MIT Center for Energy and Environmental Policy Research

WP-2022-007
Research Brief

Electricity Sector Policy Reforms to Support Efficient Decarbonization

Howard K. Gruenspecht, Hannes Pfeifenberger, Paul L. Joskow, and Richard Schmalensee

In future decarbonized electric power systems, wind and solar generation will be much more important. However, the outputs of wind and solar generators are intermittent. Storage technologies can play an important role in maintaining system reliability and controlling system costs in the face of generation intermittency. We consider how alternative regulatory rules and policy regimes will affect storage's ability to contribute to reliable, cost-effective, and equitable power system and economy-wide decarbonization. We conclude that future decarbonized power systems will render today's governance arrangements increasingly inadequate. We recommend steps that policymakers can take to meet this challenge. Effective governance of future decarbonized power systems will require development and deployment of new tools as well as reform of rules and regulations.

In future decarbonized power systems, wind and solar generation will be much more important than today. Wind and solar generators, often collectively labeled VRE (variable renewable energy), are intermittent: their output is both variable and imperfectly predictable because it is primarily determined by variations in wind and solar resource availability rather than by system operators' decisions to balance supply and demand by moving up and down a reasonably stable bid-based or marginal-cost-based economic dispatch curve as demand varies (the way system operators now manage output from mostly fossil-fuel generation resources). As a consequence, future systems will need to cope with unprecedented supply fluctuations to balance supply and demand reliably. Energy storage will play an important role in balancing supply and demand reliably in systems with high VRE penetration by filling the gaps between exogenous variations in VRE supply and demand.

Because of the key role storage can play in balancing supply and demand and thus maintaining reliability in systems with high VRE penetration, and because of substantial projected declines in the costs of storage technologies, storage should be much more important in future decarbonized power systems and play a larger variety of roles than it does today. The methods used by today's system operators and the associated regulatory rules and policy regimes that constrain them were developed for power systems that relied primarily on dispatchable generators and in which storage was of negligible importance. Investing in and operating storage so that it effectively plays appropriate roles in future decarbonized power systems will pose novel operational and financing challenges. It will also pose challenges in terms of regulation and market design.

We find that two features of efficient, decarbonized systems will have particularly important implications for the design of markets and governance institutions. The first is a very different distribution of wholesale spot prices with many hours of very low prices, along with a few hours of very high prices. The second is that storage, both grid-scale and at customer premises, is a potential substitute for, or complement to, essentially all other elements of the power system.

State regulators should develop rules that allow owners of storage (and generation) assets installed on customer premises to sell services to the vertically integrated utilities within whose geographic footprint they are located under

appropriate terms and conditions that facilitate efficient investment in and use of "behind-the-meter" generation and storage.

Market rules will need to be developed to adapt capacity mechanisms for the "effective load carrying capability" of VRE generation and to correctly determine the capacity value that storage resources can provide to meet reliability standards. ISOs should either (1) redesign existing capacity mechanisms as they apply to VRE generation and storage, taking into account the joint stochastic properties of VRE generation and demand and the fact that storage is energy-limited, or (2) replace those capacity mechanisms with an increased reliance on integrated resource planning that properly accounts for these factors.

Storage can provide benefits for transmission and distribution systems that can be particularly important in rapidly growing systems. To efficiently realize these benefits, federal regulators should integrate storage into transmission planning processes, while state regulators should require the integration of storage in distribution system planning. In addition, storage devices should be allowed to provide wholesale power market services where physically possible.

In terms of retail rates, the best approach to ideal, efficient, and equitable retail rate design is not obvious at this point, though it is clear that overall reliance on uniform volumetric charges must be reduced, and it is likely that a larger fraction of revenues must be raised by charges that do not vary with current consumption. Significant additional research is called for. The U.S. Department of Energy (DOE), in cooperation with state regulators, should increase support for independent work aimed at (1) devising efficient and equitable retail rate designs for high-VRE systems with storage and (2) encouraging their widespread adoption. Even if there is consensus in the research community about the best retail rate designs, it will be largely up to state regulators to implement the necessary reforms. Some customers will benefit from retail rate design changes while others will see higher costs. Retail competition in some states adds a further layer of regulatory complexity. Efficient mechanisms to reduce any adverse distributional impacts should be given serious consideration.

We recommend that state and federal regulatory agencies receive increased staffing and budgets to enhance their capabilities to design and implement regulatory mechanisms that can guide the transition to efficient high-VRE systems with storage. Devising state and federal rules that are both efficient and aligned will not be simple, but it will be essential for the high-VRE systems of the future. The Federal Energy Regulatory Commission (FERC), state regulators, and ISOs should reform and align market rules to enable efficient participation—in wholesale energy and ancillary service markets, as well as in capacity markets—by providers of both grid-based storage and distribution-level generation and storage (including from facilities located on customer premises). These reformed rules should accommodate the participation of aggregators in wholesale markets.

