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Memorandum

To: Interested stakeholders
From: Paul Peterson and Vladlena Sabodash
Date: November 24, 2009
Re: Impact of PRD participation in day-ahead energy market

Preface

In September, we provided an analysis of the impact of price responsive demand (PRD) that participates as a supply resource in the ISO New England day-ahead energy market. That memo focused on PRD participation during the top 5% and the top 10% of the annual high-priced hours in 2004, 2006 and 2008. This memo expands upon our prior analysis by looking at the impacts on day-ahead prices of participation during the top 15% and 20% of the annual high-priced hours. For this memo we reviewed the three years of 2006, 2007, and 2008. This expanded analysis confirms that participation during a larger percentage of hours produces additional savings, albeit at a slower rate. As with our previous analysis, we did not include estimates of the additional benefits from PRD participation in day-ahead energy markets such as reduced price volatility, enhanced system reliability, protection against attempts to exercise market power, deferral of bulk power system upgrades, and support for state and Federal policies to encourage carbon reduction and greater electric system efficiency.

Assumptions and Methodology

For the analysis of the savings from price responsive demand participation in the ISO New England day-ahead market we have used hourly system load data and hourly day-ahead market-clearing prices for the years 2006, 2007, and 2008 available from the ISO New England website.[1] We have assumed that all 2,092 MW of "ready to respond" demand, as indicated in the August 2009 NEPOOL Participants Committee Report, can participate in the day-ahead market as a supply resource on an equal basis with other supply resources.

[1] http://iso-ne.com/markets/hstdata/znl_info/hourly/index.html

We further analyzed total and net savings from PRD participation under the assumption that all 2,092 MW of PRD will be offered and dispatched during the hours when the day-ahead market-clearing price (MCP) is very high. As with any other supply resource, greater MW quantities of PRD are available at higher prices. Our simplified assumption is that 100% of PRD was available during the top price hours of the analyzed years. For example, in the top 1% of high-priced hours, all 2,092 MW of PRD would offer and clear in the day-ahead energy market. In slightly lower-priced hours, a smaller amount of PRD could clear the market and lower the price.

For this expanded analysis, we have considered four cases, with PRD being offered during the top 5% (Case 1), 10% (Case 2), 15% (Case 3) and 20% (Case 4) of hours with the highest DA MCP.[2]

Based on the amount of PRD available, we have calculated a Modified Load that needs to be met by generation resources only and a Modified Price. Modified Load is equal to the System Load for each hour reduced by the amount of PRD offered during the top price hours only, and is equivalent to the System Load for the rest of the hours, with all hours ranked from highest price to lowest.[3]

Availability of PRD during the hours with the highest expected MCP increases the total supply of resources in the day-ahead energy market, which creates downward pressure on the actual MCP. We have assumed that the new modified price, or the price that would have occurred if all 2,092 MW of PRD had been offered and dispatched in the day-ahead market, equals the DA MCP of the next first hour that has not been modified[4]. For the rest of the hours DA MCP remains unchanged.

A description of Cases 1-4 is provided in Table 1 of the Results section.

We have estimated total savings from PRD participation as the difference between the actual total cost of energy[5] for each year and the modified total cost that would have been occurred if all 2,092 MW of PRD had been offered and dispatched. For the purposes of this memo, we have assumed that the PRD resources are paid the same LMP price as all other supply resources. Therefore, total savings from PRD participation were reduced by

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[2] For the analysis that developed the savings estimates, the precise quantity of PRD participating in each hour is not critical; it is the impact on prices that is important. Sufficient PRD demand must participate in each of the top 5%, 10%, 15%, or 20% (Cases 1-4) of hours to lower the LMP to the value specified. It is likely that the total supply of PRD will need to be in excess of 2,092 MW to provide a sufficient resource base to respond in all of the top price hours.

[3] The System Load has been reduced by the amount of PRD available for 439 hours in Case 1 (5% of hours) and for 878 hours in Case 2 (10% of hours) 1317 hours in Case 3 (15% of hours), and 1756 hours in Case 4 (20% of hours).

