No. 14-840

In the Supreme Court of the United States

FEDERAL ENERGY REGULATORY COMMISSION,
PETITIONER

v.

ELECTRIC POWER SUPPLY ASSOCIATION, ET. AL.

ON WRIT OF CERTIORARI
TO THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

BRIEF OF GRID ENGINEERS AND EXPERTS AS AMICI CURIAE IN SUPPORT OF NEITHER PARTY

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Amici curiae, in their individual capacities, respectfully submit this brief in support of neither party.[1]

INTEREST OF AMICI CURIAE

Amici are engineers who are nationally recognized experts regarding the operation of the electric grid. They collectively have nearly 200 years of experience helping to manage and study the U.S. electric grid. Amici also research, publish, and teach courses on the grid.

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[1] All parties have consented to the filing of this amicus curiae brief. No counsel for any party authored this brief in whole or in part, and no person or entity, other than amici curiae or their counsel made a monetary contribution intended to fund the preparation or submission of this brief.

Amicus curiae David W. Hilt is the president and owner of Grid Reliability Consulting, LLC. He has nearly forty years of experience in electric power system engineering, operation, and regulatory activities, and has been a manager responsible for the design, specification, and construction of electric substations from distribution to EHV including protective relaying. He has also managed transmission and resource planning activities for a major Midwestern electric and natural gas utility. Mr. Hilt has directed the development and installation of state estimation and OASIS systems for a Midwestern Reliability Coordination Center. As a Vice President at NERC, he led the development of the compliance monitoring and enforcement program for the bulk-power system reliability standards in North America, working closely with the industry, FERC, and Canadian regulatory authorities. While at NERC, he led the investigation of the August 2003 blackout in the Northeastern United States and Canada, providing technical input to the U.S.-Canada Power System Outage Task Force report. Mr. Hilt's recent experience includes assessment of risk from physical attack and grid resiliency.

Amicus curiae Brendan Kirby is a private consultant with numerous clients including the Hawaii PUC, National Renewable Energy Laboratory, EPRI, AWEA, Oak Ridge National Laboratory, and others. He served on the NERC Standards Committee and is currently on the NERC Essential Reliability Services Task Force. He retired from the Oak Ridge National Laboratory's Power Systems Research Program. He has 40 years of electric utility experience and has published over 180 papers, articles, book chapters, and reports on ancillary services, wind integration, restructuring, the use of demand response as a bulk system reliability resource, and power system reliability. He has a patent for responsive loads providing real-power regulation and is the author of a NERC certified course on Introduction to Bulk Power Systems: Physics / Economics / Regulatory Policy. Mr. Kirby is a licensed Professional Engineer with a M.S. degree in Electrical Engineering (Power Option) from Carnegie-Mellon University and a B.S. in Electrical Engineering from Lehigh University.

Amicus curiae Kenneth J. Lutz has had decades of experience in energy, telecommunications, and public policy. He has developed and is teaching a new course on the smart grid at the University of Delaware, where he is an adjunct professor. For the past two years he served as the faculty-member-in-residence for the Washington Internship for Students of Engineering (WISE) in Washington, DC. In 2009 Dr. Lutz was an IEEE/AAAS Congressional Fellow for United States Senator Ron Wyden, where he was instrumental in writing federal legislation for renewable energy and energy efficiency. He then founded AMR Strategies, LLC, to help utilities modernize their grids, with smart grid technologies, renewable energy sources, energy storage, and other technological improvements. Prior to his fellowship, Dr. Lutz was a Distinguished Member of the Technical Staff at Telcordia Technologies (formerly Bell Communications Research) and at Bell Telephone Laboratories. He has a Ph.D. in electrical engineering from the Johns Hopkins University and a B.E.E. from the University of Delaware.

Amicus curiae Harvey Michaels is a lecturer and research scientist with ties to the MIT Sloan School of Management and the interdisciplinary MIT Energy Initiative, related to energy efficiency and demand management with a focus on strategy innovation. He joined MIT in 2008, following a career as a leading practitioner in the field. As Director of the MIT Energy Efficiency Strategy Project, he led business and policy studies of utility, community, and smart-grid enabled efficiency and deployment models, and was a member of the faculty team for the MIT Energy Initiative *Future of the Electric Grid Study* in 2012, as well as the MIT Industrial Performance Center's Energy Innovation Study in 2011. He currently participates in the MIT Center for Energy and Environmental Policy Research and the Center for Collective Intelligence and consults in cities including Boston and Cambridge, as well as for Massachusetts utilities on community energy and climate action. From 1997 to 2007, Mr. Michaels was chairman and CEO of Nexus Energy Software (now Aclara Software) which develops utility energy data analytic solutions. Before founding Nexus, Harvey was President of XENERGY (now part of DNV/KEMA Consulting and Con Edison Solutions), which specialized in efficiency resource studies and systems.

