

Proceedings

PJM Symposium on Demand Response III

Integrating Price Responsive Demand

November 9-10, 2009
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1.0 Executive Summary

PJM Interconnection (PJM) sponsored the third in a series of symposia on demand response, *PJM Symposium on Demand Response III – Integrating Price Responsive Demand*, to build an understanding of price responsive demand (PRD) in the wholesale PJM market and of the underlying assumptions about how PRD works; to identify risks and challenges of implementing PRD; and to develop preliminary mitigation strategies for regional PRD that will be of value for all stakeholders in the region. PRD is a “third generation” of demand response, following “first generation” demand response, which includes utility interruptible rates and direct load control, and “second generation” demand response, which involves Regional Transmission Operator (RTO) demand response programs.¹ PRD is designed to provide consumers with the opportunity to voluntarily reduce their consumption when prices rise in the regional wholesale electricity market. If implemented across the PJM footprint, cost-effective and successfully implemented PRD could have a major impact on load requirements in the region. A revised *Demand Response Roadmap for the PJM Region*,² presented at the symposium, is based on earlier versions of the Roadmap that covered second-generation demand response and adds wholesale and retail market requirements for integrating PRD. PRD enables the wholesale energy market to take account of customers’ price elasticity as a reduction in demand as opposed to paying customers’ Curtailment Service Providers (CSPs) the difference between the Locational Marginal Price (LMP) and the generation and transmission components of the retail rate for energy like payments to generators for supply.

This PRD symposium brought nearly 275 people together, including representatives from state regulatory commissions, demand response providers, electric utilities, power marketers, consumer advocates, staff of the Federal Energy Regulatory Commission (FERC), other government officials, non-government organizations, consultants, equipment vendors, and PJM.³



Presentations were given on the following topics:

- Current research on advanced metering and dynamic pricing
- Advanced metering infrastructure pilot projects
- Implications of PRD on the Reliability Pricing Model (RPM) capacity market, scarcity pricing, market operations, and system planning
- Impacts of PRD on state regulatory decision-making
- A look at the relationship of demand response, storage, and renewables to determine if they complement each other⁴

¹ Paul Centolella, Commissioner, Public Utilities Commission of Ohio, and Andrew Ott, PJM Interconnection, *The Integration of Price Responsive Demand into PJM Wholesale Power Markets and System Operations*, March 9, 2009.

² The *Demand Response Roadmap for the PJM Region* is provided in Appendix A.

³ Nearly 200 people attended in person, and another 78 listened by phone. A list of symposium participants may be found in Appendix E.

⁴ Full presentations given at the Symposium are provided in Appendix C.

Symposium participants discussed implementation of PRD – elements of success, risks, and mitigation strategies. During these discussions, they identified specific actions for moving forward to successfully implement PRD in the PJM region, serving as a follow-up to the first two symposia on demand response. Detailed discussion outputs for each group are provided in Appendix D.

1.1 Elements of Successful PRD

PRD is the “next generation” of demand response, which is becoming nationally understood as a method for revealing price elasticity, curtailing load growth, and leveling out spikes in energy consumption. PRD is designed to integrate demand response on the load side of the market. PRD needs to be integrated across the wholesale-retail market and done so in a way that is understandable, fair, and cost-effective for customers, demand response technologists, CSPs, regulators, legislators and others across the board.

1.2 Risks That Stand In the Way of Successful PRD

The most important risks associated with PRD include billing system issues; the need to develop standardized “plug and play” in-home devices, appliances, and control systems; the need for constant and effective customer interface; and equipment or software obsolescence, which could lead to stranded costs. Other risks that stand in the way of PRD include legislative and regulatory decision-making that differs across the region, but which could lead to customer confusion, dashed expectations, and/or disengagement. The interaction between wholesale and retail markets continues to be a concern, one which the *Demand Response Roadmap for the PJM Region* addresses. Across the board, customers need to be continually educated about demand response and PRD so that transactions are clear and easy to understand, which will enable them to fully participate in the electricity market. Straddling the retail-wholesale market, the use of PRD for accurate load forecasting is another risk that is of concern to stakeholders in PJM. Successful integration of PRD will require accurate data at both the wholesale and retail levels.

