Quantifying the Benefits of Imperfect Demand Response

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Abstract

Decarbonizing the electricity sector requires a massive shift away from fossil-fired generation, towards a diverse suite of newer technologies. Demand response (DR) is one of these promising technologies. It encompasses a range of techniques that adjust demand levels in response to system conditions. It could make the grid more flexible and reduce peaks in demand, potentially helping integrate renewables and operate the grid more efficiently. DR can have operating characteristics that differ from those of traditional generators. To realize the potential value of DR to a decarbonizing grid, we must understand how these unique properties affect its system-wide value. This study contributes to our understanding by characterizing the relative value of different possible properties of DR, so that market participants can focus their efforts on the most useful types of DR resources. We use a two-stage stochastic unit-commitment model, with ERCOT as our test system. Features examined include advance notification requirements, restrictions on when DR is available, the number of startups, the number of hours of operation, and the amount of energy shed. Results suggest that inexpensive DR that requires advance notification may still be quite valuable to the grid, and these limitations affect the value of DR less than other usage restrictions. Availability for early afternoon ramps and peaks is key for realizing reductions in system costs and ramp rates among thermal generation, and may be more important than the ability to respond to the real time market. The understanding gained from this study can guide the development of new DR products that provide higher system-wide value and better consumer satisfaction.