Amicus curiae Brian Parsons worked as an engineer and manager at the National Renewable Energy Lab, and its predecessor, the Solar Energy Research Institute, for over 30 years. His work included renewable power technology development, systems analysis, and variable renewable electrical grid integration topics. He led the Transmission and Grid Integration Group at NREL from its formation in 2007 until early

2013. During that time, his team led ground breaking, high renewable penetration, grid operational analyses including the Western Wind and Solar Integration studies. Since retiring from NREL, Mr. Parsons has been consulting to NREL and various organizations on various aspects of grid integration of renewables, both domestically and internationally. Mr. Parsons is also a Director of the Western Grid Group. Mr. Parsons has been a long-time participant and advisor to the Utility Variable-Generation Integration Group (formerly the Utility Wind Integration Group), and has served as a technical reviewer for numerous utility-sponsored renewable grid studies. He has presented on wind and grid integration issues to regulators, elected officials, power engineers, and other stakeholders throughout the U.S. and internationally.

Amici believe their experience with and knowledge of the electric grid may assist the Court as it considers the issues in this case. In particular, they believe the opinion of the court below reflects some misunderstandings of how the U.S. electric grid actually operates, as well as of the role that demand response resources play in the grid. And they believe that proper and effective regulation of the wholesale markets, including of demand response resources participating in those markets, will enable grid operators to fulfill their responsibilities of providing reliable and cost-effective electricity to the country.

INTRODUCTION AND SUMMARY

Amici, as experts in the operations of the electric grid, have significant experience in the way that the electric grid operates to provide reliable and cost-effective electricity to the United States. Amici are not lawyers or economists, and take no position on the specific questions at issue in this case related to FERC's jurisdiction and Order 745. Nonetheless, amici have significant interests in the effective functioning of the electricity grid and markets. Demand response resources play an increasingly important role in ensuring the reliable and cost-effective availability of electricity. Demand response resources can be as helpful as generation of additional supply in maintaining the reliability of the grid, and may, in fact, offer advantages over generation under certain circumstances. And they can be drawn on at peak times to reduce the overall cost of electricity. Ensuring that demand response resources can be drawn on (or dispatched) in the wholesale energy markets and ancillary services markets (defined below) thus allows grid engineers and operators to effectively fulfill their responsibilities. In this brief, amici make four points about the function of the electric grid and the role of demand response resources.

First, the physical properties of electricity and the geography of the U.S. electric grid require grid operators to instantaneously and continuously balance the "generation" (*i.e.*, supply) of electricity with "load" (*i.e.*, demand)—in ways that are at once interconnected across large regions, but also responsive to local needs.

Second, as grid operators balance generation and load on the grid, demand response resources are in many ways fungible with generation resources: purchasing demand response resources can, in many circumstances, fulfill the same purpose as purchasing additional generation resources.

Third, demand response resources can in some circumstances provide advantages over generation resources in facilitating grid operators' mission of maintaining a reliable flow of electricity. Not only do they provide an additional flexible tool, but because they can be quickly activated—including in specific locations where needed—they can substantially help achieve balance on the grid and thus avoid service disruptions.

Fourth, demand response resources directly affect prices in the wholesale energy and ancillary services markets. The algorithms that grid operators use to collect bids on and dispatch electricity look for the lowest price available (given reliability constraints). At times the price of purchasing demand response will be lower than the price of purchasing additional generation. Moreover, the economics of the energy market cannot be disconnected from the reliability factors involved in balancing the grid and maintaining reliable operation of the grid. The pricing system takes into account reliability factors, so that grid operations and energy markets (including their reliance on demand response resources) are inherently intertwined with each other. Also, by reducing demand on the grid, demand response resources can potentially lessen the need for additional transmission system upgrades, providing further cost efficiencies.

In all of these ways, demand response resources are not at all like "steel, fuel, and labor." Compare *Electric Power Supply Ass'n* v. *FERC*, 753 F.3d 216, 221 (D.C. Cir. 2014). Grid operators cannot call on steel or labor to balance the load overall, or to enhance the reliability of a particular sector of the grid. The algorithms that grid operators use to balance load and determine the lowest available price cannot accept bids for additional steel or additional labor. From the perspective of grid operators, it is quite helpful to regulate the energy markets in a manner that accounts for the availability and effect of dispatchable demand response resources—something that cannot be said for those other commodities.

