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AMI Demand Response: The Opportunity and Challenges of Mass Market Dynamic Pricing

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TABLE OF CONTENTS

INTRODUCTION

In the last six years, Demand Response (DR) programs have garnered renewed interest and attention. They are hailed as a significant benefit enabled by the smart grid and a method for end-use consumers to engage in managing their energy usage, environmental impact and costs. The emergence of new cost-effective technologies appears to make the process of responding to high-priced or emergency periods easy and therefore palatable to most consumers. But while the opportunities are great, challenges still remain to fully realize the potential benefits. Those challenges exist across the full landscape of this promising field and those who have spent the last several decades or more developing programs and analyzing the benefits of those programs are now faced with a new paradigm – DR for all.

THE OPPORTUNITY

The Federal Energy Regulatory Commission (FERC) reports that the United States' full-participation demand response potential is 20 percent of grid peak demand or around 188 GW by the year 2019[1]. And while the full-participation model is the best-case scenario, the achievable-participation model also shows significant reduction potential, roughly 10 percent above the business-as-usual model where demand response adoption continues on its current path, achieving 138 GW reduction. In other words, the demand reduction potential is significant and worth investment in technologies to enable its broad application.

Both dynamic pricing and demand response programs promise significant benefits for consumers and utilities. Some utilities state that these programs are almost 40 percent of the business case supporting the cost of smart metering along with labor savings, call center cost reductions, reduced theft and increased customer satisfaction. And small demand reductions during peak hours have repeatedly resulted in significant price reductions, suggesting that participation in DR programs by even a portion of an enrolled population can benefit all ratepayers. In addition to those benefits, demand response programs promise to assist in overall grid management. The Department of Energy (DOE) reports that, "10 percent of all generation assets and 25 percent of distribution infrastructure are required less than 400 hours per year, roughly 5 percent of the time."[2] Implementation of large-scale demand response programs can assist in the management of that peak condition and limit the need for additional construction of peaking power plants.

DEMAND RESPONSE AND DYNAMIC PRICING

The terms Demand Response and Dynamic Pricing are sometimes used interchangeably, but the concepts are quite unique. Demand response is a distinct reduction in energy usage for a defined and typically short period of time and can be achieved in a wide variety of ways. Dynamic pricing refers to the rules under which an end-use customer is charged for their energy usage. In some jurisdictions, introducing dynamic pricing tariffs, such as Critical Peak Pricing (CPP) rates, to mass market customers is considered a key benefit of smart metering. However, this idea is not without controversy, as some stakeholders claim that time- and event-based rates place some ratepayers, such as retirees, at a disadvantage. When a program is defined, the two concepts of demand response and dynamic pricing merge. The common mass market dynamic pricing, demand response programs currently being implemented are CPP and Peak Time Rebate (PTR) or Critical Peak Rebate (CPR). These programs combine a more targeted approach to peak load reduction with financial incentives and/or increased charges successful implementation and the realization of the promised benefits.

DEMAND RESPONSE COMPONENTS

On the surface, demand response is a simple concept; during a period of high usage, causing system constraints and/or high prices, end-users reduce their usage and are rewarded for that reduction with an incentive payment or some other form of financial compensation. The reality of demand response is much more complex, involving program design, billing and compensation rules and management or regulatory decisions, technology implementations from smart meters to analytic solutions, and customer engagement efforts from basic energy education to community awareness campaigns and competitions. Each component within the DR universe presents its own challenges, but addressed together there is promise for successful programs benefiting utilities and end-use customers alike.