1.3 Risk Mitigation Actions

Symposium participants identified clear actions for addressing these risks, most of which should be able to be implemented in the short term. These actions focused on billing system improvements that will provide customers with accurate, timely, and standardized information; robust customer support and education that clearly communicates the costs and benefits of dynamic pricing; actions to address equipment obsolescence; accurate load forecasting; and regulatory and legislative initiatives that support price responsive demand response.

2.0 Demand Response 3.0

The *PJM Symposium on Demand Response III – Integrating Price Responsive Demand* was held November 9-10, 2009, to build an understanding of PRD in the wholesale PJM market and of the underlying assumptions about how PRD works. During the symposium, speakers and participants discussed the risks and challenges of implementing PRD and identified preliminary mitigation strategies for regional PRD that could be valuable for all stakeholders in the region.

PRD is the “third generation” of demand response, following “first generation” demand response, which includes utility interruptible rates and direct load control, and “second generation” demand response, which involves offers of load reduction capability into the RTO markets by CSPs in competition with generation resources.⁵ PRD is designed to provide consumers with the opportunity to voluntarily reduce their consumption when prices rise in the regional wholesale electricity market and to thereby reduce their electricity bills. If implemented across the PJM footprint, cost-effective and successfully implemented PRD could have a major impact on load requirements in the region. A revised *Demand Response Roadmap for the PJM Region*, presented at the symposium, adds an outline of the wholesale and retail steps needed to integrate PRD.

PRD is designed to provide consumers with the opportunity to voluntarily reduce their consumption when prices rise in the regional wholesale electricity market and to thereby reduce their electricity bills.

The third demand response symposium included plenary presentations on PRD fundamentals, pilot projects underway testing advance metering infrastructure (AMI) and dynamic retail rates in the PJM region, integration of PRD into the wholesale and retail markets, and the impact of PRD as an enabler of energy storage technologies like plug-in hybrid electric vehicles. Attendees responded to a set of “real time” survey questions and participated in breakout sessions that addressed the following:

- Elements of successful PRD
- Risks of PRD that need to be addressed for it to be successful
- Actions for addressing these risks and moving forward with PRD in the PJM region

An advisory group composed of state and federal regulators, PJM members, and other stakeholders guided the development of the symposium agenda, speakers, and expected outcomes.

Invited participants to the third demand response symposium included the following:

- Demand response subject matter experts
- State regulators
- State legislators
- State energy offices
- State consumer advocates
- Retail customers
- Industrial end-use customers
- Generation and transmission owners
- Electric distributors
- Curtailment service providers
- Other suppliers
- PJM Interconnection staff



⁵ Centolella and Ott, Ibid.

- Federal agencies, including FERC, the U.S. Department of Energy (DOE), and the U.S. Environmental Protection Agency (EPA)

Approximately 275 individuals participated in person and via teleconference. In addition to plenary sessions, the symposium provided an opportunity for attendees to break into sixteen (16) small groups to discuss elements of successful PRD, risks, and possible actions that should be considered to overcome them.

The updated *Demand Response Roadmap for the PJM Region* reflects PRD in both the wholesale and retail market. Articulated as “Demand Response 3.0,” the updated Roadmap furthers the purpose of the original document as a tool for collaboration, a clearly defined integrated wholesale/retail plan, a checklist of “to do’s” developed through a collaborative process, and a record of accomplishments. The added *Price Responsive Demand* section of the *Roadmap* is an integrated and coordinated wholesale and retail policy and program document, incorporating both AMI and dynamic pricing, so as to allow load reduction capability to respond to dynamic retail price signals and to reap related reductions in electricity bills.

The added *Price Responsive Demand* section of the *Roadmap* incorporates input from state regulators and other stakeholders. This document, *Demand Response Roadmap – Version 3.0*, features the following elements:

On The Retail Side

- Dynamic pricing that will produce energy demand reductions
- Metering that reflects hourly and sub-hourly prices
- Automated customer usage decisions that respond to dynamic prices
- Presentation of pricing and quantity data for PJM by load serving entities (LSEs) in the PJM region
- Energy and capacity obligations of LSEs that take account of PRD

On The Wholesale Side

- Documented power quality data provided by LSEs in the forecast of demand response curves
- Forecasted demand response curves that will be more accurate, improve system dispatch, and inform planning and capacity procurement
- Implementation of scarcity pricing through an operating reserve demand curve framework
- Penalties and consequences for LSEs that exceed capacity expectations