ARGUMENT

I. ENGINEERS PLAN AND OPERATE THE GRID TO BALANCE GENERATION AND LOAD AND ENSURE RELIABLE AND COST-EFFECTIVE ELECTRICITY

The electric power system in the U.S. is comprised of three independently synchronized grids: the Eastern Interconnection, the Western Interconnection, and the Electric Reliability Council of Texas. *New York* v. *FERC*, 535 U.S. 1, 31 n.4 (2002).[2] Within each of those grids, wholesale electricity markets operate, in which electricity is produced by power-producing entities, or generators, and sold to resellers—typically local distribution companies. They, in turn, sell electricity to end-use customers in the retail electricity market.

Organized wholesale electricity markets cover approximately two thirds of the U.S. electricity load.[3] In areas of the country with organized wholesale electricity markets, the grids are operated by Independent System Operators (ISOs) and Regional Transmission

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[2] See MIT, *The Future of the Electric Grid: An Interdisciplinary MIT Study* 3 (2011), http://mitei.mit.edu/system/files/Electric_Grid_Full_Report.pdf (MIT).

[3] See *id.* at 4.

Organizations (RTOs).[4] ISOs and RTOs also administer the region's electricity market, and provide reliability planning to ensure dependable service. In addition to operating the grids, ISOs and RTOs also function as the financial exchange for energy sales in wholesale energy markets. See Federal Power Act § 201(b), 16 U.S.C. 824(b).[5]

In most of the country, "any electricity that enters the grid immediately becomes a part of a vast pool of energy that is constantly moving in interstate commerce." *New York*, 535 U.S. at 7. Because of the unique nature of electricity, its production and consumption must occur at virtually the same time.[6] Indeed, due to the physics of the flow of electricity and the fact that it cannot be easily stored for later use, it has been dubbed the "ultimate real-time product."

The energy grid must therefore be kept constantly in balance, such that the amount of electricity being generated and dispatched equals the amount being used by consumers at any given time.[7] "On an electricity grid, supply and demand must be balanced continuously to maintain a variety of physical network criteria—like frequency, voltage, and capacity constraints—

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[4] In the remaining areas of the country, the grids are operated by local utilities and balancing authorities.

[5] See Matthew H. Brown & Richard P. Sedano, *Electricity Transmission: A Primer* 67 (June 2004) (Brown & Sedano).

[6] See Eric Hirst, *Real-Time Balancing Operations and Markets: Key to Competitive Wholesale Electricity Markets* 1 (Apr. 2001) (Hirst).

[7] For this reason, grid operators can be fined for failure to balance load and generation within certain limits.

within narrow bounds."[8] If generation and load are not balanced, the grid will fail. More demand than supply leads to disrupted service and blackouts, as does more supply than demand.[9] Reliable, real-time balancing of supply and demand is therefore critical to the operation of the grid.[10]

Grid operators are responsible for achieving the proper balance of supply and demand on the electric grid—within narrow bounds—to ensure system integrity. In particular, grid operators (with the aid of automatic equipment) must react instantaneously in response to changes in consumers' demands for electricity.[11] Effectively the air traffic controllers of the power grid, grid operators work to address reliability issues in real time, reconfiguring the system when a major power line fails to ensure continued access to electricity, ensuring that generators meet reliability standards and transmission lines are not overloaded, and preparing for equipment failures and extreme weather.[12]

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[8] Paul L. Joskow, *Creating a Smarter U.S. Electricity Grid*, 26 J. Econ. Perspectives 29, 33 (2012).

[9] See U.S. Energy Information Administration, *Fewer Wind Curtailments and Negative Power Prices Seen in Texas After Major Grid Expansion* (June 24, 2014), http://www.eia.gov/todayinenergy/detail.cfm?id=16831 (U.S. Energy Info. Admin.); Brown & Sedano 67; Jean-Yves Blanc, et al., *The Benefits of Demand Response for Utilities* 2, 4 (2014).

[10] See William W. Hogan, *Competitive Electricity Market Design: A Wholesale Primer* 3 (Dec. 17, 1998).

[11] See ISO/RTO Council, *The Value of Independent Regional Grid Operators* 11 (Nov. 2005), http://www.nyiso.com/public/webdocs/media_room/press_releases/2005/isortowhitepaper_final11112005.pdf.

[12] See Brown & Sedano 33-34, 53.