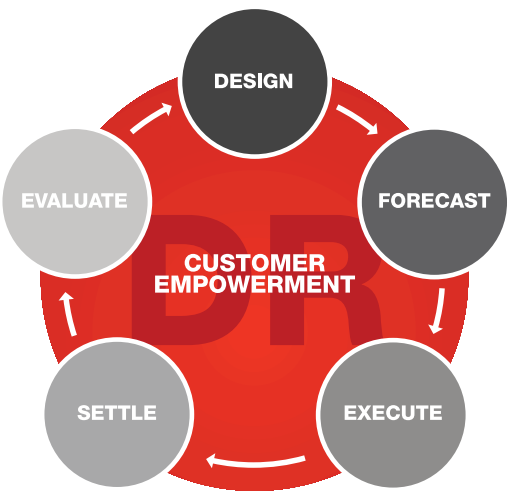

Figure 1: The Demand Response Universe

Design

The design of a demand response program or a dynamic pricing rate is critical to its adoption and success at achieving demand reduction. Because success is entirely dependent upon the response of end-users, resulting in a change of normal behavior, customer perception and understanding must be a primary goal in any design. While simplicity is key to success with customers and technical implementation, end-user perception does not always lead to the most straightforward program. For example, pay-for-performance programs such as Peak Time Rebate are designed to offer an incentive to those who reduce their usage during event periods and refrain from imposing higher prices that may be perceived as a penalty. Logically, this makes sense and feels friendly, but it introduces the concept of predicting the energy that each end-user would have used during the event period had the event not occurred. This is called a baseline and is required to calculate the customer incentive payment. That predictive model can be the source of many long hours of discussion, implementation and customer education. Most current billing systems are not capable of calculating such baselines. Therefore, this task is performed by a Meter Data Management solution. At high volumes, baseline calculation requires significant processing resources that cannot compete with loading of meter reading data and calculation of billing components. Getting the baseline right can be a challenge and poses risks to utility call center operations.

Forecasting

Effective management of a demand response program requires accurate forecasting. Unless the load reduction is predictable and repeatable, it cannot be used as an energy procurement or grid management tool. Historic event performance, customer behavior, event deployment strategies, direct load control technology, weather and much more factor into an effective forecasting model. Fortunately, existing load forecasting methods are well-established and have been proven to be highly accurate. Existing models with modifications for broad spectrum demand response programs can be just as effective.

Execution

Execution of demand response events is a multi-step process dependent upon successful communication, operational and responsive control systems and hardware, willing participation, and accurate measurement and verification. Both manual and automated responses require notification. Manual customer response can be effective but is less predictable. Success depends on received communication and action taken by an end -user who may be otherwise occupied, unaware of possible load reduction strategies or simply uninterested. Automated response, using direct load control technologies, such as programmable communicating thermostats, are more expensive, require installation and maintenance and functioning communication channels, but achieve greater and more predictable load reductions. All reductions must be accurately measured along with mid-event changes such as system overrides or opt-outs.

Settlement

Settlement of demand response programs can take many forms, from those used by PJM's Energy and Capacity markets to charges and credits on an end-use customer's utility bill. All settlement types require reliable metering data and the implementation of standard program rules. As advanced metering infrastructure (AMI) or smart meters are installed at millions of end-use customers' homes, enabling dynamic pricing, demand response and usage visibility, utility meter data management and billing systems must be prepared to support the new options while continuing to meet existing operational requirements. Above all, settlement calculations must be understood by the end-use customer, enabling reliable participation in events and minimizing the use of customer service resources.

Evaluation

Evaluation of program performance brings the process to a full circle as it is an opportunity to modify program design, forecasting methods, communication and execution strategies, as well as identify required technology improvements. It marries disparate data to illustrate what may not otherwise be visible.

Empowerment

Empowering end-use customers to understand and manage their energy use is key to the success of demand response and the only way to realize the promised benefits. Therefore, all components of demand response programs must have customer empowerment as the primary guideline. And empowerment is achieved through communication. Successful programs will offer multi-channel communications, as different customer segments prefer different notification, education and engagement methods. Websites are effective for presenting energy usage and detailed cost analytics. Text messages can be used for brief notifications and alerts. Emails can do the same along with deliver more detailed reports and educational materials. In-home displays are the most effective medium for real-time usage information and can serve as a visual reminder for consumption awareness. Traditional paper bills and even online bill presentment offer opportunities to educate and inform. And the increasing penetration of smart phone use offers a powerful touch point with almost all customer segments.

