What Duality Theory Says About Giving Market Operators the Authority to Dispatch Energy Storage

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Overview

Policymakers, industry participants, and other stakeholders are showing increased interest in integrating energy storage into electricity systems. This energy-storage development raises questions of how markets should be designed or modified to allow energy storage to provide electricity-system services. As an example, Federal Energy Regulatory Commission (FERC) Order 841 requires all FERC-jurisdictional market operators to develop models for energy storage to compete equitably with other resources in their markets for the provision of energy, ancillary services, and capacity.

A fundamental question that underlies any market reforms to this end is the role of the market operator in making binding decisions regarding the operation of energy storage. Some stakeholders raise concerns that market operators making such decisions may threaten their independence by impacting competing resources and price formation. Indeed, such a concern is highlighted explicitly by FERC and a number of pertinent stakeholders in some cases involving proposed energy-storage projects. As such, some stakeholders advocate a market-participation model whereby energy storage self-schedules its charging and discharging or relies upon price-responsive offers to "guide" its dispatch in the spot market.

Methods

We conduct a detailed analysis of the impacts of giving market operators the authority to dispatch energy storage. Using duality theory, we are able to assess the short- and long-run efficiency, incentive-compatibility, and other properties of giving market operators operational control of energy storage.

Results

We demonstrate that such a market-participation model has desirable short- and long-run properties. In the short run, the market dispatch is efficient, insomuch as the market operator uses energy storage to minimize intertemporal price differences. Market-clearing prices are dispatch-supporting and incentive-compatible, in the sense that the energy storage is incentivized to follow the market operator's dispatch. In the long run, marginal energy-storage rent equals marginal energy-storage-investment cost if energy-storage investments are socially optimal. This result means that energy prices provide the correct incentives to private third parties for socially desirable energy-storage investment.

Conclusions

Overall, our results show that concerns surrounding giving market operators operational authority over energy storage are misplaced. We do not advocate for such a market design. Rather, the goal of our work is to dispel notions regarding the design of market-participation models for energy storage. As such, our work broadens the set of market designs that are available to regulators and policymakers. Our findings and the debate surrounding the role of the market operator in determining energy-storage operations are analogous to similar discussions during the 1990s surrounding the use of transmission networks and the roles of market operators therein.

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