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Market Dynamics of Integrating Demand Response into Wholesale Energy Markets

Increasing the elasticity of demand means that in the future it may not be sufficient for balancing authorities to simply estimate quantity but that estimating the reaction to price may become important too. Market administrators, load-serving entities, and regulators should explore how they will want to integrate demand elasticity into market clearing algorithms and load forecasting, and how they might estimate demand elasticity on an ongoing basis.

Ralph Masiello, Jessica Harrison and Rana Mukerji

I. Introduction

In recent years, technical and policy advances have expanded the opportunities for demand-side resources to actively participate in power systems and have expanded the types of electricity rate options customers may consider. More active demand-side participation can enable a smarter grid by offering increased flexibility and resilience by expanding the resources available to grid operators for balancing power supply and demand in real time. Increased incorporation of these demand-side assets into wholesale electric markets requires careful consideration as intelligent demand capabilities can affect market outcomes and create inadvertent system dynamics if not properly accounted for by system operators. This article

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explores the potential implications of incorporating increasing amount of dynamic demand-side capability under today's market operations. In presenting the results of market simulations, the article provides examples of the types of operational issues that could occur without purposeful integration of non-conforming loads. Ultimately, better understanding the nature of demand response resources and their impact on market dynamics can enable power systems to fully harness the value of these resources.

II. Evolution in the Capabilities of Demand Side Resources

The evolution of communications and computer technologies and electric power policies in recent years has enabled load to serve as a dynamic resource for the power system. The capabilities of load resources vary significantly among customers. Customer differences in size, end-use technologies, and retail rate design vary the amount of demand response a customer might offer at any given time. In addition, customers making use of on-site distributed energy resources (DERs) can significantly modify their net loads as seen by the grid.[1] Net loads can become negative, for example, and loads can be shifted from peak to off-peak periods without visibility or advance notice to system operators. Recently, more sophisticated control systems have provided customers with additional capabilities, allowing customers to provide more demand response during high-value time periods, obtain load response with minimal disruption to comfort, and react to demand response signals in an automated fashion.

Fundamentally, two categories of demand response resources exist today: dynamic pricing demand response (DP) and dispatchable demand response (DDR). Dispatchable demand response is most like a supply resource in that it can be dispatched similarly to generation.[2] In contrast to dispatchable demand response, dynamic pricing is a voluntary customer response with the market providing a signal to which a customer can respond.[3] At present, a notable distinction between these two types of demand response is the interaction between the market operator and the customer or aggregator. With dispatchable demand response, the market operator is aware of the likely load response to be provided by the demand response resource as a commitment of some kind that is arranged prior to a signal being issued. Quite often, a dispatchable demand response is verified and contrasted to the original commitment, and any discrepancies are accounted for via future interactions or via a separate resolution process such as a penalty designed to incent customers to meet obligations. With dynamic pricing, there is no commitment to respond at a given point in time and therefore the expected response is uncertain and not necessarily verified. Furthermore, predicting dynamic pricing responses to a signal requires using voluntary information provided by customers or applying expectations about customer behavior, such as forecasted price elasticity, to estimate likely responses.

Ultimately, better understanding the nature of demand response resources and their impact on market dynamics can enable power systems to fully harness the value of these resources.

A further characterization of a dynamic pricing resource is a self-optimizing customer (SOC). Such customers can make use of distributed energy resources and controls to manage their demand. Program payments or time-varying prices provide an incentive for such customers to optimize their demand for financial benefit. For example, a self-optimizing customer might schedule its resources to minimize consumption during periods where it expects energy prices to be high and to maximize consumption during periods

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