

Demand Response Pricing in Organized Wholesale Markets

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Summary

The Federal Energy Regulatory Commission's Notice of Proposed Rulemaking (NOPR) addresses the question of proper compensation for demand response in organized wholesale electricity markets. The Commission proposes to pay the full Locational Marginal Price (LMP) for all types of demand response acting as a resource in the energy market. The analysis here addresses this issue by considering three general types of demand response.

- **Real-time Pricing Demand Response.** Consumers are paying the applicable LMP for their marginal consumption.
- **Explicit Contract Demand Response.** Consumers purchase a fixed quantity of electricity but consume less than the purchased amount and sell back the difference.
- **Imputed Demand Response.** Consumers have an estimated consumption baseline and the difference between actual consumption and the baseline is the imputed demand response.

The three types of demand response are different in important ways. The differences lead to different frameworks for appropriate pricing and incentives. Real-time pricing demand response and explicit contract demand response have straightforward frameworks for using the applicable LMP. The method for full LMP application would be different in each case, but easy to understand.

The less straightforward but important case of imputed demand response presents conditions where full payment of the applicable LMP would not be appropriate under rate structures where customers are not charged for the full consumption baseline.

The goal of supporting demand response is appropriate and the principles laid out by the Commission to guide this integration are legitimate. The central difficulty is that the Commission's stated principles do not support the policy recommended by the Commission under all conditions. The complication arises in the simple equation of demand response as being equivalent to energy supply. This equation is valid under certain conditions. But the equation breaks down in the case of imputed demand response for consumers without an explicit contract to purchase a fixed quantity of energy, or without an implicit contract to purchase energy up to the estimated baseline when engaging in demand response. If the equation is not valid, then care is required to structure efficient compensation to achieve the stated policy objectives and conform to the principles laid out by the Commission. The Commission has available a number of alternatives that would emulate real-time pricing or explicit contract demand response.

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Introduction

The Federal Energy Regulatory Commission's Notice of Proposed Rulemaking (NOPR) addresses the question of proper compensation for demand response in organized wholesale electricity markets.¹ This NOPR follows from and subsumes other proceedings that have considered this issue, such as in the matter of the PJM Economic Load Response Program.² The PJM record includes a previous white paper, Providing Incentives for Efficient Demand Response, that addresses a wide range of issues related to demand response programs.³

The analysis in the PJM proceeding covered more topics but continues to apply to issues appearing in the present NOPR, and to comments that might arise in response. However, the NOPR has a narrower focus and constructs a recommended compensation policy on a foundation of principles that simplify much of the argument. The limited issue addressed in the NOPR is the proper pricing for demand response. Ignoring the details of transport charges and practical matters of implementation, the focus is on pricing demand response in the energy market at the applicable locational marginal price (LMP), as the Commission proposes, or at the LMP less an imputed generation portion of retail rates (LMP-G) that attempts to simulate a virtual contract purchase and sale at different prices. In supporting its recommended policy, the Commission emphasizes the impacts of demand response on the costs of the Regional Transmission Organization (RTO) or Independent System Operator (ISO), the importance of equivalent or comparable treatment of different resources, and the need to support development of demand response. The present paper addressed further the issues raised by this foundation as laid out by the Commission.

A key feature of the Commission's proposed rule is to pay the full LMP for all types of demand response acting as a resource in the energy market. The premise is that all types of demand response are the same, and that LMP is the applicable price that should apply

¹ Federal Energy Regulatory Commission, "Demand Response Compensation in Organized Wholesale Energy Markets," Notice of Proposed Rulemaking, Docket No. RM10-17-000, Washington DC, March 18, 2010. Footnote 4 limits attention to "demand response acting as a resource in organized wholesale energy markets," separate from demand response as an ancillary service or in capacity markets.

² PJM Interconnection, L.L.C., FERC Docket No. EL09-68-000, August 26, 2009.

