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Memorandum

To: Interested stakeholders

From: Paul Peterson, Doug Hurley, and Vladlena Sabodash

Date: October 16, 2009

Re: Impact of PRD participation in day-ahead energy market

Preface

Below is 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. We estimate the system savings that PRD can produce in the day-ahead energy market and the changes to system load duration curves. We do not try to quantify the additional benefits from significant PRD participation in wholesale markets in this analysis. Those additional benefits include 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 that support 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 2004, 2006 and 2008 available from the ISO New England website.[1] We have assumed that all 2092 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.

We further analyzed total and net savings from PRD participation under the assumption that all 2092MW 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

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

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 would clear the market.

We have considered two cases, with PRD being offered during the top 5% (Case 1) and 10% (Case 2) 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 in the top 5% or 10% hours, or the price that would have occurred if all 2092MW 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 Case 1 and Case 2 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 2092MW 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 the amount of total payment to PRD[6] to produce the value of net savings from PRD participation.

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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% (Case 1) or 10% (Case 2) 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 2092 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).

[4] Modified MCP is equal to the DA MCP of the 440th hour for the first 439 hours in Case 1 and 879th hour for the first 878 hours in Case 2, 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.

[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.

Results

Day-ahead market-clearing prices ranged from $20/MWh to $520/MWh in 2004, $22/MWh to $217/MWh in 2006, 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 $76/MWh in 2004, $88/MWh in 2006, and $127/MWh in 2008. If PRD participated in the top 10% of the highest price hours (Case 2), price in those 10% of hours would not exceed $68/MWh in 2004, $80/MWh in 2006, and $114/MWh in 2008.[7]

The chart below shows the impact of the 5% and 10% cases on the hourly day ahead energy prices ($/MWh) for the three different years (2004, 2006, and 2008).

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

Case	Percent of modified hours	Number of modified hours	2004		2006		2008		Maximum Amount of DR (MW)
			Actual Highest Price, $/MWh	Modified Highest Price, $/MWh	Actual Highest Price, $/MWh	Modified Highest Price, $/MWh	Actual Highest Price, $/MWh	Modified Highest Price, $/MWh	
1	5	439	520	76	217	88	367	127	2,092
2	10	878	520	68	217	80	367	114	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.

The table below shows the impact of the two cases (5% and 10%) on the three selected years.

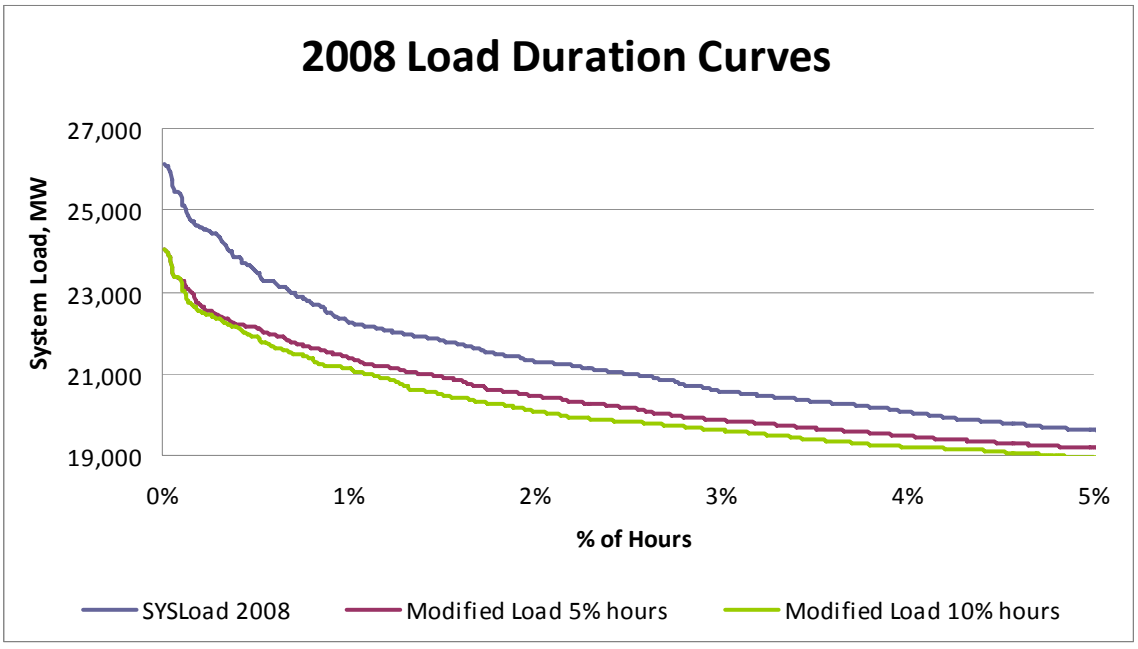
[7] We ranked all hours form highest to lowest DA MCP and substituted the DA MCP for the first 5% or 10% of hours when PRD participated by the DA MCP of the first hour when DA MCP did not participate. Since system load of the first 5% or 10% of hours has been reduced by 2092MW of PRD, load in some of 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.

Table 2 Savings from PRD Participation in the Day-Ahead Energy Market

Year	Total Cost, $m	Modified TC, $m	Savings from PRD, $m	Payment to PRD, $m	Net Savings, $m
Case 1					
2004	7,318	7,024	294	70	224
2006	8,205	7,996	209	80	128
2008	11,015	10,616	398	116	282
Case 2					
2004	7,318	6,884	433	125	309
2006	8,205	7,846	358	147	211
2008	11,015	10,365	649	209	440

Participation of 2092MW of PRD in the day-ahead energy market in ISO New England could produce substantial savings that would significantly offset all payments needed for PRD to participate. Moreover, it would result in more efficient system load utilization by shedding peak load, as shown on the graph below. System peak load in 2008 was 26,111MW. Participation of PRD would reduce system peak to 24,019MW.

Figure 1 Impact of PRD Participation on Load Duration curve 2008, Top 5% of hours



Summary

The participation of price-responsive demand as a supply resource in the day-ahead energy market can achieve significant energy price reductions, overall savings for consumers, and more efficient system load utilization. If all 2092MW of PRD was available to participate in the day-ahead energy market in 5% or 10% of hours of year 2008, ISO New England would save $280m or $440m, respectively. PRD participation would reduce the 2008 system peak load from 26,111MW to 24,019MW.

Allowing PRD participation as a supply resource will produce substantial savings to consumers by curtailing the need for electricity (both peak load and overall energy consumption), reducing day-ahead energy prices, and potentially deferring the need for transmission expansions. These impacts would also put downward pressure on prices in capacity markets and reserve markets, and help attain carbon reduction goals.