[4] Modified MCP is equal to the DA MCP of the 440th hour for the first 439 hours in Case 1, 879th hour for the first 878 hours in Case 2, etc., with all hours ranked from highest DA MCP to lowest.

[5] Total cost is calculated as a summation of hourly products of system load and day-ahead market-clearing price.

the amount of total payment to PRD[6] to produce the value of net savings from PRD participation.

Results

Day-ahead market-clearing prices ranged from $22/MWh to $217/MWh in 2006, $25/MWh to $207/MWh in 2007, and $31/MWh to $367/MWh in 2008. Based on our analysis assumptions, if PRD participated in the top 5% of the highest price hours (Case 1), the price in each of those 5% of hours would not exceed $88/MWh in 2006, $103/MWh in 2007, and $127/MWh in 2008. We calculated the comparable impacts of 10%, 15% and 20% PRD participation (Cases 2-4).[7]

The table below shows the impact of Cases 1-4 on the hourly day ahead energy prices ($/MWh) for the three different years (2006, 2007, and 2008).

Table 1 Effect of PRD Participation on Hourly Day-Ahead Market-Clearing Prices

Case	Percent of modified hours	Number of modified hours	Highest Price, $/MWh			Maximum Amount of DR (MW)
			2006	2007	2008	
Actual	-	-	217.43	207.35	367.19	-
Case 1	5	439	87.53	102.82	126.63	2,092
Case 2	10	878	80.22	90.53	113.66	2,092
Case 3	15	1317	76.06	84.1	105.43	2,092
Case 4	20	1756	73.19	80	99.49	2,092

The MCP of energy in the day-ahead market was set equal to the marginal cost of the last MW of a resource dispatched, which can be determined as an intersection of the supply and demand curves for each particular hour. A regular hourly supply curve in the day-ahead energy market is very flat in the beginning (base generation resources) and very steep at the end (peaking resources). Any shift of supply or demand at the steep portion of the curve can produce a very significant change in price. Therefore, participation of PRD during the hours with expected high prices, or "peak" hours, may result in a large reduction in market-clearing price, as is observed in Table 1. Given the number of hours of PRD participation and the amount of PRD, this price reduction produces substantial system savings.

[6] Total payment to PRD is calculated as a product of the amount of PRD participating, the number of hours of PRD participation and the market-clearing price.

[7] We ranked all hours form highest to lowest DA MCP and substituted the DA MCP for the first 5% or 10% of hours when PRD participated by the DA MCP of the first hour when DA MCP did not participate. Since system load of the first 5% to 20% of hours has been reduced by 2,092 MW of PRD, load in some of the top hours was significantly lower than load in the following hours that were not modified. Therefore, setting modified market-clearing prices during hours of PRD participation equal to the price of the first next hour that has not been modified may overestimate prices that result from PRD participation and underestimate savings from PRD.