³ William W. Hogan, Providing Incentives for Efficient Demand Response ("October White Paper"), Oct. 29, 2009, at 4-6, contained in Motion for Leave to Answer and Answer of the Electric Power Supply Association and White Paper by Professor William W. Hogan, Docket No. EL09-68-000, Oct. 30, 2009. (available at www.whogan.com)

to equivalent responses.⁴ The analysis here addresses this issue by considering three general types of demand response.

- **Real-time Pricing Demand Response.** Consumers are paying the applicable LMP for their marginal consumption.
- **Explicit Contract Demand Response.** Consumers purchase a fixed quantity of electricity but consume less than the purchased amount and sell back the difference.
- **Imputed Demand Response.** Consumers have an estimated consumption baseline and the difference between actual consumption and the baseline is the imputed demand response.

The three types of demand response are different in important ways. The differences lead to different frameworks for appropriate pricing and incentives. Real-time pricing demand response and explicit contract demand response have straightforward frameworks for using the applicable LMP. The method for full LMP application would be different in each case, but easy to understand.

The less straightforward but likely ubiquitous case of imputed demand response presents conditions where full payment of the applicable LMP would not be appropriate under usual rate structures where customers are not charged for the full consumption baseline. However, if the rate structure were designed such that imputed demand responder is required to purchase energy up to its baseline when engaging in demand response, then wholesale energy market compensation at the applicable LMP would be appropriate because imputed demand response would emulate explicit contract demand response.

The goal of supporting demand response is appropriate and there are benefits that could be obtained through better integration of the demand side with the generation supply side of the market. Furthermore, the principles laid out by the Commission to guide this integration are legitimate. The central difficulty is that the Commission's stated principles do not support the policy recommended by the Commission under all conditions. The complication arises in the simple equation of demand response as being equivalent to energy supply. This equation is valid under certain conditions. The equation is most obvious in the case of explicit contract demand response. But the equation breaks down in the case of imputed demand response for consumers without an explicit contract to purchase a fixed quantity of energy, or without an implicit contract to purchase energy up to the estimated baseline when engaging in demand response.⁵ If the equation is not valid, then care is required to structure efficient compensation to achieve the stated policy objectives and conform to the principles laid out by the Commission. The Commission has available a number of alternatives that would emulate real-time pricing or explicit contract demand response.

⁴ The locational marginal price (LMP) serves as the price for real-time settlements. In systems such as Alberta without locational differences, the applicable price would be the system marginal price (SMP).

⁵ October White Paper, pp. 12-13, 19-21. See also Hung-po Chao, "Price-Responsive Demand Management for a Smart Grid World," *The Electricity Journal*, January-February 2010, pp. 7-20.

Value of Resources to RTOs

The Commission addresses the role of demand response from the perspective of the RTOs and ISOs.

“...we believe paying demand response resources the LMP in all hours will compensate those resources in a manner that reflects the marginal value of the resource to each RTO and ISO, comparable to treatment of generation resources.”⁶

If this were true, if the marginal value of each resource is the LMP, then the equivalent treatment of demand and generation would make the problem simple. However, if it is not true then there should be an adjustment of the compensation to deal with the difference between demand response resources and generation resources.

In many cases, the assumption that LMP reflects the marginal value of demand and generation is true. For example, under market-clearing prices with economic dispatch, the marginal cost of an increment in demand met through the dispatch is the LMP. Any consumer who is paying the real-time price for energy is charged the full LMP for its consumption and avoids paying the full LMP when reducing consumption. Thus, full LMP compensation is already applied to the real-time price demand response in the form of avoiding the cost of consumption and no further explicit payment from the wholesale energy market would be necessary.

Similarly, anyone who has purchased a fixed quantity of delivered energy under a contract can either use the energy or sell it to others. The difference between the amount purchased and the amount actually consumed is the explicit contract demand response. The applicable price for the energy purchased, but not consumed, and sold into the energy market would be the LMP. The contract would account for the payment for the energy purchased to establish ownership and the ability to provide the explicit contract demand response.