THE CHALLENGES

The challenges of a successful demand response program are varied, numerous and continue to change as the demand response landscape shifts and develops. The rate at which the demand response landscape is changing is likely the greatest challenge to utilities struggling to gain a foothold or even to those leading the way. But a change in landscape is paramount to actualization, for there are still many barriers to success. A few of the challenges are listed below.

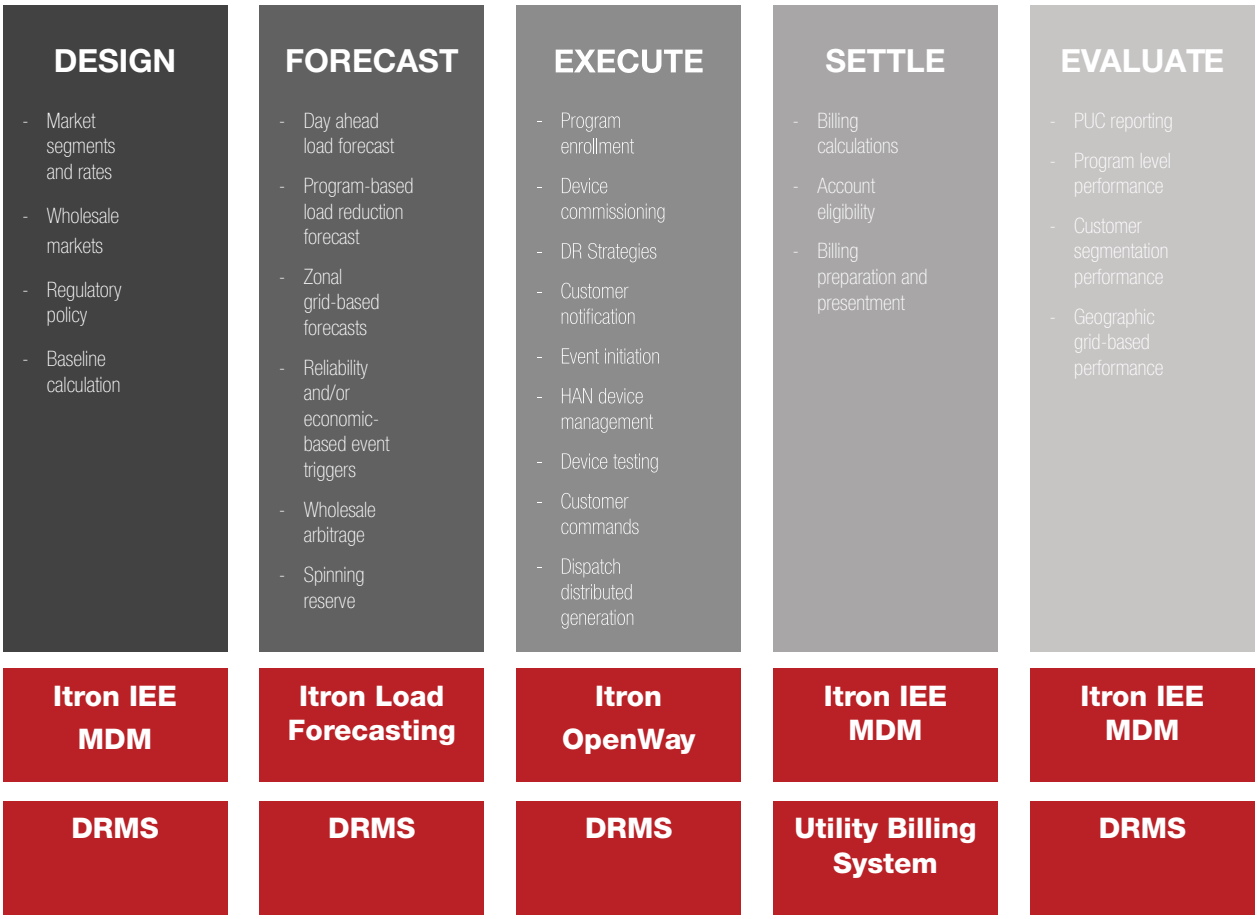

Figure 2: Demand Response Components and Systems

Policy

Demand response program policy is influenced and formulated at multiple levels, from federal to regional, state, local and corporate levels. Since the issuance of the 2005 Energy Policy Act in which the U.S. Congress officially recognized demand response as a national strategy, policies at all levels have been initiated in support of technology implementation including modifaction of financial structures to encourage that implementation. The 2007 Energy Independence and Security Act reinforced the federal government's support for demand response as a national policy and the Emergency Economic Stabilization Act of 2008 funneled significant funding towards demonstration and technology development projects. Utilities in California, Texas, and the Northwest and Northeast are leading the way toward large-scale implementation of those policies, but there is still a long way to go.

Guidlines for participation in programs vary by region and state, and in some jurisdictions, policies limit participation of demand resources in certain programs. This is especially true of residential demand resources, as many guidelines are targeted at larger market players exclusively. Thus, to fully realize the potential of residential demand response, barriers to demand response in general must be addresssed, in addition to barriers specifically limiting residential participation.

General demand response program barriers stem largely from the operating environments and market mechanisms of various Regional Transmission Operators (RTOs.) Some RTOs include wholesale forward capacity markets, which provide price transparency, and which allow demand resources to directly participate. Where these markets are absent, demand response cannot be bid alongside tradional generation resources. The March 2011 FERC ruling starts to lower those barriers. This ruling stipulates that by June 2011 RTOs and Independent System Operators (ISOs) will have to pay the same price for demand response resources as they do for generating resources, making demand response an economically feasible alternative to building new peaking power plants. In addition, stringent communications requirements prevent some programs from utilizing demand response, such as some utilized reserve programs, which require near real-time verification of load curtailment.

