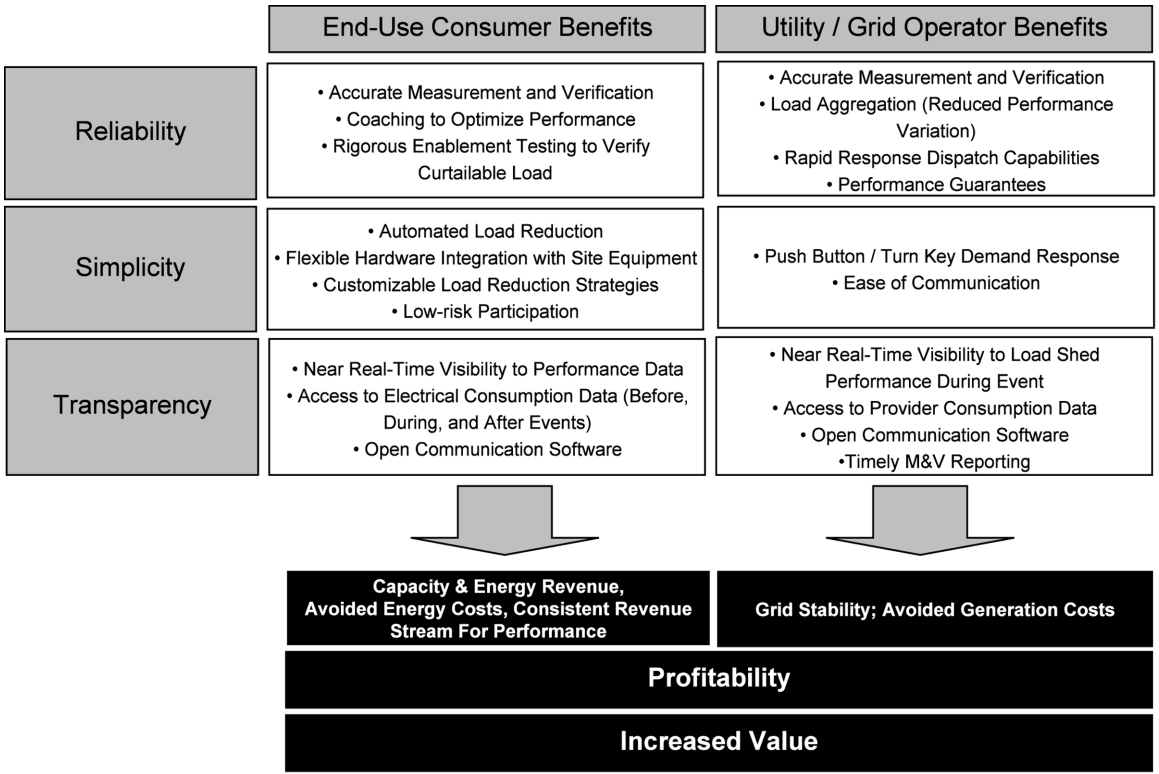
End-Use Consumer Benefits
Utility / Grid Operator Benefits
Reliability
• Accurate Measurement and Verification
• Coaching to Optimize Performance
• Rigorous Enablement Testing to Verify Curtailable Load
• Accurate Measurement and Verification
• Load Aggregation (Reduced Performance Variation)
• Rapid Response Dispatch Capabilities
• Performance Guarantees
Simplicity
• Automated Load Reduction
• Flexible Hardware Integration with Site Equipment
• Customizable Load Reduction Strategies
• Low-risk Participation
• Push Button / Turn Key Demand Response
• Ease of Communication
Transparency
• Near Real-Time Visibility to Performance Data
• Access to Electrical Consumption Data (Before, During, and After Events)
• Open Communication Software
• Near Real-Time Visibility to Load Shed Performance During Event
• Access to Provider Consumption Data
• Open Communication Software
•Timely M&V Reporting
Capacity & Energy Revenue, Avoided Energy Costs, Consistent Revenue Stream For Performance
Grid Stability; Avoided Generation Costs
Profitability
Increased Value

**Figure 1**

technology is required to fully support these interests.

For utilities and grid operators, DR is often an alternative to firing up a peaking power plant or buying power from one. Therefore, DR must reduce the demand for energy as accurately as generation produces it. Consistent, accurate, rapid DR capacity is required for grid operators to ensure grid stability. These benefits are all made possible by DR technology. Load aggregation is a key distinguisher between technologically advanced DR and more basic systems. By managing multiple customer sites within a territory or program, aggregation allows strategic diversification according to load profiles, response times, and other site contingencies. Diversification and management allows the aggregator to reduce performance variability and strategically execute consumer participation. Additionally, rapid response dispatch and accurate measurement and verification are minimum requirements for capacity reliability comparable to generation options.