Under the policy as proposed by the Commission, the situation would be different in the case of imputed demand response with a rate structure where customers are not charged for the estimated baseline consumption. The definition of the LMP is the change in the total cost to the RTO or ISO, who has to charge for load to pay for the energy resources delivered. If the value of different energy resources is the same under the Commission’s proposal, then the net change in the RTO costs (and revenues) should be the same. In particular, the final net change in costs and revenues at the margin should be the same for increasing demand through higher load or decreasing demand through demand response.

In the case of imputed demand response, it may help to unpack the definition of the LMP and see how imputed demand response under the proposed policy as envisioned by the Commission affects “the marginal value of the resources to each RTO and ISO.” To illustrate, for simplicity ignore transport and other non-energy charges and assume for the moment that the supply curve is flat and, therefore, the demand response has no impact on the LMP. Suppose that the LMP is \$50/MWh, and the putative load before the demand response would be 100 MWh. Then the total cost to the RTO would be \$5,000.

⁶ FERC NOPR, p. 13.

This is balanced by the total revenue from load of \$5,000, and the RTO breaks even. Under these conditions a consumer offers an imputed demand response of 1 MWh. What happens? Under the Commission's proposed rule, the load would reduce to 99 MWh, and the RTO would pay \$4,950 to generators to balance the load, receive \$4,950 from remaining load, and pay \$50 to the demand responder. Apparently, the RTO loses \$50 in acquiring the imputed demand response, and this will have to be made up in additional charges to other market participants.

By comparison, suppose under the same conditions the load increases to 101 MWh. The RTO would now purchase 101 MWh from generators at a cost of \$5,050 and receive revenue from load of \$5,050, and would break even. There is no additional charge. Apparently, under the Commission's proposed rule, there is not an equivalence of the marginal value of the resources for imputed demand response. The value of generation resources or the cost of incremental load is not equal to the value of imputed demand response. The Commission's proposed rule for compensation in the case of imputed demand response would impose a net loss on the RTO. By contrast, real-time pricing or explicit contract demand response would maintain the equation and full LMP would be applied either to the actual consumption or to the difference between consumption and the contracted amount.

Equivalent Treatment of Resources

The equivalent or comparable treatment of equivalent resources is a sound principle. But the equivalence should include all of the elements that enter into the economic evaluation. The proper compensation and the definition of LMP inherently embrace both the physical characteristics and the economic details. Furthermore, equivalent treatment of resources implies that simple accounting definitions should not affect the net compensation.

Prices and Quantities

We cannot look only at quantities. The prices and the pricing rules matter. This is usually implicit and not an important observation, but in the case of defining the rules for demand response the implicit assumptions make a difference. For example, in the NOPR the Commission states:

“Given that the LMP represents the marginal value of the resource being used by the RTO or ISO to balance supply and demand, it follows that the LMP should be paid to any resource clearing in the RTO's or ISO's energy market. In balancing supply and demand, a one megawatt reduction in demand is equivalent to a one megawatt increase in energy for purposes of meeting load requirements and maintaining a reliable electric system.”⁷

The observation of physical equivalence of meeting supply and demand is a necessary but not sufficient condition for determining that LMP represents the marginal value of a resource. Were this not true, were physical equivalence the only thing that mattered, then

⁷ FERC NOPR, p. 15.

there would be a well-defined LMP in the spot market that would be independent of the supply offers and demand bids. But we know this is not true, and changes in the offers or bids of various resources will change economic dispatch of the physical quantities, total cost, and the LMPs.

An inherent and inescapable feature, real but often hidden from view, is that imputed demand response incorporates a particular offer and compensation structure that affects incentives, changes costs to the RTO, and changes revenues from the physical load. The October White Paper deals at length with the incentive and total welfare effects.⁸ In addition, the example above illustrates the impacts on costs and revenues.

Hence, while the principle of equivalent treatment is valid, the Commission's policy for treatment of imputed demand response does not follow from the principle. An imputed demand response compensation policy like LMP-G or some other variant that emulated explicit contract demand response by charging for the imputed purchase would adhere more closely to the Commission's principles.