3.0 Demand Response Symposium III – Price Responsive Demand Response

Susan Covino and Stu Bresler of PJM began Day 1 of the symposium with opening remarks and an overview. In framing the goals and objectives of the symposium, Mr. Bresler clarified PRD from both the customer’s perspective and the operator’s perspective. PRD for customers

is defined as management of energy costs by reducing or shifting consumption away from high price periods and a commitment to reducing demand in response to reliability requirements. For operators, PRD reflects customers' ability to change their consumption in response to energy market prices and to reduce their consumption to meet system needs during an emergency.

Mr. Bresler identified three key requirements for incorporating PRD into the dispatch market, including close coordination with Electric Distribution Companies (EDCs) on quantities and prices; location detail of PRD quantities; and recognition in dispatch and pricing software.

Following these remarks, Roger Levy, a consultant to the Mid-Atlantic Distributed Resources Initiative (MADRI), provided the keynote address. He reflected on the past 30 years of conservation programs, many of which have led to price-driven demand response. Organizations and institutions supporting demand response have learned that customer choice is a key to successful mitigation of energy demand; but in order to successfully implement demand response, customers need data and product information that is reliable and easy to understand. Although there is tremendous potential for demand response, there are risks inherent in implementing it. Lessons learned from other demand response practitioners – utilities, regulators, states, CSPs, etc. – need to be better applied to new product offerings. And price is the centerpiece between the utility system and customers. Regulators, interveners, consultants, and consumers all have a role to play in facilitating customer participation in the energy marketplace.

Ahmad Faruqui of the Brattle Group provided an overview of PRD, or “Price Responsive Fundamentals.” He stressed that load forecasting is a misnomer – that load can only be “guessed at,” but that price is used to balance demand and supply in an uncertain marketplace. Mr. Faruqui described 36 different scenarios for incorporating PRD into the market, based on technology, elasticity, and market penetration, all of which can impact customer response to energy demand. The key is applying enabling technologies and prices to increase demand response.

Price is what balances demand and supply in an uncertain marketplace. The application of enabling technologies and prices is the key to increasing demand response.

Representatives from Pepco Holdings Inc. (PHI), Baltimore Gas & Electric (BGE), and ComEd/CNT Energy presented the results of their AMI pilot programs to illustrate their impact on PRD in the PJM region. Through a combination of technology enhancements at customers' homes and information/feedback



on usage and pricing at varying times of day, both the PHI and BGE pilot programs have resulted in significant peak reduction and overall reductions in energy. BGE engaged customers first in an AMI pilot and then, following its success, in a critical peak pricing/dynamic peak pricing pilot, with a peak time rebate. Customers in their serving territory have seen over a 37% savings in demand. Pepco/PHI's Smart Meter Pricing Pilot is more

recent, but has shown that 92% of program participants saved an average of 7.8% on their energy bills as a result of the program. Following the success of these pilots, both utilities

submitted Smart Grid funding requests to the U.S. Department of Energy under the *Smart Grid Investment Program* with very positive results for system-wide AMI and smart grid rollouts.

ComEd launched a full scale residential real time pricing program in 2007 and is currently serving 8,000 participants. The program has resulted in good demand response and increased energy efficiency. ComEd is rolling out an AMI pilot program that will assess various combinations of rate and technology enhancements, including pricing alternatives and combinations of web, in-home devices, and programmable communicating thermostats. The company will evaluate the economic benefits of this pilot program, which begins in June 2010 and ends in May 2011, to determine the most advantageous elements for full-scale rollout.

These programs are just a few of the many AMI and Smart Grid programs underway in the PJM region. Additional programs are described in Appendix F; a full listing of similar programs underway throughout the country is available at <http://www.edisonfoundation.net/iee/issueBriefs/index.htm>.

Participants were polled using an electronic voting system to contrast the new focus on dynamic pricing as a key element of successful demand response in the PJM region with prior views of demand response in both the wholesale and retail markets. Questions addressed opinions of effective demand response policies and programs; dynamic pricing for various customer classes; education and outreach methods to reach customers with demand response information and data; and elements of PRD that should be made available to PJM customers in the next 5-15 years.