The electric grid shares characteristics with a "pool of water," but in some ways too it can act like a series of "water pipes," albeit not in a simplistic way. See *New York*, 535 U.S. at 7 n.5. On the one hand, energy disperses throughout the electric grid, so that adding some in one place and taking it out in another leaves the system in balance. "[A]ny activity on the interstate grid affects the rest of the grid." *Ibid.* On the other hand, the "pool" metaphor does not fully capture the complexity of the grid. *Ibid.* The location and capacity of transmission lines (and related equipment such as transformers and transmission stations that convert voltage from the high levels used for long-distance transmission to the low levels used by consumers) can limit how much energy can be moved from Point A to Point B. As a result, grid operators must balance supply and demand not just on the grid as a whole, but in each location on the grid, accounting for how much transmission inflow and outflow is possible between locations. Grid operators must also maintain system reliability parameters by ensuring that system voltage, limits, and stability are maintained.

In order for grid operators to balance generation and load, they must estimate the demand for electricity and then dispatch resources to meet that demand while maintaining system reliability parameters. Estimating demand enables grid operators to ensure that there are sufficient generation resources ready to produce the needed power in the proper locations.

Generation is matched with load at various time intervals in the energy markets, including the day-ahead and real-time (typically, five- to fifteen-minutes-ahead) markets.[13] (In addition to the wholesale energy markets, there are also "capacity" and "ancillary services" markets. Capacity markets cover time periods "such as a month, season or year," through auctions held "up to three years prior to when the capacity is needed." Ancillary services markets provide for immediate operating reserves necessary to "provide the system operator with control over the real-time generation/load balance."[14]). In the day-ahead market, grid operators forecast the next day's load based on historical usage data, weather forecasts, and current usage data from the real-time market and commit generators to serve that load on a least-cost basis. In the real-time energy market, grid operators dispatch generators based on near-term sophisticated load forecasts that use instantaneously-reported load (as measured and reported by a variety of measuring devices) to provide the most accurate forecast.

Forecasting demand—either in the real-time or day-ahead market—permits grid operators to coordinate generation and transmission and schedule generation to assure that sufficient power (and, to the extent demand rises or generation is lost, back-up power) is available and can be reliably delivered. However, notwithstanding scheduling of generation in day-ahead markets, imbalances "unavoidably occur in real time"

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[13] See Eric Hirst & Brendan Kirby, *Retail-Load Participation in Competitive Electricity Markets* 39 (January 2001).

[14] FERC, *Energy Primer, a Handbook of Energy Market Basics* 67 (July 2012), http://www.ferc.gov/market-oversight/guide/energy-primer.pdf; see Brendan J. Kirby, *Demand Response for Power System Reliability: FAQ* 2-3 (2006), https://esdr.lbl.gov/sites/all/files/dr-for-psr-faq_0.pdf (Kirby).

because of factors such as unexpected generator outages, generators not accurately following schedules, the intermittent nature of certain types of generation, sudden changes in weather conditions, load forecast error, and inevitable short-term load fluctuations.[15]

II. DEMAND RESPONSE RESOURCES ARE IN MANY WAYS FUNGIBLE WITH GENERATION RESOURCES

From the perspective of grid operators, who must balance the grid to maintain a reliable flow of electricity, demand response resources and generation resources serve many similar functions. The traditional form of demand response can be defined as "a reduction in the consumption of electric energy by customers from their expected consumption in response to an increase in the price of electric energy or to incentive payments designed to induce lower consumption of electric energy." 18 C.F.R. 35.28(b)(4).[16] A demand response resource, in turn, is "a resource capable of providing demand response." 18 C.F.R. 35.28(b)(5). Demand response programs can reduce demand by providing payment or other incentives to reduce consumption of electricity. See, *e.g.*, 18 C.F.R. 35.28(b)(4).

In wholesale electricity markets and ancillary services markets, providers of dispatchable demand response often are large industrial or commercial custom-

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[15] See Hirst 1.

[16] With recent advances in technology, the term has evolved to additionally encompass increases in demand called upon to offset gluts in supply. Further, a grid operator may pay for a provider to stand ready to reduce demand very rapidly in response to a system emergency, even if, ultimately, no response is required.

ers, or companies that act as third party "aggregators" of smaller commercial and residential customers.[17] These demand response providers offer this resource by contracting to curtail electricity use during periods of peak demand or high prices by reducing or modifying their operations during such periods (*e.g.*, temporarily cycling off factory equipment used for industrial processes, marginally reducing commercial in-store lighting, or, in the case of residential demand response resources, cycling off water heaters or air conditioners). These entities may also provide second-to-second demand response used by grid operators to fine-tune the balance of the grid on a real-time basis (termed "regulation" in industry parlance). This type of demand response is not predicated on there being peak demand or high prices, but rather is used as an ongoing maintenance mechanism whereby an industrial or commercial provider automatically adjusts its energy consumption up or down based on commands from the grid operator or in direct automated response to imbalances in the grid.