Location of the Meter

Another way to view demand response through the lens of equivalent treatment is to consider the impact on the behavior of consumers. In the NOPR, the Commission states:

“The ISO or RTO is able to avoid dispatching suppliers with higher bids, be they generation or demand response, by accepting a lower bid to either reduce consumption or increase generation. As Dr. Alfred E. Kahn noted in a recent PJM proceeding in Docket No. EL09-68-000, consumers offering to reduce consumption should be induced ‘to behave as they would if the market mechanisms alone were capable of rewarding them directly for efficient economizing.’ ”⁹

One way to test this proposition would be to consider the behavior of the consumer who is installing a new generator at its location. Presumably under our simplified assumptions, the behavior should be the same with respect to placing the generator on the consumer side of the meter versus on RTO side of the meter. If the new generator is on the consumer side of the meter, then running the generator would reduce net demand and would be accounted as and would be observationally equivalent to imputed demand response. However, if the consumer installs the generator on the RTO side of the meter then the sale of energy would be treated as a normal sale, and the purchase of energy to satisfy load would be treated as a normal purchase. The net physical flows would be the same in either case. Again, for simplicity, ignore non-energy charges. Would the consumer see the same economics?

Suppose the LMP is \$50/MWh and the consumer has a load of 10 MWh. In addition, assume the putative generator would produce 6 MWh in the same hour at a cost of \$50/MWh. Suppose the consumer installs the generator on the RTO side of the meter. Then the consumer pays \$500 for its 10 MWh of load, receives \$300 for its 6 MWh of

⁸ October White Paper, pp. 12-19.

⁹ FERC NOPR, p. 15. Footnote in the original refers to the embedded quote from Dr. Fred Kahn.

generation, and incurs a cost of \$300 for generating the power. In effect, the consumer is paying \$500 for 10 MWh of load and its generating subsidiary is breaking even in producing and selling the output of 6 MWh.

In the case of the installation on the consumer side of the meter, the consumer would reduce its measured load from 10 MWh to a net of 4 MWh. The consumer would incur the cost of \$300 for 6 MWh of generation, and pay \$200 to the RTO for net load of 4 MWh. In addition, under the Commission's proposal, the consumer would be treated as having provided 6 MWh of imputed demand response, and would receive \$300 payment for the imputed demand response. The net position of the consumer would now be a net payment of \$200 rather than a net payment of \$500 for the load. In other words, the consumer is getting 6 MWh for free. Apparently the location of the meter relative to the generator matters, although it should not.

By comparison, the same example would show a different result for application of the full LMP in the case of real-time pricing demand response or explicit contract demand response. In these cases, the location of the meter would not matter.

Once again a simplified example illustrates that under the Commission's proposal, imputed demand response is not equivalent to incremental supply, and consumers will not "behave as they would if the market mechanisms alone were capable of rewarding them directly for efficient economizing."

Supporting Demand Response

The Commission invokes a different argument that addresses concern with overcoming barriers to demand response. In the NOPR, the Commission states:

"Given the current barriers to demand response and the evolving nature of the technology enabling demand response, a perfect solution or payment scheme may not exist. We nonetheless believe that paying LMP in all hours to the demand response resources that can participate in the organized wholesale energy markets is the correct approach at this time, because that payment reflects the marginal effect of each demand response resource in the hour, just as the LMP reflects the marginal effect of generation resources in each hour."¹⁰

The emphasis on barriers and evolving technology appeals to the notion that a good solution that is attainable is preferred to perfect solution that is not available. To be sure, paying demand response LMP in all cases looks simple, but so would paying providers nothing or twice as much.

Proper design of the compensation scheme would depend on the details.¹¹ If there are barriers to entry, then the focus of policy should first be on addressing the barriers. For example, better dynamic pricing would dovetail with improved scarcity pricing in RTOs and help with other problems as well as providing added incentives for all types of

¹⁰ FERC NOPR, pp. 18-19.