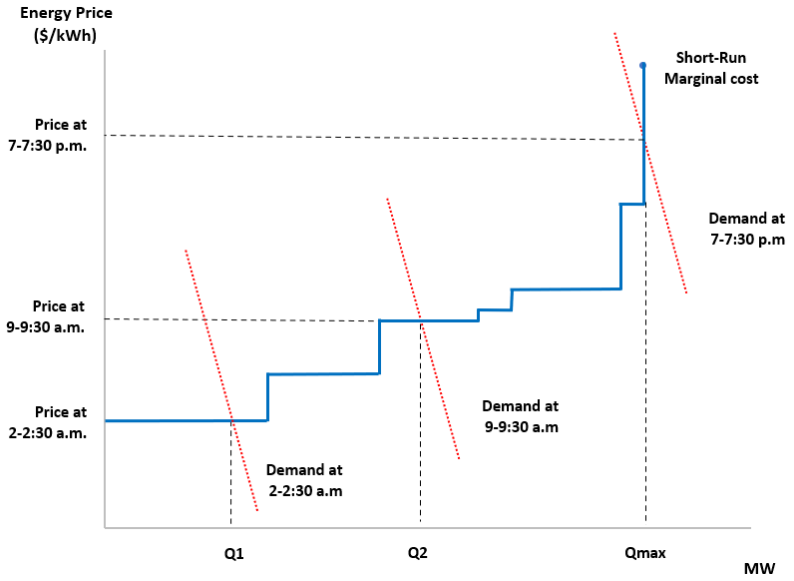


Figure 1. A contemporary electricity market in the short run.

In today's competitive electricity markets, wholesale prices reflect generators' marginal costs of producing electricity at each potential level of demand. In short, the economic dispatch curve is upward sloping and reasonably stable

ceepr.mit.edu

About the Center for Energy and Environmental Policy Research (CEEPR)

Since 1977, CEEPR has been a focal point for research on energy and environmental policy at MIT. CEEPR promotes rigorous, objective research for improved decision making in government and the prinvate sector, and secures the relevance of its work through close cooperation with industry partners from around the globe. CEEPR is jointly sponsored at MIT by the MIT Energy Initiative (MITEI), the Department of Economics, and the Sloan School of Management.

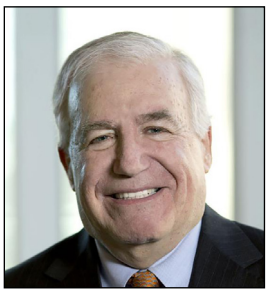
References

Gruenspecht, H., J. Pfeifenberger, P. Joskow, and R. Schmalensee (2022), "Electricity Sector Policy Reforms to Support Efficient Decarbonization," MIT CEEPR Working Paper 2022-007, April 2022.

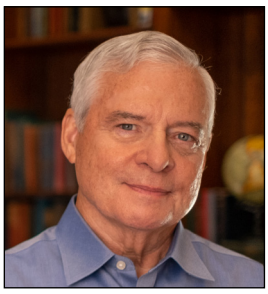
About the Authors

Howard Gruenspecht recently joined Massachusetts Institute of Technology's (MIT) Energy Initiative as a senior energy economist. From 2003 through August 2017, he was deputy administrator of the U.S. Energy Information Administration, the statistical and analytical agency within the U.S. Department of Energy (DOE). As the agency's senior career official he was responsible for directing its energy data and analysis programs. From 1991 to 2000, Howard served DOE's Office of Policy in key leadership positions, including deputy assistant secretary for economic and environmental policy. His accomplishments at DOE were recognized with two Distinguished Presidential Rank Awards, the highest honor conferred on a career senior executive, first by President Bill Clinton and later by President George W. Bush. Howard received his B.A. from McGill University in 1975 and his Ph.D. in economics from Yale University in 1982.

Hannes Pfeifenberger is an economist with a background in electrical engineering and over 25 years of experience in the areas of electricity markets, regulation, and finance. Johannes specializes in electricity market design and energy policies, transmission pricing and cost-benefit analyses, analysis and mitigation of market power, strategy and planning, storage and generation asset valuation, ratemaking and incentive regulation, contract disputes and commercial damage. Mr. Pfeifenberger is a Senior Fellow at Boston University's Institute of Sustainable Energy (BU-ISE) and a Visiting Scholar at MIT's Center for Energy and Environmental Policy Research (CEEPR).



Paul Joskow is the Elizabeth and James Killian Professor of Economics at the Massachusetts Institute of Technology (MIT) and President emeritus of the Alfred P. Sloan Foundation. Joskow has been on the MIT faculty since 1972, where he was the head of the MIT Department of Economics from 1994 to 1998 and director of the MIT Center for Energy and Environmental Policy Research from 1999 to 2007. Joskow became president of the Sloan Foundation in 2008 and returned to MIT in 2018. At MIT his teaching and research areas include industrial organization, energy and environmental economics, competition policy, and government regulation of industry. He has served on the boards of the New England Electric System, National Grid PLC, TC Energy, State Farm Indemnity, Exelon Corporation (current), Putnam Mutual Funds (current), and the Whitehead Institute for Biomedical Research.



Richard Schmalensee served as the John C Head III Dean of the MIT Sloan School of Management from 1998 through 2007. He was a member of the President's Council of Economic Advisers from 1989 through 1991 and served for 12 years as Director of the MIT Center for Energy and Environmental Policy Research. Professor Schmalensee is the author or coauthor of 11 books and more than 120 published articles, and he is co-editor of volumes 1 and 2 of the Handbook of Industrial Organization. His research has centered on industrial organization economics and its application to managerial and public policy issues, with particular emphasis on antitrust, regulatory, energy, and environmental policies. He has served as a consultant to the U.S. Federal Trade Commission, the U.S. Department of Justice, and numerous private corporations.

About the Center for Energy and Environmental Policy Research (CEEPR)

Since 1977, CEEPR has been a focal point for research on energy and environmental policy at MIT. CEEPR promotes rigorous, objective research for improved decision making in government and the prinvate sector, and secures the relevance of its work through close cooperation with industry partners from around the globe. CEEPR is jointly sponsored at MIT by the MIT Energy Initiative (MITEI), the Department of Economics, and the Sloan School of Management.