Given the energy-intensive nature of their businesses, curtailment by these large energy consumers can produce substantial reductions in demand. Thus, a large industrial consumer may act in multiple capacities. In one respect, it is a consumer who purchases electricity on the retail market. In another respect, it is a demand response provider in the wholesale market that has the right to bid into the day-ahead and real-

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[17] See Department of Energy, *Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them* 42, n.47 (Feb. 2006) (Department of Energy).

time energy markets when it makes economic sense to do so. In a third respect, it may be a provider of reliability services (*i.e.*, "ancillary services"), either providing real-time response at the grid operators' command to rebalance the grid in the event of an emergency outage, or supplying regulation, meaning the second-to-second balancing of net demand with net supply under the grid operator's automatic control.

For now, the provision of demand response into the *wholesale* markets by smaller commercial and residential electricity consumers is less prevalent.[18] These consumers generally are unable to participate directly in wholesale markets because their individual demand response capabilities are too small to satisfy applicable minimum bidding requirements.[19] Smaller consumers

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[18] See Doug Hurley et al., *Demand Response as a Power System Resource* 11 (May 2013) ("The residential market remains largely untapped for now. Few demand response providers have even approached the residential market to date due to the amount and variety of load available from large customers. However, cost-effective technology to provide small amounts of demand response from a very large number of residential customers is not far away, and may lead to widespread implementation by the end of the decade.").

[19] See Joel B. Eisen, *Who Regulates the Smart Grid? FERC's Authority Over Demand Response Compensation in Wholesale Electricity Markets*, 4 San Diego J. Climate & Energy L. 69, 81 n.67 (2013) ("As an example, the minimum individual or aggregated curtailment that may be bid into the PJM RTO's markets is 100 kW, larger than the amount that could be provided by any single residential customer."); see also PJM Interconnection, L.L.C, Amended and Restated Operating Agreement of PJM Interconnection, L.L.C. ¶ I.5A.10 (2015) ("Aggregation for Economic Load Response Registrations"), http://www.pjm.com/~/media/documents/agreements/oa.ashx.

may therefore consolidate demand response resources through an aggregator, which will often provide the technological capabilities necessary to harness such resources through "smart" technologies (such as programmable thermostats or appliances that turn off at night without the consumer even being aware) that allow consumers automatically to curtail energy consumption in response to price signals.[20] As buildings become "smarter" by incorporating new lights, appliances and thermostats with web-communicating controllers, building owners and residents can provide general instructions via web-based applications to regulate the building's energy consuming devices and appliances. "In addition, these ['smart-grid' communication and control] systems can allow utilities to directly control building loads."[21] These "smart" technologies thus may also be capable of responding (i) directly to grid operator commands and (ii) autonomously to changes in the balance of the grid.[22] Over time, these types of demand response resources may become easier to bundle, facilitating their ability to participate

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[20] See Eisen, 4 San Diego J. Climate & Energy L. at 82 ("Typically, the [aggregator] offers * * * a technological solution designed to manage and control the response to price signals[—*e.g.*,] a program might allow a consumer to set a programmable thermostat to reduce demand of specific devices at given price levels.").

[21] See Harvey Michaels and Kat Donnelly, *Energy Innovation, Architecting the Consumer Side of the Grid for Energy Efficient* 5 (June 2011) (Michaels & Donnelly).

[22] See Paul Centolella, *Next Generation Demand Response: Responsive Demand through Automation and Variable Pricing*, 4-5 (Mar. 2015) (Centolella) (noting that "smart devices can continuously and autonomously optimize the timing of power use.").

(through aggregators) in the wholesale energy markets.[23]

It is true that demand response resources and generation resources differ in some respects. For instance, demand response resources alone cannot power the electric grid, and generation resources will always be required to input new megawatts into the system in order to keep power flowing. See FERC Order 745 ¶ 22.