4.0 Integrating PRD into the Wholesale Market

PRD will be accounted for through revisions to the Unit Dispatch System, leading to more efficient resource use. The concept of scarcity pricing further aligns real-time market prices with system conditions and leads to more enhanced demand response and PRD. Integrating PRD into the regional planning process is expected to improve the accuracy of the load forecasts used for both the Regional Transmission Enhancement Plan (RTEP) and the Reliability Pricing Model (RPM) auctions. PRD may also lead to a better calculation of the value of lost load.

Integrating PRD into the regional planning process is expected to improve the accuracy of the load forecasts used for both RTEP and RPM auctions.

5.0 Integrating PRD into the Retail Environment

A number of state commissions in PJM, including but not limited to Ohio, Pennsylvania, Delaware and the District of Columbia, have expressed interest in integrating PRD into their markets. State commission interest in integrating PRD stems from EDC filings that ask for approval and cost recovery for AMI and strong policy support for demand response as a way for consumers to manage their electricity bills. Restructured states like Pennsylvania support options for bill management as market-based rates replace expiring rate caps.

Ongoing AMI pilots are testing various combinations of interval meters with and without two-way communication, automated load reduction technologies, software, dynamic retail rates, and customer acceptance and education needs in advance of broad AMI deployment. See Appendix F for an update of the AMI pilots in the PJM region. The allocation by DOE of significant funding for AMI deployment provided through the American Recovery and Reinvestment Act of 2009 has accelerated the urgency and timeline for state commission consideration of AMI filings.

As articulated in section 7.0 below, questions and concerns remain about the customer experience, impact on the low-income residential segment, customer acceptance of AMI and dynamic retail rates, and the elasticity of demand for customer segments. Retail market change of the magnitude required to implement PRD requires careful planning, good customer education, and smooth execution to be successful.

6.0 Implementing PRD for Energy Storage and Renewables

PRD—when successfully integrated—will benefit the entire PJM region. First, it will empower all customers to make decisions about their usage that will impact monthly bills as well as the total megawatts of transmission and generation resources required to meet the region’s peak requirements. Second, PRD will provide the pricing platform essential for reliably integrating intermittent renewable resources like wind and solar and a successful rollout of a variety of electric vehicles (Plug-in Hybrid Electric Vehicle [PHEV], Neighborhood Electric Vehicle [NEV], and All-Electric Powered Vehicle [EV]).

PRD will not only empower all customers to make decisions about their usage, but also provide a pricing platform for integrating renewable resources reliably.

7.0 Implementing PRD in PJM: Actions for 2010

On Day 2, symposium participants tackled implementation of PRD through small group discussions that identified the elements of successful PRD, risks inherent in implementing it in the PJM region, and activities that need to be considered to overcome those risks. PRD needs to be integrated across the wholesale-retail market and done so in a way that is understandable, fair, and cost-effective for customers, demand response technologists, CSPs, regulators, legislators, and others across the board. Successful PRD must protect customer identity, reflect cost recovery for LSEs, provide monetary incentives for changes in behavior, and be able to be measured and verified. Specific elements of successful PRD identified by symposium participants are listed below:

- Technologies and prices must reflect real-time and wholesale LMPs.
- Real-time transparent price signals need to incorporate energy conservation, wind, and other renewable-generated electricity.
- Smart meters must accurately and reliably measure use at the retail level.
- Customers need to be provided with monetary incentives for changes in behavior, have access to real-time use and savings information, and be assured of protected customer identity and usage data. This will lead to educated and willing participants in PRD.
- Customers need to be able to opt-out and/or to default to a rate that reflects time-of-use (TOU).

- To limit risk for LSEs, utilities need to be assured of cost recovery prior to program launch.
- Performance metrics (accurate measurement and verification) on expectations and results must be included in all program offerings.
- Just and reasonable “rules of the road” for PRD need to be established and accepted by all participants.
- PRD needs to accommodate different business models, e.g., cooperative and municipal utilities as well as investor owned utilities.
- PRD needs to reflect revenue neutrality.
- Successful PRD must harmonize the wholesale and retail marketplace.