Customer Education and Empowerment

Unlike other energy management strategies, such as energy efficiency which focuses on how good equipment is at generating or consuming energy, demand response depends upon a change to the norm. That could be a change in normal human behavior or a change in normal equipment operation. For either to occur, the end-use customer must be involved at some level, either in physically activating a strategy or in enabling advanced technologies to be installed. And the first step is customer education.

From the formulation of policy to the deployment of a demand response event, the end-use customer must be engaged and supportive. Without that, normal human behaviors, such as rejection of the unknown, can place greater barriers to fulfillment than any lacking policy. In addition, mass market consumers are unlikely to participate if it requires significant effort. "Research indicates that consumers are ready to engage with the smart grid as long as their interface with it is simple, accessible and in no way interferes with how they live their lives."[2] In other words, consumers want technologies that enable them to set-it-and-forget-it while still reaping any resulting benefits. But they also want to be able to understand how they benefit. Determining the best ways to deliver information that will result in action is among the most difficult challenges.

Grid Management Strategies

The ultimate goal of demand response, in addition to avoiding high energy prices, is the management of constrained transmission and distribution systems. Successful grid management requires dynamic and real-time information, monitoring of equipment health, and automated controls. While demand response is not the only tool available, it does add to the system operators' ability to manage resources. Some believe that large scale deployment of plug-in hybrid electric vehicles (PHEVs) will enable demand response programs and smart metering to reach the next level in realizing the full potential of demand reduction and management. While this may be true, they also introduce a highly variable demand resource and consumer that grid managers must be able to successfully model. Similarly, renewable energy resources introduce grid variability. And with the growth in renewable energy sources, driven by various state mandated renewable portfolio standards and incentives, grid management becomes even more challenging. From this perspective, demand response programs provide a valuable and necessary tool to grid managers.