Nonetheless, from a grid operator's perspective, demand response resources and generation resources are comparable for purposes of balancing supply and demand in wholesale electricity markets over all time scales from cycles to hours. "This balance of supply and demand can be done equally effectively by controlling the load side of the equation."[24] It is no surprise, then, that "numerous commentators" on FERC's Order 745 "address[ed] the physical or functional comparability of demand response and generation, agreeing that an increment of generation is comparable to a decrement of

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[23] See Centolella 3, 4 ("We soon will reach the tipping point when network connected devices in millions of homes and businesses could [change the power system by] efficiently tim[ing] their use of electricity to minimize costs[.] The integration of these devices with power markets and system operations could greatly reduce costs, make the power system more resilient, and facilitate the low cost integration of wind and solar energy."); *see also* MIT 144 (noting that advanced metering technologies and "'smart' energy response and management technologies—such as programmable controllable thermostats and 'smart charging' of electric vehicles— * * * can, in principle, involve even smaller commercial and residential customers in more active management of their electricity consumption and facilitate their responses to price or other supply-side signals.").

[24] Kirby 3.

load for purposes of balancing supply and demand in the day-ahead and real-time energy markets." FERC Order 745 ¶ 20.

The essential fungible nature of generation resources and demand response resources is particularly relevant given the dynamics of how electricity moves through the grid. Operators of wholesale markets benefit from visibility into all potential load-balancing resources across the broad footprint of the grid. That way, when appropriate, they can draw on the least-cost resource, whether it is a generator that produced electricity or a demand response resource that will reduce electricity consumption, to meet the load in each geographic area—regardless of whether this crosses state lines or involves multiple retail distributors.

III. DEMAND RESPONSE RESOURCES ENHANCE THE RELIABILITY OF THE GRID

As explained above, any imbalance between supply and demand ("generation" and "load") on the grid creates reliability issues—described as "security" concerns in the parlance of grid operators. Grid operators historically focused on the supply side of the market to maintain this balance, adjusting supply by increasing or decreasing the deployment of generation resources in specific locations in order to meet demand and maintain system reliability parameters.[25] Balancing the grid by controlling only the generation facilities can be costly and inefficient.[26] Adjusting the outputs of generators

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[25] See, *e.g.*, MIT 145.

[26] See, *e.g.*, Michael Milligan & Brendan Kirby, *Utilizing Load Response for Wind and Solar Integration and Power System Reliability* 2 (June 2010) ("Historically, this control has concentrated

up and down uses excessive amounts of fuel, causes increased wear and tear on generators, and creates additional levels of pollution compared to running generators at a steady rate. It can also take an extended period of time for generation resources to power up. And, the location of generation resources in certain fixed spots can make them less optimal for addressing peak load requirements, transmission system limitations and reliability parameters (such as voltage and system stability) in other places on the grid. (As explained above, although the electric grid is interconnected, it also requires meeting the load at each place along the topography of the grid.)

The availability of demand response addresses these deficiencies, providing additional flexibility that generation alone cannot provide. "[T]he fungibility of demand response and generation output creates greater operational flexibility that, in turn, offers RTOs and ISOs multiple options to solve system issues both in energy and ancillary service markets." See FERC Order 745 ¶ 20 (citing Occidental May 13, 2010 Comments at 11). "[W]hen load can be predicted and controlled in response to price, system reliability and efficiency is increased because the system operator can rely on actively managed load as a resource that can retain system balance." See FERC Order 745, Reply Comments of Viridity Energy, Inc. at 9 (June 18, 2010).

Because of the additional flexibility they provide operators, demand response resources lower the likeli-

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on the generation side, but that is not necessary. Control of energy consumption can be equally effective and often more economic than control of energy supply.").

hood of outages that "impose financial costs and inconvenience on customers."[27] For this reason, demand response has been described as a "safety valve that lessens system pressure[,]" helping to alleviate systemic strain that could otherwise result in service disruptions.[28]

Demand response resources enhance grid reliability not just by providing an additional tool for engineers and operators to draw on, but also because of their unique characteristics. *First*, unlike some generation resources, some demand response resources can be activated and dispatched relatively quickly (with notification of anywhere from seconds to days), to reduce load at critical times such as peak demand periods or "when a generator or a transmission line unexpectedly fails." See FERC Order 719-A, Wholesale Competition in Regions with Organized Electric Markets, 128 FERC ¶ 61,059, 2009 WL 2115220, at *12 & n.76 (July 16, 2009); FERC Order 745-A, 137 FERC ¶ 61,215, 2011 WL 6523756, at *6 ("[S]ystem reliability realizes a benefit because demand response generally can be dispatched by the system operator with a minimal notice period, helping to balance the electric system in the event that an unexpected contingency occurs."). Some types of demand response are "technically superior to generation" for purposes of providing quick-response ancillary services, because they "can curtail consumption faster than generation can increase production."[29] Demand response can therefore reduce load expedi-

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[27] Department of Energy vi.