**Simplicity**

DR is complex; DR aggregators provide value by creating smart technology and effective process to make it simple for the grid operators, utilities, and end-user consumers involved.

By simplifying the experience for end-users, technology has facilitated increased participation in DR programs by engaging new customers and identifying additional load reduction capacity at existing sites. Most commercial and industrial electricity consumers are not highly educated on DR. Therefore, most are not aware of the intricacies involved with enrollment in a DR program, including enablement, load reduction, and performance verification. Without a simple process to facilitate participation, many would not participate due to the challenges of identifying curtailable load, installing equipment, predicting performance calculations, and optimizing load curtailment. Automated load reduction, flexible hardware integration, customizable load reduction strategies, and user-friendly communication software are examples of the key technological differentiators that deliver simplified solutions for end-users.

Automated load reduction is a key technological benefit that has greatly simplified the process for end-users. By designing DR solutions that can integrate easily with building management systems, remotely respond to curtailment signals, and quickly relay load data, end-users feel confident that they are maximizing their curtailment opportunity

easily and without devoting time or resources.

DR technology simplifies the experience for utilities and grid operators by enabling aggregators to offer turn-key DR programs. These programs don't require the utility or grid operator to make a significant capital or human resources investment. DR technology has allowed flexibility in program design such that utilities can be guaranteed load reduction at the push of a button and receive timely measurement and verification reporting. With communication software that can easily integrate with utility systems, the process of event notification and event monitoring can be streamlined within current operations.

**Transparency**

DR technology fosters transparency by giving stakeholders access to important data. For an end-use consumer, access to energy consumption data can provide near-real-time feedback on DR event performance, which can improve performance throughout the event. In addition, some consumers will take the opportunity to better understand their overall consumption patterns and seek solutions to reduce energy costs. For utilities and grid operators, access to data enables trust and accountability. By having access to near real-time data on portfolio availability and event performance, utilities and grid operators will have more confidence in DR as a reliable energy resource.

## TECHNOLOGY PLATFORM

EnerNOC's advanced DR technology platform is one example of a system that was built to ensure reliable and transparent DR resources for utilities and to simplify participation for consumers. EnerNOC's proprietary suite of technology applications and operational processes enable EnerNOC to quickly customize peak load management programs for utilities, deliver verifiable and economical demand capacity, and optimize event performance for consumers during DR events.

Fundamentally, there are three components to EnerNOC's technology platform. All three components work together to simplify this complex operation utilizing EnerNOC's scalable technology platform:

1. Network Operations Center (NOC)—A centralized communication

infrastructure from which EnerNOC conducts its remote monitoring, dispatch, data collection, and reporting.

2. EnerNOC Site Server (ESS)—An advanced metering and communications node located at each consumer site. The ESS is an integrated system that relays electrical data to EnerNOC in near real-time. That data is then captured and used to analyze curtailment performance.

3. PowerTrak™—This is EnerNOC's enterprise energy management web-based software platform. PowerTrak seamlessly links all stakeholders to the information needed to effectively deliver reliable DR. NOC operators, the consumer, and the utility access PowerTrak through a user-friendly interface.

By linking together the hardware, software, and communication infrastructure into a robust management system, EnerNOC demonstrates the critical role that technology plays when increasing a program's value*.

## CASE STUDIES

### C&I Provider Case Study—Grocery Chains

EnerNOC remotely controls certain energy-consuming processes at more than 600 major grocery locations across the United States, including stores such as Raley's, Shaws, and Stop & Shop/Giant. Demand reduction capacity at each site is not significant—generally between 50 to 150 kW. However, in aggregate, grocery stores provide over 60 MW of networked capacity.

Many grocery stores deploy similar curtailment strategies, such as shutting down auxiliary lighting and turning off anti-sweat devices on refrigeration units. Some stores also shift consumption from grid power to onsite generation. Sophisticated notification and response technology replaces unreliable phone chains and other communication methods. The NOC is capable of remotely controlling load to relieve facilities of the burden of switching off lights or turning on generators so that store

*EnerNOC holds two business process patents for its automated DR solutions.

managers can focus on their daily work. The technological window into energy usage enables regional managers to compare consumption patterns across stores so that data can replace best guesses to forecast energy efficiency or procurement needs. With innovative technology, DR is creating new streams of recurring revenue, reducing energy costs, and simplifying energy management capabilities for these stores.