The most important risks associated with PRD identified by symposium participants include billing system issues; the need to develop standardized “plug and play” in-home devices, appliances, and control systems; the need for constant and effective customer interface; and equipment or software obsolescence, which could lead to stranded costs. Other risks that stand in the way of PRD include legislative and regulatory decision-making that differs across the region, which could confuse consumers and prove negative for customer participation in demand response programs.

The interaction between wholesale and retail markets continues to be a concern, one which the *Demand Response Roadmap for the PJM Region* addresses. Across the wholesale-retail market, the use of PRD for load forecasting is another risk that is of concern to stakeholders in PJM. Similarly, understanding resource availability, security, and safety will require accurate data at both the wholesale and retail levels.

Specific risks identified by symposium participants include the following:

- Utility concerns include billing system security and related issues; load forecasting impacts; security breaches (IT); cost recovery; customer interface; shifting loads that lead to increased use of “dirty” generation; and settlement systems.
- New equipment needs to be maintained over time and upgraded when necessary.
- The costs and potential benefits (the over-riding economic value) of PRD are not clearly identified or understood.
- Since customers are naturally resistant to change, widespread education is necessary. CSPs need to help manage customer expectations.
- Several uncertainties exist, including such factors as carbon requirements, the effectiveness of new technologies, wholesale and retail requirements, political and regulatory risks, and equipment and software obsolescence.
- Industry inertia affects RTOs, utilities, and manufacturers.



Mitigation strategies serve as preliminary actions for implementing PRD in the PJM region. The strategies identified by symposium participants are listed below:

Billing System Improvements

- Bills need to provide customers with clear and timely billing information with verified consumption and pricing detail.
- Billing system data needs to be validated and tested.
- Requirements for billing infrastructure across the PJM footprint need to be standardized.

Customer Interface, Support, and Education

- High-load end users need to be targeted first.
- Programs need to be simple and easy to implement.
- The costs, benefits, and risks of PRD need to be properly communicated.
- A collaborative, agreed upon messaging program on PRD needs to be implemented throughout the PJM region.
- Together, all stakeholders need to create and conduct extensive customer education programs, including workshops and service “hotlines.”
- An extensive “lessons learned” database for PJM customers and stakeholders needs to be created.
- Consumer advocates in PRD programs and evaluations need to be engaged throughout the PJM region.
- Open and transparent participation in PRD throughout the PJM footprint needs to be encouraged.

The costs, benefits, and risks of PRD need to be properly communicated.

Equipment and Software Obsolescence

- Equipment and software product designers need to design and roll out quality service and maintenance programs.
- Flexible and open technologies for PRD and equipment production and performance standards need to be created so that competitive suppliers can meet them.
- Open forums to design realistic technology implementation scenarios should be sponsored by product developers.
- Rate recovery for PRD equipment and systems should be allowed.
- A robust infrastructure that is consistent with component life needs to be developed.
- Standardized “plug and play” technologies and systems for PRD, including in-home devices, appliances, and control systems, need to be developed.
- Performance risk should be shifted to equipment vendors.
- Implementation testing should take place in a staged manner.

Accurate Load Forecasting

- PJM needs to require and assure load forecasting transparency and consistent treatment of utility load forecasts that reflect PRD.
- Accountability through accurate documentation, measurement, and verification is critically important for all PRD program developers, implementers, and technologists.
- LMP should be implemented at the operator level.

Accurate measurement and verification and documentation are critically important for all PRD program developers, implementers, and technologists.

Legislative and Regulatory Decision-Making

- Retail prices should be set so that they follow wholesale costs.
- Stakeholder groups should be established within state regulatory environments to exchange ideas and “best practices” experiences.
- The utility billing system needs to be upgraded, including standardization of billing infrastructure across the PJM footprint.
- Regulatory agencies should approve real-time benchmarking to show the financial impact of customer decisions.
- Tariff structures need to be simplified.
- Stranded cost recovery for PRD programs needs to be allowed at the state level.
- Accountability needs to be built into ratemaking.
- Customer and utility needs should be aligned with CSP capability.
- Federal and state PRD policies need to be aligned.

Appendices A through H include the updated *Demand Response Roadmap for the PJM Region*, the PJM Symposium on Demand Response III Agenda, Presentations, Breakout Group Reports, Participant List, AMI Pilot Programs in the PJM Footprint, State Goals for Energy Efficiency and Demand Response in the PJM Footprint, and Web Links.