[28] See Eisen, 4 San Diego J. Climate & Energy L. at 78.

[29] Kirby 8.

tiously, helping to balance the grid and avoid the potential for brownouts or rolling blackouts when demand exceeds forecasts and available supply.[30]

Second, the use of demand response resources can avoid some operational difficulties that can arise from attempting to achieve balance through generation alone. "Factors that can affect grid capabilities include generation and transmission facility outages, line capacities as affected by loading levels and flow direction, and the weather."[31] These types of security constraints are less relevant for demand resources, because reducing load in the proper locations does not present the same operational challenges (*e.g.*, grid congestion) as increasing generation. Demand response thus may be dispatched as a means of alleviating operational issues presented by generation resources.

Third, demand response can enhance the reliability of the grid in another, counter-intuitive way as well. Although demand response is most often thought of as turning off requests to use electricity to avoid high usage peaks that strain generation resources and overload transmission lines, demand response can also involve using additional electricity to bring the grid into balance when there is excess generation. In West Texas, for example, there is so much wind-generated electricity at night that the price of electricity often goes negative. Demand response resources can help allevi-

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[30] See *id.* at x, 8.

[31] FERC, *Security Constrained Economic Dispatch: Definition, Practices, Issues and Recommendations* 6 (2006), http://www.ferc.gov/industries/electric/indusact/joint-boards/final-cong-rpt.pdf (FERC).

ate such situations by increasing demand as needed to offset excess supply, which in turn will help integrate low-cost renewable resources such as wind power into the grid.[32] In fact, because renewable electric generation sources are often highly intermittent—such as solar and wind—integrating these resources into the energy markets benefits from the use of quickly activated demand response resources to balance load.

IV. THE AVAILABILITY OF DEMAND RESPONSE RESOURCES LOWERS RATES FOR WHOLESALE ELECTRICITY

As grid operators and engineers balance supply and demand to achieve stability and a reliable flow of electricity, they also operate markets to provide that electricity in a cost-effective manner. To ensure that end-use customers are supplied with power at the lowest possible price, grid operators dispatch power (to retailers) on a least-cost basis. Through the use of sophisticated and proprietary algorithms and computer systems, ISOs and RTOs coordinate an open bidding process in the wholesale electricity market.

Most simply, generators bid into the market, stating the price at which they are willing to sell electricity during a specified time period. The bids are ranked from lowest to highest, forming what is known as the "bid stack." The ISO or RTO then dispatches the generators, from the lowest to highest bid in the bid stack, until all power demand is met, at which time the mar-

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[32] See U.S. Energy Info. Admin.

ket is said to "clear."[33] The hourly clearing prices also establish the locational marginal prices, or LMPs, that take into account congestion or other limitations on the grid. Market prices must satisfy the Federal Power Act's requirement that rates be just and reasonable. See Federal Power Act § 201(b), 16 U.S.C. 824(b).

The priority rule by which generators are dispatched on a least-cost basis can be departed from to ensure the security and reliability of the grid, *i.e.*, to avoid congestion or other operational problems associated with dispatching the least-cost generator, as described above. This modification—to account for reliability concerns—is often referred to as security-constrained unit commitment and economic dispatch.[34] Hence, grid operators will dispatch lower-cost resources before higher-cost resources unless operational considerations require otherwise.

Grid operators dispatch demand response resources in much the same way as generation resources. Under security-constrained economic dispatch, grid op-

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[33] At the same time, the ISO or RTO also establishes reliability reserves for regulation and contingencies (*i.e.*, ancillary services), and "co-optimizes" the provision of energy and ancillary services as it clears both the energy markets and the ancillary service markets simultaneously.

[34] See generally FERC 5 (endorsing the definition of security-constrained economic dispatch set forth in "Section 1234 of the EPAct 2005: 'the operation of generation facilities to product energy at the lowest cost to reliably serve consumers, recognizing any operational limits of generation and transmission facilities.'"). "Unit commitment" refers to the selection of which generators will be on line each hour, and "economic dispatch" refers to the selection of the power level at which each on-line generator will operate.

erators meet increased load by dispatching the lowest-cost reliable power supply or demand response that is then available.[35] Pursuant to the least-cost basis principle and security-constrained economic dispatch methodology, demand response resources are dispatched when it is operationally expedient and economically efficient to do so. Stated differently, demand response typically will be dispatched when it is "able to displace a generation resource in a manner that serves the [grid operator] in balancing supply and demand" and "is cost-effective." See FERC Order 745 ¶ 48; see also 18 C.F.R. 35.28(g)(1)(v)(A).