**Utility Case Study—Public Service New Mexico**

Public Service New Mexico (PNM) is New Mexico's largest utility and natural gas provider. With its transmission and generation assets at full capacity, PNM is exploring new and better alternatives to purchasing or building expensive electric power. In 2007, PNM partnered with EnerNOC to create PNM Peak Saver™, an innovative DR program designed to reduce energy usage from hundreds of commercial, institutional, and industrial customers in PNM's service territory. The PNM program is unique in several ways that highlight the opportunities made available by innovative DR technology. First, one hundred percent of the EnerNOC capacity is available to PNM within ten minutes. Second, most of the demand reduction is remotely automated through EnerNOC's NOC. Third, nearly all of the demand is reduced by curtailing processes at customer sites, not by shifting load off the grid and onto backup generation, which shows a heightened need for innovative curtailment strategies enabled through DR technology.

EnerNOC's technology solution enabled the success of the program and continues to deliver increasing value for PNM and the consumers in their territory. PNM Peak Saver is an ongoing program for PNM.

**The Future of DR Technology**

Just as the technology for load response programs has advanced over the past few years to enable greater impact in the marketplace, it is clear that the future of DR will be impacted by the technological advancements happening within the electrical market structure.

As a leading DR aggregator, EnerNOC understands that the future of this resource will become increasingly more complex to meet utilities' needs. Technology and advanced software tools will be critical to solve the challenges presented by those developing needs. More and more, utilities are seeking rapid response, more program hours, more targeted load reductions, curtailment only programs, variable load shape DR,

and deeper integration into system operations and site automation capabilities. The technological advancements needed to address these challenges will require sophisticated software and hardware capabilities. Additionally, the program advancements will need to take into consideration several complex implications that the technology will impact. Customer operations, cost of enablement and control, and scalability are all important factors to consider as the technological solutions emerge and the resource capabilities expand.

## CONCLUSION

As shown, the value of innovative technology in DR is significant for all stakeholders. The benefits derived from the technological resources are different for end-use consumers and utility/grid operators; however, they all relate to the core benefits of *reliability, simplicity,* and *transparency.* EnerNOC has successfully built a technological platform that delivers these benefits efficiently. As the needs of the electrical grid become increasingly complex, technological advancements will continue to drive the DR resource capability forward to meet the system requirements.

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## ABOUT THE AUTHOR

**David B. Wells** is business development manager for EnerNOC. He has been working in the energy industry for over 12 years. During that time he has focused his efforts on working with commercial and industrial customers to help identify energy saving opportunities through electricity conservation measures and demand response opportunities. He has also worked to help educate customers on the opportunities available in the deregulated markets of New England, where customers can choose their own electricity supplier.

Mr. Wells has worked at EnerNOC since November of 2005. Since joining EnerNOC he has enrolled over 250 MW of demand response capacity that can respond to system emergencies in as little as 10 minutes. He has worked with customers that can reduce their load by as much as 100 MW and has also worked with customers that reduce their load by 100 kW per site through direct load control managed by EnerNOC.

Prior to joining EnerNOC, Mr. Wells worked as a key account

manager for National Grid, where he secured over $3 million in energy conservation rebates for customers. He also helped launch a resource conservation manager initiative in which a large school district reduced yearly electricity costs by over $400,000.

Mr. Wells has a Bachelor of Science Degree in electrical engineering and an MBA from Northeastern University. He lives at his home in West Bridgewater, MA, with his wife and two children.

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ABOUT ENERNOC INC.

**EnerNOC, Inc**., is a leading developer and consumer of clean and intelligent energy solutions to commercial, institutional, and industrial customers, as well as electric power grid operators and utilities. EnerNOC's technology-enabled DR and energy management solutions help optimize the balance of electric supply and demand. The company uses its network operations center, or NOC, to remotely manage and reduce electricity consumption across a network of commercial, institutional, and industrial customer sites and to make DR capacity and energy available to grid operators and utilities on demand.

EnerNOC is active in 27 DR programs throughout 14 markets, both regulated and deregulated, across North America, and it employs the same technology and remote control capability everywhere. As of June 30, 2008 EnerNOC had over 3,000 sites in its international network and more than 1,600 MW of DR capacity under management. For more information, visit www.enernoc.com.