Utility Business Processes

Utilities are continuously faced with changing technologies that impact business processes and resources; now, more so than ever. However, the underlying requirements remain unchanged; deliver quality power safely and reliably and recover a fair and approved rate for that service. The opportunities that AMI enable are only realized with the utility's ability to manage the massive amount of data related to those meters, the changing standards related to that data, and the exceptions introduced in the process.

Rules and standards are evolving to meet the changing conditions but those in the forefront will experience the greatest degree of impact. As previously mentioned, the requirements related to pay-for-performance programs introduce significant complexity into utility processes. Baselines require tracking of prior events and event participation, retroactive program enrollment, account and rate changes, and possible adjustment related to pre-event usage. The complexity of the baseline algorithm alone requires significant processing resources that may be in direct competition with the daily meter reading, validation and estimation, and billing calculation processes. The degree of complexity to be supported is therefore not only weighed against the consumer's ability to understand the methodology but the system's ability to perform the required calculations within an integrated operating schedule.

Consumer Technology

Consumer technologies also evolve at high-speed. In the last twenty-five years alone, cellular phones have matured from clunky gadgets used only by the elite or leading-edge technophiles to an everyday tool used by over 70 percent of the world's population. There is no reason to believe that consumer technologies used for home energy management will develop at any lower rate. In fact, home-automation via personal computing may circumvent the need for consumers to understand their energy usage. The challenge may come with the real and perceived value of the technology in relation to the effort required to achieve the benefits of incentive payments or the intrinsic value of environmental stewardship.

Systems Architecture and Integration

Systems play a huge role in the success of the smart grid and pose a significant cost to utilities and grid managers. Therefore, systems being implemented today must be flexible and extensible. A loosely coupled and scalable architecture is essential to support new and changing requirements that are inevitable during the nascent stage of smart grid evolution. Integration of systems is an ongoing challenge for any enterprise. In the case of demand response at a mass market level, the networking requirements are on the scale of the Internet with added requirements for data and messaging security rivaling that of the global banking industry. With this network, utilities have around 100 times more direct interaction with customers than ever before. Therefore, integrating the systems that manage the network, devices within that network and the data transferred over that network is critical to its success.

Measurement & Verification

Measurement and verification (M&V) has always been viewed as a critical part of DR program evaluation, necessary to quantify the actual results of events and assign a value of benefit. Implementation of dynamic pricing programs at mass market scale only introduces the additional challenge of accessing and quantifying data for millions of customers rather than thousands or tens of thousands. The advantage of AMI DR program M&V is the quality of data that can be accessed. Smart meters and AMI

meter data management systems enable the delivery of multiple channels of interval data that have not been available in legacy C&I metering systems. In addition, the verification of load shifts from automated devices is also possible with AMI systems equipped with gateways to inhome devices. The secure, reliable delivery of these data streams from an entire service territory of smart meters makes AMI systems a much more reliable source of M&V for DR programs. Rich and reliable data for M&V enables a wider variety of DR programs targeted at broader segments of participants than legacy metering systems.

Evaluation and Forecasting

Evaluation and forecasting are strongly related components of the demand response universe. Measurement and evaluation efforts examine program effectiveness and provide estimates of program load impacts. As experience is gained, continuing evaluation leads to program design modifications, and these changes will lead to expected changes in load impacts. Initially, forecasting models are based on impacts from evaluation studies and assumptions about how these impacts will evolve in a broader population. As programs are more fully deployed, AMI data for program participants provides the basis for technical analysis of load impacts, and this supports evaluation work as well as the construction of more rigorous forecasting models.

ITRON DEMAND RESPONSE SOLUTIONS

Itron believes in building sustainability into our already resource-stretched global systems. It is only through technology and process innovations that promised opportunity can be realized. We work with our customers to achieve their goals and continuously enhance our offering to meet the increasing challenges we all have to be responsible global citizens. The solutions listed below enable utilities to begin to address the challenges of dynamic pricing and demand response.