As a result, the availability of demand response resources has a direct effect on the wholesale price of energy. See FERC Order 719-A, 2009 WL 2115220, at *12 ("[L]ower demand means a lower wholesale price."). The availability of demand response further directly impacts the wholesale price of energy by virtue of its related effect on the price of ancillary services, because the two are inextricably interdependent. More specifically, adding ancillary service capability from demand response reduces the price of both ancillary services (by providing them in a cost-effective manner) and the price of energy (by freeing up generation resources from providing ancillary services and allowing these resources to dedicate their full capacity to providing energy).

The availability of demand response resources can exert a significant influence on price during periods of peak demand, when the cost of generation is highest,

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[35] See FERC 5.

and the supply curve steepest.[36] See FERC Order 745 ¶ 38. This is because supply bids are organized in ascending order—from lowest to highest—meaning that the higher the demand, the higher the price that will clear the market.[37] When demand is extremely high, the wholesale price can increase exponentially. For instance, in January 2001, wholesale prices in California, which had averaged approximately $27 per megawatt hour, spiked to $450 per megawatt hour.[38] Further, accounting for dispatchable demand response in integrated resource planning for future supply and delivery systems will prevent overbuilding and maintain the lowest prices.[39]

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[36] This salutary influence on wholesale energy prices is not limited to periods of peak demand, however, as demand response can also be used to provide contingency reserves at any demand level, which reduces wholesale energy and ancillary services costs at the same time. Thus, demand response can be used both to "shave" peak demand and to provide ancillary services, both of which contribute to lowering wholesale energy prices.

[37] See Joskow, 26 J. Econ. Perspectives at 33 ("As demand increases, 'dispatchable' generating capacity—first 'base load,' then 'intermediate,' then 'peaking' capacity—with higher and higher marginal operating costs, is called to balance supply and demand.").

[38] See The Electric Energy Market Competition Task Force, *Report to Congress on Competition in Wholesale and Retail Markets for Electric Energy* 28, http://www.ferc.gov/legal/fed-sta/ene-pol-act/epact-final-rpt.pdf.

[39] See Michaels and Donnelly 3 ("Finding ways to enable building energy demands to be more responsive to utility system loads may optimize our utilization of electric system capacity, supporting future growth without as much need for expensive and hard-to-site new facilities.").

Dispatching demand response resources at these peak times can alleviate the need to activate so-called "peaker" generation resources, which are back-up resources reserved for the highest periods of demand. Peaker generators are typically among the most expensive generation resources to operate. Avoiding resort to such maximally expensive generation resources brings wholesale prices down during peak hours. "[L]ower wholesale market prices * * * result because demand response averts the need to use the most costly-to-run power plants during periods of otherwise high demand, driving production costs and prices down for all wholesale electricity purchasers."[40] Indeed, the deployment of "even modest amounts of demand response can lead to significant reductions in wholesale prices at times of capacity constraints."[41] For example, one study found that in five Mid-Atlantic states, a three percent load or demand reduction during the top 100 hours of peak demand would yield net annual economic benefits of approximately $138–$281 million.[42]

The advantages that demand response resources have for maintaining the reliability of the grid also help

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[40] Department of Energy vi.

[41] Steven Braithwait & Ahmad Faruqui, *The Choice Not to Buy: Energy Savings and Policy Alternatives for Demand Response* 48 (Mar. 15, 2001).

[42] See Sam Newell & Frank Felder, *Quantifying Demand Response Benefits in PJM* 4 (Jan. 29, 2007), http://www.brattle.com/system/publications/pdfs/000/004/917/original/Quantifying_Demand_Response_Benefits_in_PJM_Jan_29fits_in_PJM_Jan_29_2007.pdf?1379343092.

them achieve lower prices in the wholesale energy markets. As explained pp. 23-24, *supra*, with respect to generation resources, it is not infrequently necessary to diverge from a pure least-cost basis approach in order to protect the power system from operational problems. In these scenarios, the grid operator may be constrained to dispatch a more costly resource to ensure that load can be met reliably. But that is not necessarily the case for demand response resources, which, when priced appropriately, can be drawn on to achieve a lower overall price while minimizing security constraints.

CONCLUSION

For the foregoing reasons, the availability of demand response resources in the energy markets plays a critical role in the provision of reliable and cost-effective electricity.

Respectfully submitted.

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