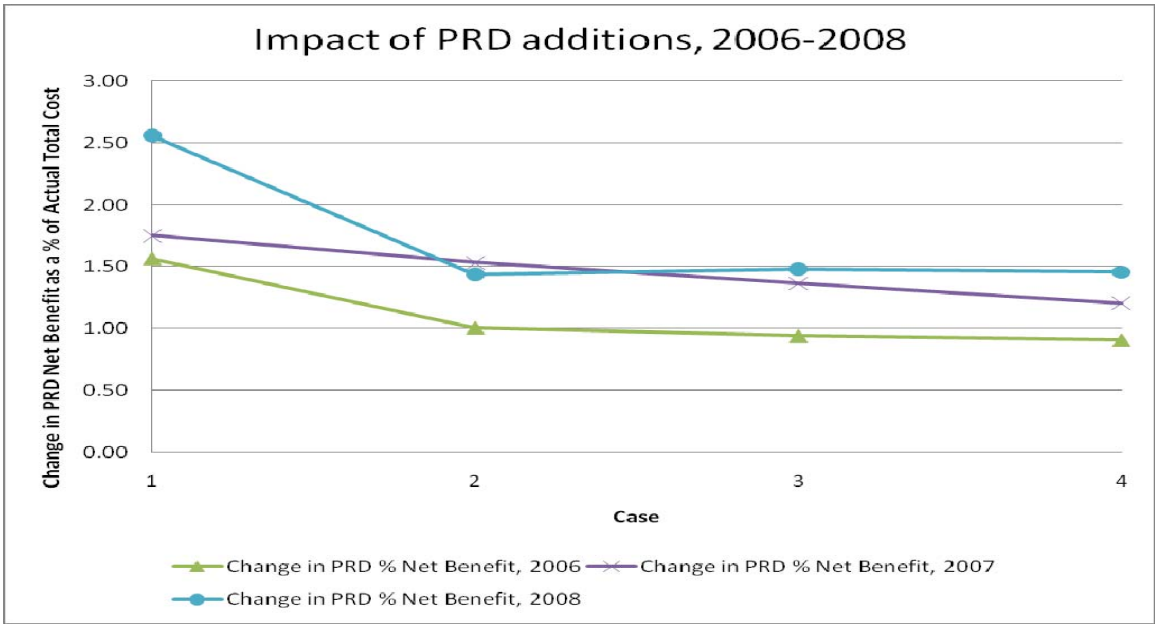
The savings from additional PRD participation above the initial 5% of hours produced significant additional savings, but at a lesser rate. This is what one would expect as PRD participation at greater levels (10%, 15%, and 20%) impacts relatively lower priced hours. Table 2 shows the increased savings for each percentage level of PRD participation in the four cases (5% to 20%) as a percentage increase from the prior level of participation for the three years we examined (2006-2008). The results show a consistent pattern, although there are slight variations in each year.

Table 2 PRD Net Benefits, Cases 1-4

Case	2006			2007			2008		
	PRD Net Benefit $m	PRD Net Benefit, % of Actual Total Cost	Change in PRD % Net Benefit, 2006	PRD Net Benefit $m	PRD Net Benefit, % of Actual Total Cost	Change in PRD % Net Benefit, 2007	PRD Net Benefit $m	PRD Net Benefit, % of Actual Total Cost	Change in PRD % Net Benefit, 2008
Case 1 5%	128	1.56%	1.56	166	1.75%	1.75	282	2.56%	2.56
Case 2 10%	211	2.57%	1.01	312	3.29%	1.53	440	4.00%	1.44
Case 3 15%	289	3.52%	0.94	442	4.65%	1.37	604	5.48%	1.48
Case 4 20%	363	4.43%	0.91	557	5.86%	1.21	764	6.94%	1.46

The data in Table 2 shows that the cumulative (total) savings increase as PRD participation increases. For 2008, the total savings in the DA energy market increase from 2.56% to 6.94% as PRD participation increases from 5% to 20% of the hours. However, the percentage change of savings from each case (1-4) generally decreases as PRD participation increases. This is true for 2006 and 2007; for 2008 the percentage increase is essentially level after the first 5% of PRD participation. This is illustrated by the Figure 1 graph.

Figure 1 Change in PRD Net Benefit as a Percentage of Total Cost



Summary

The participation of price-responsive demand as a supply resource in the day-ahead energy market can achieve significant energy price reductions and overall savings for consumers. If all 2,092 MW of PRD was available to participate in the day-ahead energy market in 5% of the hours of year 2008, ISO New England would save $280m. If the same quantity of PRD participated in 20% of the hours, the annual savings would increase to $764m. In addition, PRD participation would reduce the 2008 system peak load from 26,111 MW to 24,019 MW.

PRD participation is not a linear function. The initial 5% of participation produces the largest percentage benefit. Increasing participation up to 20% produces a lower percentage benefit for each additional 5% of PRD participation for the years 2006 and 2007. For 2008, each additional 5% of PRD participation shows an essentially level benefit.

This analysis is dependent on the assumptions we used. In particular, the use of a static 2,092 MW of PRD in all cases studied was a simplification that may understate the overall benefits. The use of an actual PRD "supply curve" would be a significant enhancement to this analysis.