OpenWay® Smart Meters

Itron's smart meter, the OpenWay CENTRON®, delivers two-way communications utilities need to build an AMI. CENTRON electric meters are built upon industry standards and provide unprecedented interval data storage, remote upgradeability and configuration changes, and a gateway to consumer smart devices. Each OpenWay CENTRON meter comes factory-equipped with a ZigBee® radio chip to provide a built-in communications pathway into the home for data presentation, load control and demand response.

IEE Meter Data Management

Itron Enterprise Edition™ (IEE) Meter Data Management is an enterprise-wide data management solution for interval, register, meter event, and demand response event data for residential and C&I customers. It is a scalable, open-architecture system that manages data from many different collection systems and supports the billing determinant calculations required for dynamic pricing and demand response programs. It interfaces to existing billing systems to deliver billing determinant calculations and enables utilities to implement large scale dynamic pricing programs.

IEE Customer Care

Itron's integrated customer care applications help energy providers deliver exceptional value to their residential and commercial and industrial (C&I) customer base. Our comprehensive software portfolio supports rate and profitability analysis, complex billing for large C&I customers and presentation of usage and billing and demand response event information over the Internet to both residential and C&I customers.

IEE Curtailment Manager

Itron's Curtailment Manager solution provides a powerful set of software tools to energy providers and their C&I customers to design, issue, monitor, and settle load curtailment events. IEE Curtailment Manager enables multiple program types and has the flexibility to create both day-ahead and same-day events.

Smart Grid Analytics

The Smart Grid Analytics solution provides the tools necessary to manage, interpret and act on the diverse types of data produced from different areas of your smart grid. Itron Smart Grid Analytics brings together data from all pertinent enterprise solutions, enabling insight that is only possible when multiple perspectives are actively visible.

Demand Response Partners

Itron partners with a number of industry leading organizations to complement our demand response portfolio, and provide integrated solutions to utilities seeking to introduce demand response programs at any scale. Itron integrations focus on program execution of automated load control, consumer education and empowerment, demand response management solutions (DRMS), and program evaluation and analysis tools. Itron continues to enhance its partnerships to fully serve its customers' requirements.

Demand Response Forecasting System

Itron's automated forecasting system (MetrixIDR™) can be configured to forecast demand response availability. Initially, models for a program can be based on evaluation results from pilot studies and results of other programs. Once significant program experience is gained, models can be based on AMI data for program customers and the weather and calendar conditions that impact customer response on the event days. Forecasts of demand response availability can be generated by program and by region. Forecasted availability can then be passed on to other systems to develop optimal dispatch strategies and to schedule demand response quantities with the transmission system operator.

Consulting and Analysis Services

Itron's Consulting and Analysis Services offers expertise in economics, engineering, statistics, econometrics, energy and the environment, business management, public policy, and related fields. This group provides clients with industry-leading research and evaluation services addressing both demand-side and supply-side energy programs and energy issues. Itron's experience with the planning, design, and evaluation of demand response programs ensures complete and unbiased assessment of its clients' peak load curtailment strategies.

CONCLUSION

Demand response will play an ever-increasing role in the management of the grid for the foreseeable future. More than likely, automated control of appliances and systems will ultimately become standard daily operations, evolving from an exciting and novel idea to one that goes almost unnoticed but renders significant value. We can only reach that level of stability and comfort with DR execution by realizing a smooth-flowing DR universe where each component fulfills is goals and feeds the cycle with information for improvement. Achieving that success requires a strong partnership between policy makers, technologists, educators and consumers.

ENDNOTES

1 A National Assessment of Demand Response Potential, Staff Report – Federal Energy Regulatory Commission,

June 2009. Prepared by The Brattle Group, Freeman, Sullivan & Co., and Global Energy Partners, LLC.

2 The Smart Grid: An Introduction, Prepared for the U.S. Department of Energy by Litos Strategic Communication under contract No. DE-AC26-04NT41817, Subtask 560.01.04

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