¹¹ October White Paper, pp. 12-21.

demand response. Better design of default hedges for retail consumers, to include the Chao model of subscription service, would address the devilish problem of establishing the imputed demand response baseline and provide crisp incentives for demand response by satisfying the conditions for the equation with energy resources.

The Commission is correct in promoting the objective of supporting demand response and enunciating principles that would support efficient compensation. However, the simple solution offered of paying all demand response the LMP, rather than something more appropriate for the particular type of demand response, is neither supported in theory nor likely to work in practice. The Commission's policy would create perverse incentives that would shift costs. For example, the Commission's policies would create an incentive for a consumer to avoid real-time pricing demand response since it would be much more profitable to embrace the Commission's proposed imputed demand response payments. Similarly, the consumer would have an incentive not to sign fixed quantity contracts such as envisioned in the efficient subscription service described by Chao. A likely consequence would be to precipitate more rules to undo the unintended consequences.

Supporting Efficient Electricity Systems

If there is anything we have learned from the history of electricity restructuring, a prominent lesson must be that under the principles of open access and non-discrimination, market participants will respond to incentives. It is difficult enough to get the incentives approximately right. Witness the long struggle to put in place efficient organized markets with LMPs. However, the success of that effort indicates the value of providing policy that supports efficient electricity systems.

There are many things that the Commission could do. Improving scarcity pricing is already an item in the RTO/ISO markets and should be a priority for the Commission. Expanding the use of dynamic pricing, particularly the real-time pricing version, to provide smarter prices for the smart grid would be a related priority and would provide stronger incentives for all types of demand response, efficient distributed generation, and other flexible supply options. Encouraging better contracting regimes, which would explicitly establish quantities and property rights in energy sales, would provide efficient incentives for reducing demand and selling the energy that had been purchased but not used. All these would be consistent with efficient markets and would fit naturally into the RTO/ISO market designs. These would provide efficient support for demand response valued at LMP entirely through avoided cost in the case of real-time pricing demand response, or through the explicit re-sale of energy at LMP that was purchased under contract.

For the cases where rate structures and full requirements service leave the purchase quantities implicit or undefined at the tariff rate, the Commission faces an incentive problem. In order to maintain faithfulness to the efficiency and equal treatment principles, the Commission should take up the burden of approximating an efficient outcome through some variant of LMP-G pricing or unbundled contract emulation

applied to imputed demand response.¹² This would address the inability of the flat rate (proxied by G) to provide efficient incentives at the margin while avoiding the unintended consequences of upsetting the principle of equal treatment of equivalent resources.

To the extent that the Commission simply wishes to tilt the paying field the other way, and provide pump-priming incentives for imputed demand response, rather than all forms of demand response, the Commission should call it what it is, follow the logic of an analysis of market failure, and design a policy for that does not create new unintended consequences.

But putting in place incentives which are inconsistent with the usual rate structures, and which are not supported by either the Commission's stated goals or principles, is a recipe for trouble. The Commission and support for demand response, including imputed demand response, would be better served in the long run if the Commission constructed a system for compensation that is coordinated with retail rate structures and is consistent with the principles it has laid out as the foundation of its policy.

Conclusion

The Commission's principles in support of competitive markets and efficient compensation call for equivalent or comparable treatment of equivalent resources. The principles deserve support. In application to demand response a difficulty arises because not all forms of demand response are the same economically due to contractual arrangements or retail rate structures and physically due to explicit or implicit contract quantities. The proposed policy to pay full LMP for all forms of demand response is not supported by the Commission's principles. In the case of real-time and explicit contract demand response, full LMP enters in natural ways, charging the full LMP or paying the full LMP for the difference between the amounts consumed and purchased. By contrast, for imputed demand response without an explicit purchase, the compensation policy should follow any of many variants that would emulate some form of explicit contract. There are many possible solutions that would be consistent with efficient electricity markets and the Commission's principles.

¹² October White Paper, pp. 12-13,19-21.

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